

HEATING AND VENTILATING GUIDE

1925–26

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AMERICAN SOCIETY *of* HEATING *and* VENTILATING ENGINEERS GUIDE

1925-26

CONTAINING DESIGN AND SPECIFICATION DATA USEFUL IN THE PLANNING AND CONSTRUCTION OF MODERN HEATING AND VENTILATING INSTALLATIONS—PREPARED FROM THE SOCIETY'S TRANSACTIONS—INVESTIGATIONS OF ITS RESEARCH LABORATORY—AND THE PRACTICE OF ITS MEMBERS

TOGETHER WITH A

MANUFACTURERS' CATALOG DATA SECTION CONTAINING ESSENTIAL AND RELIABLE FACTS CONCERNING MODERN EQUIPMENT

AND A

CONSULTING SERVICE SECTION FOR ENGINEERS

ALSO

THE ROLL OF MEMBERSHIP OF THE SOCIETY

Vol. 4

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FOREWORD

A LARGE amount of time and thought has been contributed to the preparation of this issue of THE GUIDE by a number of the ablest members of the profession.

One of the chief improvements, and one which has only been possible through the generosity of these men, is the putting of a large amount of the highly technical heating and ventilating data, which have been accumulating from the Research Laboratory and other sources during the past decade, into readily usable form, in order that busy Engineers, Architects, Contractors and others, who make use of this book, may find it possible to do so without laborious deductions, or study of a mass of superfluous matter.

A large percentage of heating and ventilating equipment is improperly and inadequately planned and specified and considerable part of the responsibility for this condition is due to attempts, on the part of some of those into whose hands such data falls, in trying to make use of them to cover fields for which they are not properly trained, experienced or fitted.

The success of heating and ventilating equipment does not originate with any, or even with all, of its technical particulars; such as the sizes of boilers, the sizes of pipes, the quantities of radiation, the sizes of fans, ducts, etc., but with the general marshalling and arranging of its affairs and in deciding the proper methods and apparatus to be used.

The data presented for selecting the proper size of boiler do not attempt to supply the means of knowing whether this should be for high or low pressure, of cast iron or steel construction, of water tube or fire tube type, coal or oil fired, etc. In the same way the pipe size tables may be used for determining proper sizes of pipes for heating systems, for fan heaters, or other apparatus, but they are not intended to supply the judgment necessary to determine as to whether or not the heating system, the method of ventilation, or other apparatus and methods contemplated, are proper and adequate for the service intended. These same thoughts apply to the various other data throughout this book and it is hoped that, with these ideas in mind, the widest possible use will be made of these data.

A. S. H. & V. E. GUIDE PUBLICATION COMMITTEE,
PERRY WEST, *Chairman*

CODE *of* ETHICS *for* ENGINEERS

ENGINEERING work has become an increasingly important factor in the progress of civilization and in the welfare of the community. The engineering profession is held responsible for the planning, construction and operation of such work and is entitled to the position and authority which will enable it to discharge this responsibility and to render effective service to humanity.

That the dignity of their chosen profession may be maintained, it is the duty of all engineers to conduct themselves according to the principles of the following Code of Ethics:

1—The engineer will carry on his professional work in a spirit of fairness to employees and contractors, fidelity to clients and employers, loyalty to his country and devotion to high ideals of courtesy and personal honor.

2—He will refrain from associating himself with or allowing the use of his name by an enterprise of questionable character.

3—He will advertise only in a dignified manner, being careful to avoid misleading statements.

4—He will regard as confidential any information obtained by him as to the business affairs and technical methods or processes of a client or employer.

5—He will inform a client or employer of any business connections, interests or affiliations which might influence his judgment or impair the disinterested quality of his services.

6—He will refrain from using any improper or questionable methods of soliciting professional work and will decline to pay or to accept commissions for securing such work.

7—He will accept compensation, financial or otherwise, for a particular service, from one source only, except with the full knowledge and consent of all interested parties.

8—He will not use unfair means to win professional advancement or to injure the chances of another engineer to secure and hold employment.

9—He will cooperate in upbuilding the engineering profession by exchanging general information and experience with his fellow engineers and students of engineering and also by contributing to work of engineering societies, schools of applied science and the technical press.

10—He will interest himself in the public welfare in behalf of which he will be ready to apply his special knowledge, skill and training for the use and benefit of mankind.

PREFACE

IN a continued effort to render greater service to the science of heating and ventilating than ever before special attention is called to the fact that in this, the fourth annual edition of THE GUIDE, the following new and important changes have been made, which it is believed will greatly increase the value of this 1925-26 volume to the largest number of its users.

The DESIGN AND SPECIFICATION DATA SECTION has been made more of a practical interpretation of the various existing scientific heating and ventilating data, including the CODE OF MINIMUM REQUIREMENTS FOR THE HEATING AND VENTILATION OF BUILDINGS developed by L. A. Harding and his fourteen technical sub-committees, so as to present this data in THE GUIDE in the simplest and most accessible form for practical use by Engineers, Architects and Contractors.

The TECHNICAL DESIGN AND SPECIFICATION DATA SECTION has been expanded to cover the general and fundamental data on the various kinds of heating and ventilating systems and the MANUFACTURERS' CATALOG DATA SECTION has been arranged to properly supplement this with the most desirable amplifying and specializing data on specific systems and particular kinds of apparatus. In this section will be found much design and specification data and many layouts and hook-ups to display the various kinds of heating and ventilating systems in use and the proper application, operations and results to be expected of various kinds of apparatus.

In connection with the MANUFACTURERS' CATALOG DATA SECTION a more determined effort has been made to carry out the original idea of having this data as free as possible from all unnecessary selling talk and to present therein only such technical information and instructions concerning each item of apparatus referred to as is of the greatest practical value to both the user and manufacturers, of this apparatus.

While desiring to provide the engineer, architect, contractor, estimator, purchasing agent and draftsman with a complete, convenient and reliable reference data book on modern heating and ventilating practice and equipment, the Guide Publication Committee finds that as progress is made in the industry, changes will be necessary and each GUIDE will represent the best known engineering practice at the time of publication.

As in the case of the first edition issued in 1922, the second edition published in 1923 and the third designated 1924-25, the present GUIDE has extended and simplified much of the technical data. In line with the Council's resolution it has been prepared for publication by Secretary F. C. Houghten under the supervision of Chairman Perry West and the members of the Guide Publication Committee and has been compiled with the idea of assisting the engineer, architect and contractor in designing and producing the most effective installations for heating and ventilating various types of buildings.

Now in this fourth edition a rearrangement of chapters has been made and much new data added and the old data amplified and brought up to date. In the heating section the chapters on Heat Losses from Buildings

and Heating by Radiation have been entirely rewritten. A chapter has been devoted to each of the Systems of Heating and new data has been contributed in each case on steam, hot water, warm air and gas. The chapters on Code for Testing Low Pressure Heating Boilers, Pumps for Heating and Ventilating Service, Oil for Industrial and Domestic Heating have been retained and new chapters on Automatic Heat Control and Insulation have been supplied.

For the Ventilation Section a new introductory chapter outlines the present status of the science while other new chapters include The Hill Synthetic Air Chart, Systems of Ventilation and the Application of Refrigeration to Air Conditioning, the revised chapters are on Temperature, Humidity and Air Motion, Air Washers, Duct Design, Exhaust and Collecting Systems and Ventilators.

In every case the various chapters are the product of one or more specialists, nearly all members of the Society, and revisions have generally been made by the original authors. Publications of the Society, as well as other sources of information, have been drawn upon for some material and credit has been given in each case.

Great care has been taken to maintain a logical arrangement of data in order that it may be most useful. Briefly the points covered are: Consideration of the required system, the figuring of heat losses, choice of proper equipment for heating by steam, hot water or warm-air with various fuels, pipe sizes, insulation and automatic heat control systems; ventilation systems, air conditioning, air washers, duct design, exhaust and collecting systems and other related facts that must be considered in the design and installation of a modern Heating and Ventilating Plant.

The increased size of the Manufacturers' Catalog Data Section, gives engineers, architects and contractors who use THE GUIDE when buying a wider selection of modern equipment and the list of products made by the users of Catalog Data pages affords an accurate Index to the Modern Equipment available. As in the case of both the First, Second and Third editions all Catalog Data have been carefully edited in an effort to eliminate exaggerated statements or claims.

No effort has been spared in compiling data for the improvement of this Fourth Edition of THE GUIDE and the suggestions of its users have been most helpful, in making it the standard reference work in our field, thereby performing a needed and valuable service in the advancement of the science.

THE AMERICAN SOCIETY *of* HEATING *and* VENTILATING ENGINEERS having for its purpose the advancement of the arts and sciences in its fields dedicated this volume to the service of the Industry and hopes that a closer contact between the maker and user of equipment will result in improved service to the country at large.

THE GUIDE for 1925-26, is released with the sincere hope that it will again perform a worth-while service in advancing the ideals of modern Heating and Ventilating.

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AMERICAN SOCIETY *of* HEATING *and* VENTILATING ENGINEERS GUIDE

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PART I

HEATING

IN an effort to establish a more uniform practice in the design of heating systems and the installation of the necessary equipment by engineers, architects and contractors, the Society has undertaken the compilation of the most practical information available on the subject and for this data has drawn upon the experience of its members, the results of its Research Laboratory investigations, reports of its technical committees, the TRANSACTIONS and other reliable sources.

Heating, like any other service, depends largely upon conditions to be met and the quality of service required. The capacity of a heating system is generally based upon the most severe conditions of outside temperatures and wind velocities to be found in a particular locality. Its design should be governed by the character of the building, the purpose to which it is devoted, the period during which it is to be occupied and the reasonable and most practical methods for operating the heating system should be taken into consideration.

Attention is called in this connection to the following:

That the average winter requirements (extending over a period of about 200 days in the colder climates and 150 days in the milder climates) are about 40 per cent, in the colder climates and about 60 per cent in the milder climates, of the requirements generally estimated for the most severe winter conditions, also that these severe conditions exist for just a few days each season. The load factor of a heating system averages from 40 to 60 per cent of the maximum and is considerably below this during a large part of the heating season. Then a heating system designed for maximum conditions will be operating under a comparatively low load factor for the greater part of the time and may be correspondently inefficient and uneconomical, unless properly designed to meet these conditions.

In the smaller plants this is hard to overcome without either having a plant too large for economy or too small to heat up in a reasonable time. This is sometimes attempted by having the normal capacity of steam boilers about 60 per cent of that required for maximum conditions which provides for their average operation at about normal capacity and at corresponding overloads for the maximum conditions. In order to make

this successful the boiler plant must be adapted to operate successfully on at least 50 per cent overload for short periods. In larger plants the boilers may be divided into two or three units, so that one unit may be operated during mild weather, one or two units during average weather and the entire plant during extreme weather which arrangement is ideal for flexibility and economy.

Another important design problem is to bring the building up to its working temperature. This is a general requirement for buildings that are not heated over night, or which are used periodically and not heated during the time that they are not used. Recent tests have indicated that from 10 to 20 per cent more fuel is required for maintaining normal working temperatures in office buildings throughout the 24 hours than is ordinarily required for maintaining working temperatures throughout the day and allowing the heat to be shut off during the time that the building is not in use. It may be assumed that other classes of buildings would show similar results.

In office buildings, factories and other work places, it is not generally considered so necessary to have the temperature up to normal at the beginning of the working period as it is in schools, churches, theatres and other places of assemblage where the occupants are sitting still, and for this reason the relative capacity of the heating system may be less.

In school buildings and other buildings where the heating of the air for ventilation is a large part of the load, this factor may be greatly reduced by recirculating the air during the heating up period, so that while the entire normal average load on the building may be from two to three times as much for heating the air as for supplying the direct radiation the heating-up load for the air may be reduced to from one-half to one-third of its normal value, so that the total load may not be more than twice the direct radiation load.

By continuous recirculation for the ventilation, arranged to vary the amount of air taken in from the outside from 100 per cent at an outside temperature of 55 deg. to 25 per cent at an outside temperature of 0 deg. the boiler capacity required for heating the air may be held practically constant at about 25 per cent of that required for 100 per cent of 0 deg. air from the outside.

The load factor of the average heating plant is such that the total heat required per month will vary according to the following, when measured in percentage of the total heat required for the season:

OCTOBER	NOVEMBER	DECEMBER	JANUARY	FEBRUARY	MARCH	APRIL
7%	12%	17%	20%	18%	16%	10%

CHAPTER I

HEAT LOSSES FROM BUILDINGS

By ARTHUR C. WILLARD[1], Member

THE procedure to be followed in determining the heat loss from any building can be divided into seven consecutive steps, as follows:

1. Determine on the inside air temperature, at the breathing line, which is to be maintained in the building during the coldest weather.

2. Determine on an outside air temperature for design purposes, based on the minimum temperatures recorded in the locality in question, which will provide for all but the most severe conditions. Such conditions as may exist for only a few consecutive hours are readily taken care of by the heat capacity of the building itself.

3. Select or compute the heat transmission coefficients for outside wall and glass, also for floor, or top-floor ceiling, if these are next to unheated space. Include roof if next to heated space.

4. Measure up net outside wall, glass and roof next to heated spaces, as well as any cold floor or ceiling next to unheated space. Such measurements are made from building plans.

5. Compute the heat transmission losses for each kind of wall, glass, floor, ceiling and roof in the building by multiplying the heat transmisison coefficient in each case by the area of the surface in square feet and the temperature difference between the inside and outside air. See paragraphs 1 and 2 above.

6. Select unit values and compute the heat equivalent of the infiltration of cold air taking place around outside doors and windows. These unit values depend on kind or width of crack and wind velocity, and when multiplied by the length of crack and the temperature difference between the inside and outside air, the result expresses the heat required to warm up the cold air leaking into the building per hour.

7. The sum of the heat losses by transmission (paragraph 5) through the outside wall and glass, as well as through any cold floors, ceilings or roof, and the heat equivalent (paragraph 6) of the cold air entering by infiltration is the total heat required for warming any building.

INSIDE TEMPERATURE

The inside air temperature which must be maintained within a building, and which should always be stated in the heating specifications, is understood to be the temperature at the breathing line 5 ft. above the floor and not less than 3 ft. from the outside walls. Inside air temperatures usually specified vary in accordance with the use to which the building is to be put, and Table 1 presents values which are in conformity with good practice.

[1]Professor of Heating and Ventilation and Head of Department of Mechanical Engineering, University of Illinois.

TABLE 1. INSIDE TEMPERATURES USUALLY SPECIFIED

Type of Building	Deg. Temp.		Deg. Temp.
Warm Air Baths	120	Residences	70
Steam Baths	110	Schools	70
Hospital Operating Room	85	Factories	65
Bath Rooms	85	Stores	65
Paint Shops	80	Gymnasium	55 to 60
Hospitals	72 to 75	Machine Shops	60 to 65
Public Buildings	68 to 72	Foundries, Boiler Shops, etc.	50 to 60

In making the actual heat loss computations, however, for the various rooms in a building it is often necessary to modify the temperatures given in Table 1 so that the air temperature at the proper level will be used. By "air temperature at the proper level" is meant, in the case of walls, the air temperature at the mean height between floor and ceiling; in the case of glass, the air temperature at the mean height of the glass, in the case of roof or ceiling, the air temperature at the mean height of the roof or ceiling above the floor of the heated room, and in the case of floors, the air temperature at the floor level. In the case of heated spaces adjacent to unheated (no heat of any kind) spaces, it will usually be sufficient to assume the temperature in such spaces as the mean between the temperature of the inside heated space and the outside air temperature.

The air temperature at the mean height between floor and ceiling is the "breathing line" temperature, Table 1, for rooms not over 10 ft. in height. For rooms above this height, add 2 per cent per foot of height to the breathing-line temperature for each foot or fraction of a foot difference between the mean height of the vertical wall glass roof or ceiling surface, and the height of the breathing line.

In determining mean air temperatures just above floors which are next to ground or unheated spaces, a temperature 5 deg. lower than breathing-line temperature may be used, provided breathing-line temperature is not less than 55 deg. fahr.

OUTSIDE TEMPERATURE

The outside air temperature used in computing the heat loss from a building is seldom taken as the lowest temperature ever recorded in a given locality. Such temperatures are usually of short duration and are rarely repeated in successive years. It is therefore evident that a temperature somewhat higher than the lowest on record may be properly assumed in making the heat loss computations.

The outside temperature to be assumed in the design of any heating system must not be more than 15[1] deg. fahr. above the lowest recorded temperature as reported by the U. S. Weather Bureau (Table 2) during the preceding 10 years for the locality in which the heating system is

[1]There seems to be no agreement in this country at present as to the method of arriving at the proper outside temperature to be used in the calculations or design of a heating system. Some offices use the average of the lowest yearly temperatures for the preceding ten years. The *Heating and Piping Contractors' National Association* in their Code arrive at the assumed outside temperature to be used in the design by including a factor for wind movement as recorded for the locality in question. Thus, of two localities with the same minimum recorded outside temperature, the locality having the higher wind velocity would be assigned a lower outside air temperature for the calculation or design of a heating system than the other locality. However, since the effect of wind movement is actually reflected only in the heat transmission coefficients of wall, roof or glass, and in the inleakage (infiltration) of cold air at the cracks around outside windows and doors, its effect should be applied to the transmission and infiltration coefficients and not to the outside air temperature. In this chapter, the practice of correcting transmission and infiltration coefficients for unusual wind movement is followed and the method discussed in detail.

to be installed. The outside temperature assumed and used in the design should always be stated in the heating specifications.

TABLE 2. CLIMATIC CONDITIONS COMPILED FROM U. S. WEATHER BUREAU RECORDS

Col. A	Col. B	Col. C	Col. D	Col. E	Col. F
State	City	Average Temp., Oct. 1st–May 1st	Lowest Temperature	Average Wind Velocity Dec., Jan., Feb., Miles per Hr.	Direction of Prevailing Wind, Dec., Jan., Feb.
Ala.	Mobile	57.7	−1	8.3	N
	Birmingham	53.9	−10	8.6	N
Ariz.	Phoenix	59.5	16	3.9	E
	Flagstaff	34.9	−25	6.7	SW
Ark.	Fort Smith	49.5	−15	8.0	E
	Little Rock	51.6	−12	9.9	NW
Cal.	San Francisco	54.3	29	.....	N
	Los Angeles	58.6	28	.....	NE
Colo.	Denver	39.3	−29	7.4	S
	Grand Junction	39.2	−16	5.6	SE
Conn.	New Haven	38.0	−14	9.3	N
D. C.	Washington	43.2	−15	7.3	NW
Fla.	Jacksonville	61.9	10	8.2	NE
Ga.	Atlanta	51.4	−8	11.8	NW
	Savannah	58.4	8	8.3	NW
Idaho	Lewiston	42.5	−13	4.7	E
	Pocatello	36.4	−20	9.3	SE
Ill.	Chicago	36.4	−23	17.0	SW
	Springfield	39.9	−24	10.2	NW
Ind.	Indianapolis	40.2	−25	11.8	S
	Evansville	44.1	−15	8.4	S
Iowa	Dubuque	33.9	−32	6.1	NW
	Sioux City	32.1	−35	12.2	NW
Kans.	Concordia	38.9	−25	7.3	N
	Dodge City	40.2	−26	10.4	NW
Ky.	Louisville	45.2	−20	9.3	SW
La.	New Orleans	61.5	7	9.6	N
	Shreveport	56.2	−5	7.7	SE
Me.	Eastport	31.1	−23	13.8	W
	Portland	33.6	−17	10.1	NW
Md.	Baltimore	43.6	−7	7.2	NW
Mass.	Boston	37.6	−13	11.7	W
Mich.	Alpena	29.1	−27	11.3	W
	Detroit	35.4	−24	13.1	SW
	Marquette	27.6	−27	11.4	NW
Minn.	Duluth	25.1	−41	11.1	SW
	Minneapolis	29.6°	−33	11.5	NW
Miss.	Vicksburg	56.0	−1	7.6	SE
Mo.	St. Joseph	43.3	−24	9.1	NW
	St. Louis	43.3	−22	11.8	NW
	Springfield	43.0	−29	11.3	SE
Mont.	Billings	34.7	−49	.....	W
	Havre	27.7	−57	8.7	SW
Nebr.	Lincoln	37.0	−29	10.9	N
	North Platte	34.6	−35	9.0	W
Nev.	Tonopah	39.6	−7	9.9	SE
	Winnemucca	37.9	−28	9.5	NE
N. H.	Concord	33.4	−35	6.0	NW
N. J.	Atlantic City	41.6	−7	10.6	NW
N. Y.	Albany	35.1	−24	7.9	S
	Buffalo	34.7	−14	17.7	W
	New York	40.3	−6	13.3	NW
N. M.	Santa Fe	38.0	−13	7.3	NE

TABLE 2. CLIMATIC CONDITIONS COMPILED FROM U. S. WEATHER BUREAU RECORDS—(Continued)

COL. A	COL. B	COL. C	COL. D	COL. E	COL. F
State	City	Average Temp., Oct. 1st–May 1st	Lowest Temperature	Average Wind Velocity Dec., Jan., Feb., Miles per Hr.	Direction of Prevailing Wind, Dec., Jan., Feb.
N. C.	Raleigh	49.7	−2	7.3	SW
	Wilmington	53.1	5	8.9	SW
N. D.	Bismark	24.5	−45	.....	NW
	Devil's Lake	18.9	−44	11.4	W
Ohio	Cleveland	36.9	−17	14.5	SW
	Columbus	39.9	−20	9.3	SW
Okla.	Oklahoma City	48.0	−17	12.0	N
Ore.	Baker	34.1	−20	6.0	SE
	Portland	45.9	−2	6.5	S
Pa.	Philadelphia	41.9	−6	11.0	NW
	Pittsburgh	40.8	−20	13.7	NW
R. I.	Providence	37.6	−9	14.6	NW
S. C.	Charleston	56.9	7	11.0	N
	Columbia	53.7	−2	8.0	NE
S. D.	Huron	28.1	−43	11.5	NW
	Rapid City	32.3	−34	7.5	W
Tenn.	Knoxville	47.0	−16	6.5	SW
	Memphis	50.9	−9	9.6	NW
Texas	El Paso	53.0	−2	10.5	NW
	Fort Worth	54.7	−8	11.0	NW
	San Antonio	60.7	4	8.2	N
Utah	Modena	38.1	−24	8.9	W
	Salt Lake City	40.0	−20	4.9	SE
Vt.	Burlington	29.3	−27	12.9	S
Va.	Norfolk	49.1	2	9.0	N
	Lynchburg	45.2	−7	5.2	NW
	Richmond	47.4	−3	7.4	S
Wash.	Seattle	45.3	3	9.1	SE
	Spokane	37.5	−30	.....	SW
W. Va.	Elkins	38.8	−21	4.8	W
	Parkersburg	41.9	−27	6.6	S
Wis.	Green Bay	28.6	−36	12.8	SW
	La Crosse	31.2	−43	5.6	NW
	Milwaukee	33.0	−25	11.7	W
Wyo.	Sheridan	31.0	−45	5.3	NW
	Lander	28.9	−36	3.0	NE

If U. S. Weather Bureau reports are not available for the locality in question, then the U. S. Weather Bureau reports for the station nearest to this locality are to be used, unless some other temperature is specifically stated in the specifications.

In computing the *average* heat transmission losses for the heating season the average outside temperature from October 1 to May 1 shall be used. This average temperature is to be that reported by the U. S. Weather Bureau during the preceding 10 years, for the locality in question.

General Statement on Temperatures and Wind Velocity

In order that no misunderstanding may occur, the specifications for all heating systems or plants shall include a clause stating the following:

1. The lowest recorded outside temperature in the locality, as reported by the U. S. Weather Bureau for the preceding 10 years;

2. The outside air and inside breathing-line temperatures which were assumed and actually used in making the heat loss computations;

3. The average wind velocity in miles per hour for December, January and February, and the direction of the prevailing wind during these same months for the locality in which the heating plant is located—both wind velocity and direction are to be taken from the U. S. Weather Bureau records for the preceding 10 years.

HEAT TRANSMISSION COEFFICIENTS

Definition

The amount of heat expressed in B.t.u. which is transmitted in 1 hr. per square foot of the material as used in the building, for a difference in temperature of 1 deg. fahr. between the air on the inside and outside of the building, is called the coefficient of heat transmission for the material. The heat transmission coefficient for any given building material depends on the structure of the material and its density. Heavy or dense materials, the weight of which per cubic foot is high, usually transmit more heat than light or less dense materials, the weight of which per cubic foot is low.

Transmission Coefficients

By means of suitable tests on an actual wall construction, heat transmission coefficients (Table 6) may be determined directly, or they may be computed if certain physical constants are known. If tests are made to determine heat transmission coefficients, the inside and outside air temperatures should correspond with those actually existing in heating practice, and the amount of air movement, both on the inside and outside of the test wall, should be definitely stated in reporting the coefficients. Since actual temperature differences vary widely in different parts of the country, it is desirable to adopt some standard basis for testing, such as 70 deg. inside and 0 deg. outside, and in very precise work make a correction for other temperatures. It has been found that the absolute mean temperature of the wall affects the coefficient materially. The coefficient increases with the absolute mean temperature.

Tests are usually run under still air conditions, which means there was no wind movement, during the test, over the surfaces of the wall. In practice, some wind movement over the exterior surface of the wall should always be allowed for; hence *still air* coefficients cannot be used in actual work as they do not provide for the normal wind movement over the outside of the building in the locality in question during the heating season. Moreover, *still air* transmission coefficients cannot be corrected to provide for moving air conditions by multiplying by a single constant factor, for the reasons set forth under *Effect of Wind on Heat Transmission Coefficients* in Appendix to Section III., Code of Minimum Requirements of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.

The coefficient of heat transmission of various building materials and types of construction as given in Table 6, are for still air and for a wind movement of 15 miles and are generally applicable to heat transmission computations using equation (9). Such heat transmission co-

efficients are always based on the difference between the air temperatures on the inside and the outside of the wall.

Transmission Coefficients by Computation

If heat transmission coefficients are to be computed, and in many, if not most cases, they should be computed, the following analysis of the transmission of heat through a simple, solid wall is used as the basis for such computations.

The diagram in Fig. 1 exhibits four important temperatures: *First* the air temperature t inside of the building; *second*, the temperature t_1 of the inside surface of the wall; *third*, the temperature t_2 of the outside surface of the wall, and *fourth*, the air temperature t_0 outside of the building. Heat reaches or enters the inside surface of the wall by radiation and convection, since the air and objects A within the building are *always*

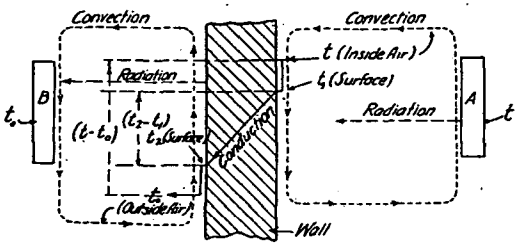


FIG. 1. TEMPERATURE CURVE OR GRADIENT FROM AIR INSIDE TO AND THROUGH WALL TO AIR OUTSIDE, WALL MATERIAL ASSUMED AIR-TIGHT

A represents warm surfaces at temperature t of inside air; *B* represents cold surfaces at temperature t_0 of outside air. For an actual temperature gradient curve see Fig. 2.

warmer than the inside surface of the wall, when the inside air temperature t is greater than the outside air temperature t_0. This heat must then pass through the material of the wall from inside to outside surface by conduction, and is finally given off from the outside surface by radiation and convection, provided, of course, that equilibrium has been established and all four temperatures are constant.

The amount of heat reaching or entering the wall per hour depends on t and t_1 and a coefficient K_1 varying with the character of the wall material. K_1 may be defined as the B.t.u. per hour entering each square foot of wall surface per degree difference between the inside air temperature t and the inside surface temperature t_1. Hence the heat received by inner surface of the wall per hour by both radiation and convection is

$$H_1 = K_1 (t - t_1) S \qquad (1)$$

where S is the inner wall surface area in square feet and the other terms are as heretofore indicated.

Whatever amount of heat H_1 enters the inner wall surface must be given off from the outer wall surface, so that if H_2 represents heat emitted from outer surface

$$H_1 = H_2 = K_2 (t_2 - t_0) S. \qquad (2)$$

Now K_2 may not equal K_1, in which case (t_2-t_0) will not equal $(t-t_1)$. Usually, in an actual wall exposed to wind on the outside, K_2 (Table 5) is greater than K_1 and (t_2-t_0) must be less than $(t-t_1)$. Moreover, the heat H_c passing through the wall by conduction is equal to H_1 and H_2, and if C is the coefficient of conduction = B.t.u. transmitted per hour per square foot of material per 1 in. thickness per degree difference between the surface temperatures, then

$$H_1 = H_2 = H_c = \frac{C}{x} (t_1 - t_2) S \qquad (3)$$

where x = wall thickness in inches.

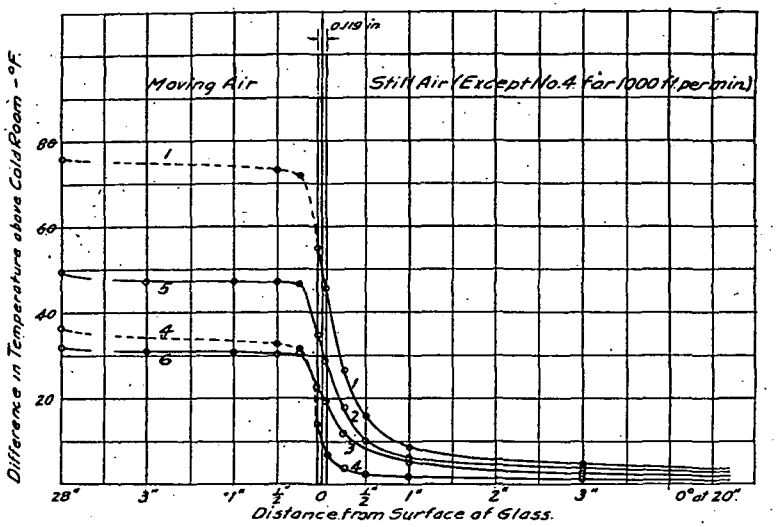


FIG. 2. TEMPERATURE GRADIENT CURVES FOR GLASS (TAKEN FROM BULLETIN NO. 24, ENGRG. EXP. STA., PENNA. STATE COLLEGE)

These equations (1), (2) and (3) are fundamental and are used for determining values for K_1, K_2 and C for actual wall materials by test. They cannot be used for computing heat losses in an actual building, since the surface temperatures t_1 and t_2 are seldom known, although these surface temperatures can be determined in a test by means of thermocouples. Hence, for actual conditions where the only temperatures known are the inside and outside air temperatures t and t_0, it is necessary to use a transmission coefficient U = B.t.u. transmitted per hour per square foot of wall surface per degree difference between the inside and outside air temperatures. Values of U for a limited number of walls are given in Tables 6-12. The heat H transmitted per hour from air inside to air outside is then computed as follows:

$$H = U (t - t_0) S \qquad (4)$$

and since $H = H_1 = H_2 = H_c$, the right hand members of equations (1), (2), (3) and (4) are all equal.

The coefficient U may be determined by test, or it may be computed for any wall provided values for K_1, K_2 and C are known. By proper substitution in the four equations, the unknown temperatures t_1 and t_2 can be eliminated and the value of the transmission coefficient for a simple wall x inches thick is

$$U = \frac{1}{\frac{1}{K_1} + \frac{1}{K_2} + \frac{x}{C}} \qquad (5)$$

and for a compound wall of several materials having thickness in inches of x_1, x_2, x_3, etc., the coefficient is

$$U = \frac{1}{\frac{1}{K_1} + \frac{1}{K_2} + \frac{x_1}{C_1} + \frac{x_2}{C_2} + \frac{x_3}{C_3} + \text{etc.}} \qquad (6)$$

As in the case of the simple wall, K_1 and K_2 are always the inside and outside surface coefficients for the two materials in contact with air. If the air is still (no wind), then for the same material K_1 and K_2 are the same, and $K_1 = K_2$; but if the outside air is in motion then K_2 is always greater than K_1 and will increase as the wind velocity increases. Values for K_1 in still air as determined by various investigators are given in Table 3. Values for C, the conductivity of building materials, are given in Table 4, and are taken from the published values of various investigators. It should be noted that values of C as well as U are dependent on the temperature range, and it is therefore desirable that the investigator determine conductivity values when the wall is subjected to an air temperature of about 70 deg. fahr. on the inside and about zero on the outside.

TABLE 3. SURFACE COEFFICIENTS (K_1) FOR VARIOUS BUILDING MATERIALS UNDER STILL AIR (NO WIND) CONDITIONS

The values in the table are in B.t.u. per sq. ft. of wall surface per hour per 1 deg. fahr. difference between the mean air temperature in the room and the inside surface temperature of the wall.

Building Material	Surface Coefficient K_1 (Still Air) Harding and Willard	Wood
Asbestos (sheet)	1.40	.....
Brickwork (ordinary)	1.40	.....
Cement Plaster (finished)	0.93	.....
Concrete	1.30	.....
Corkboard	1.25	1.20
Glass (window)	1.50	1.90*
Magnesia (blocks)	1.45	.....
Wood (finished surface)	1.40	.....
Building paper	.....	1.40
Average of all values	1.34	.....

*Average of both sides of glass 0.12 in. thick and for 70 deg. fahr. total temperature difference from air to air with moving air on one side. Probable value for still air on both sides 1.60.

TABLE 4. CONDUCTIVITY COEFFICIENTS FOR VARIOUS BUILDING MATERIALS[2]

Building Material	Coefficient of Conductivity C and Weight per Cu. Ft.				
Authority	*Harding and Willard		Peebles**	Norton	U. S. Bur. Standards
	Lb. per Cu. Ft.	C	C	C	C
Asbestos (sheet)	48.3	0.29	.....	.....	.....
Asbestos Board (corrugated)	20.4	0.48	.....	.....	.....
Brickwork	132.0	4.00*	.....	.....	.....
Concrete (Stone 1:2:4 Mix)	140.0	8.30	6.30	6.30	.....
Cinder Concrete	.....	.....	5.20	.....	.....
Cork Board	9.7	0.32	0.30	.....	.....
Magnesia (board)	13.5	0.51	.....	.....	.....
Wood (Fir, ⅛ in. thick)	33.4	1.00	.....	.....	.....
Yellow Pine Sheathing	.....	.....	1.00	.....	.....
Drop Siding	.....	.....	1.10	.....	.....
Pine Plank	.....	.....	.....	1.25	.....
Maple Flooring	.....	.....	1.20	.....	.....
Mortar (lime)	.....	8.00	.....	.....	.....
Oak Door	.....	.....	1.30	.....	.....
Wood Lath and Plaster	.....	.....	1.10	.....	.....
Metal Lath and Plaster	.....	.....	1.25	.....	.....
Gypsum Partition Tile	.....	.....	1.00	.....	.....
Pyrobar (gypsum)	.....	.....	.....	0.83	.....
Gypsum Reinforced Roof Tile	.....	.....	1.20	.....	.....
Insulex (very light gypsum)	.....	.....	0.50	.....	.....
Cabot's Quilt	.....	.....	0.40	.....	.....
Insulite	.....	.....	0.33	.....	.....
Celotex	.....	.....	0.33	.....	.....
Fibrofelt	.....	.....	.....	.....	0.329
Linofelt	.....	.....	.....	.....	0.300
Lith	.....	.....	.....	.....	0.379
Mineral Wool (medium packed)	.....	.....	.....	.....	0.275
Plaster Board	.....	.....	.....	.....	3.040
Porete	.....	.....	.....	.....	0.941
Sawdust (ordinary)	.....	.....	.....	.....	1.040
Shavings (ordinary)	.....	.....	.....	.....	0.707
Cypress (across grain)	.....	.....	.....	.....	0.667
Keystone Hair	.....	.....	0.29	.....	.....
Hair Felt	.....	.....	0.25	.....	.....
Roofing Paper and Pitch	.....	.....	.....	1.382	.....
One thickness building paper	.....	.....	4.20***	.....	.....
One course No. 2 tar felt	.....	.....	3.00***	.....	.....
Cornell Wall Board $\frac{3}{16}$ in. thick	.....	.....	2.50***	.....	.....
Glass (act. glass 91.4% total area)	.....	2.06	.....	.....	.....
Double Glass ½ in. air space (glass 69.3% total area)	.....	1.50***	.....	.....	.....
2 in. Tile, ½ in. plast. both surf.	.....	1.00***	.....	.....	.....
4 in. Tile, ½ in. plast. both surf.	.....	0.60***	.....	.....	.....
6 in. Tile, ½ in. plast. both surf.	.....	0.47***	.....	.....	.....
2 in. Tile, plastered as above and roofing covered	.....	0.84	.....	.....	.....

*For damp or wet brickwork take $C = 5$.
**Flat plate method using a test sample 18 in. square and up to 4 in. in thickness.
***For thickness and construction stated, not per 1 in. of thickness.

The values in the tables are in B.t.u. per square foot of wall surface per hour per inch thickness per 1 deg. fahr. difference between the two surfaces, for thoroughly dry materials. For use where air temperature difference on two sides of wall is about 70 deg. and outside air is near zero.

[2]See Chapter IX by Charles H. Herter of the Report of the Insulation Committee, *A. S. R. E.*, Annual Meeting 1922, Revised to 1924, entitled "Heat Transmission of Insulating Materials," for the most comprehensive collection of heat transmission data relating to building and insulating material which is now in print.

In the case of air space construction, two additional surface coefficients for each air space must be inserted in either equation (5) or (6). These surface coefficients may be taken the same as the K_1 (still air) values for the materials forming the sides of the air spaces; thus for a simple wall with one air space,

$$U = \frac{1}{\frac{1}{K_1} + \frac{1}{K_2} + \frac{1}{K_1} + \frac{1}{K_1} + \frac{x}{C}} \qquad (7)$$

or

$$= \frac{1}{\frac{3}{K_1} + \frac{1}{K_2} + \frac{x}{C}} \qquad (8)$$

With certain very special forms of construction which have irregular air spaces, it is necessary to use the conductivity for the unit construction as actually assembled in the wall. This condition exists when hollow tile is used as furring, in which case $\frac{x_1}{C_1}$ is replaced by $\frac{1}{C_u}$, where C_u is the unit conductivity. See third footnote of Table 4.

TABLE 5. FACTORS TO BE USED IN DETERMINING VALUES OF OUTSIDE SURFACE COEFFICIENTS (K_2) UNDER MOVING AIR CONDITIONS

Wind Velocity in Miles per Hour	Multipliers of K_1*		
	Brickwork	Wood	Average
5	2.38	2.19	2.28
10	3.20	2.71	2.96
15	3.76	2.95	3.36**
20	4.22	3.02	3.62
Additional Values—Smooth Surface			
10	.....	2.20	.....
20	.....	2.60	.....
Above 20	.....	3.00	.....

*Taken from Engineering Experiment Station Bulletin No. 102, of the University of Illinois. Additional values from Engineering Experiment Station, Pennsylvania State College, reported by Professor Wood. Tests at Pennsylvania State College indicate character of surface, rough or smooth, more important than material of surface.

**This is usually taken as 3 even.

In each case factor is based on still air coefficient (K_1) for *same* material. For conditions where wind velocity is not known use the factor (3) or take K_2 as $3K_1$ for same material.

Examples of Computations for Walls

The following examples, Fig. 3, will serve to illustrate the method of computing heat transmission coefficients for building walls, including solid walls (simple and compound) and hollow walls. In these examples it has been assumed that a wind movement of about 15 miles per hour exists on the outside of the wall.

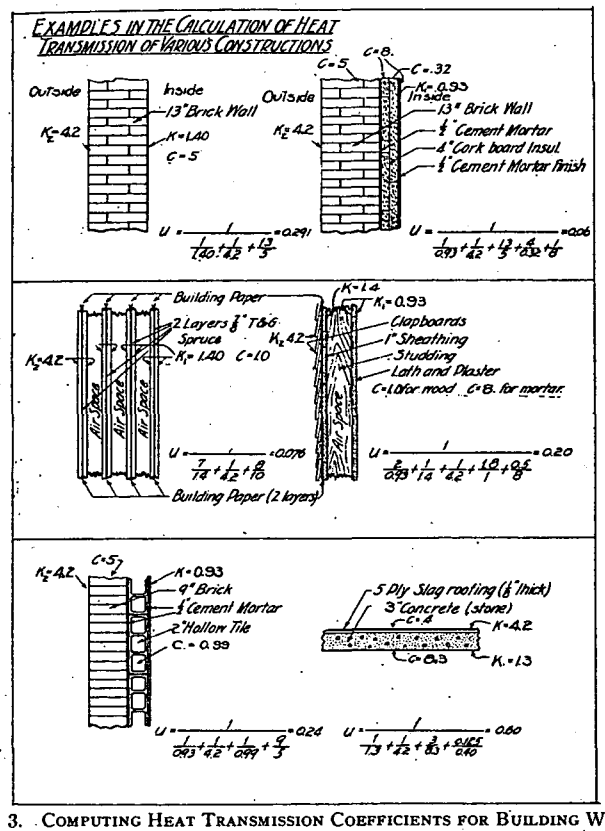


FIG. 3. COMPUTING HEAT TRANSMISSION COEFFICIENTS FOR BUILDING WALLS.

Tables 6 to 12 give transmission constants for a number of types of building construction. These values were determined by computation similar to that shown in Fig. 3, using the values for K and C indicated.

C = conductivity constant for the material. C_{pl}, C_s, C_b etc. conductivity for plaster, stucco, brick etc. C_t4 in. = conductivity constant for the actual (4 in.) thickness of tile. Considerable variation exists in heat transmission constants used by different authorities, which is due in part to the fact that further research work must be done along this line and also to the fact that the same kind of building material may differ widely depending upon the source and treatment of the raw material from which it is made.

Transmission constants are given for both still air and 15 mile wind. For practical purposes, the constants for any other wind velocity may be obtained with a fair degree of accuracy by interpolating between these values. In a table of this kind it is practically impossible to give values for all types of construction in use and the engineer will frequently be required to determine his own values, as in the examples Fig. 3.

Table 6. Heat Transmission from Various Types of Wall Construction

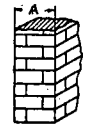
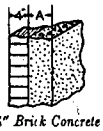
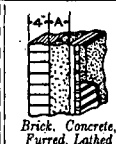
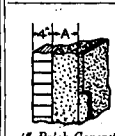
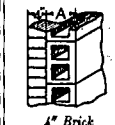
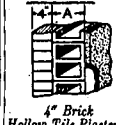
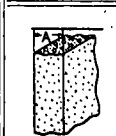
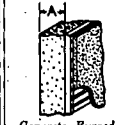
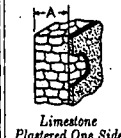
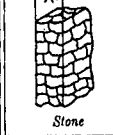
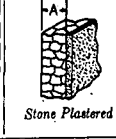
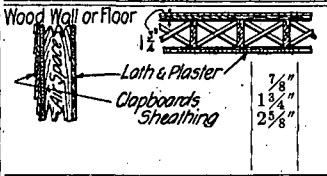
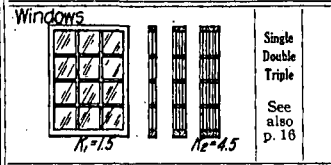
Construction (C = conductivity; K_1 = inside still air; K = air space; K_2 = outside still air; K_3 = outside 15-mi. wind)	Thickness A	B.t.u. Transmitted per Sq. Ft. per Hr. per Deg. Temp. Difference between Air Inside and Air Outside: Still Air	15-mi. wind
 Plain Brick Wall K_1 = 1.40; K_3 = 4.20; C = 5.0	9″	0.31	0.36
	13″	0.25	0.27
	18″	0.20	0.22
	24″	0.16	0.18
 Brick Wall and Air Space, Furred and Plastered K_1 = 0.93; K_3 = 4.2; C_b = 5; K = 1.4; C_{pl} = 8	9″	0.20	0.22
	13″	0.17	0.19
	18″	0.14	0.16
	24″	0.13	0.13
 Brick Plastered One Side K_1 = 0.93; K_2 = 1.40; K_3 = 4.2; C_{pl} = 8; C_b = 5	9″	0.27	0.30
	13″	0.22	0.25
	18″	0.18	0.20
	24″	0.15	0.16
 4″ Brick Concrete K_1 = 1.30; K_2 = 1.40; K_3 = 4.20; C_b = 5; C_c = 8	4″	0.36	0.43
	8″	0.30	0.36
	12″	0.26	0.30
	16″	0.23	0.26
 Brick, Concrete, Furred, Lathed and Plastered K_1 = 0.93; K = 1.3; K_2 = 1.4; K_3 = 4.2; C_b = 5; C_c = 8	4″	0.21	0.23
	8″	0.19	0.21
	12″	0.17	0.19
 4″ Brick Concrete Plastered K_1 = 0.93; K_2 = 1.4; K_3 = 4.2; C_b = 5; C_c & $_{pl}$ = 8	4″	0.32	0.38
	8″	0.27	0.32
	12″	0.24	0.27
 4″ Brick Hollow Tile K_1 = 1.4; K_2 = 1.4; K_3 = 1.3; C_b = 5; $C_t2″$ = 0.99; $C_t4″$ = 0.61; $C_t6″$ = 0.47	2″	0.31	0.36
	4″	0.26	0.30
	6″	0.23	0.26
 4″ Brick Hollow Tile Plastered K_1 = 0.93; K = 1.4; K_3 = 4.2; C_b = 5; C_{pl} = 8; $C_t2″$ = 0.99; $C_t4″$ = 0.61; $C_t6″$ = 0.47	2″	0.27	0.31
	4″	0.23	0.26
	6″	0.21	0.23
 4″ Brick Hollow Tile Furred, Lathed and Plastered K_1 = 0.93; K = 1.4; K_2 = 1.4; K_3 = 4.2; C_b = 5; C_{pl} = 8; $C_t2″$ = 0.99; $C_t4″$ = 0.61; $C_t6″$ = 0.47	2″	0.19	0.21
	4″	0.15	0.19
	6″	0.14	0.17
 Concrete K_1 = 1.3; K_2 = 1.3; K_3 = 3.9; C = 8.0	2″	0.56	0.81
	3″	0.53	0.72
	4″	0.49	0.66
	6″	0.40	0.50
	8″	0.33	0.40
	12″	0.28	0.33
 Concrete, Furred, Lathed and Plastered K_1 = 0.93; K = 1.4; K_2 = 1.3; K_3 = 3.9; C_c & $_{pl}$ = 8	4″	0.26	0.30
	6″	0.24	0.28
	8″	0.23	0.26
	12″	0.20	0.23
	16″	0.19	0.21
 Hollow Tile K_1 = 1.4; K_2 = 1.4; K_3 = 4.2; $C_t4″$ = 0.61; $C_t6″$ = 0.47; $C_t8″$ = 0.32	4″	0.33	0.39
	6″	0.27	0.32
	8″	0.22	0.25

Table 6. Heat Transmission from Various Types of Wall Construction—Continued

Construction (C = conductivity; K_1 = inside still air; K = air space; K_2 = outside still air; K_3 = outside 15-mi. wind)	Thickness A	B.t.u. Transmitted per Sq. Ft. per Hr. per Deg. Temp. Difference between Air Inside and Air Outside: Still Air	15-mi. wind
 Hollow Tile Plastered One Side K_1 = 0.93; K_2 = 1.4; K_3 = 4.2; C_{pl} = 8; $C_t4″$ = 0.61; $C_t6″$ = 0.47; $C_t8″$ = 0.32	4″	0.29	0.33
	6″	0.25	0.29
	8″	0.20	0.23
 Stucco, Hollow Tile Plaster K_1 = 0.93; K_2 = 0.93; K_3 = 2.81; C_s & $_{pl}$ = 8; $C_t4″$ = 0.61; $C_t6″$ = 0.47; $C_t8″$ = 0.32	4″	0.26	0.31
	6″	0.23	0.27
	8″	0.19	0.21
 Stucco, Hollow Tile, Furring, Lath and Plaster K_1 = 0.93; K = 1.4; K_2 = 0.93; K_3 = 2.81; C_s & $_{pl}$ = 8; $C_t4″$ = 0.61; $C_t6″$ = 0.47; $C_t8″$ = 0.32	4″	0.18	0.21
	6″	0.17	0.19
	8″	0.15	0.16
 Limestone or Sandstone	6″		0.90
	8″		0.80
	10″		0.70
	12″		0.65
	16″		0.55
	20″		0.47
	24″		0.39
 Limestone Plastered One Side	4″		0.94
	6″		0.83
	8″		0.70
	10″		0.65
	12″		0.60
	16″		0.50
	20″		0.41
 Limestone, Furred, Lathed and Plastered	4″		0.71
	6″		0.60
	8″		0.53
	10″		0.48
	12″		0.43
	16″		0.36
	20″		0.30
 Stone	4″		0.99
	6″		0.85
	8″		0.70
	10″		0.64
	12″		0.56
	16″		0.49
	20″		0.39
 Stone Plastered	6″		0.79
	8″		0.65
	10″		0.59
	12″		0.51
	16″		0.45
	20″		0.33
 Stone, Furred, Lathed and Plastered	6″		0.56
	8″		0.46
	10″		0.42
	12″		0.39
	16″		0.32
	20″		0.25
	7/8″		0.547
	1 3/4″		0.370
	2 5/8″		0.279
	Single		1.126
	Double		0.450
	Triple		0.281
	See also p. 16		

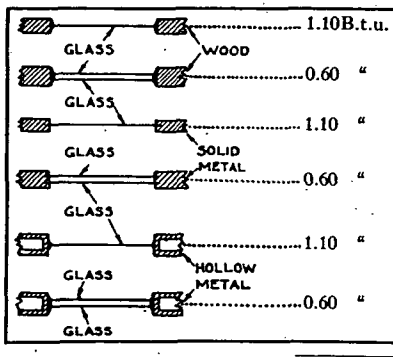
Infiltration Loss—B.t.u. per hour = cu. ft. [leaking in at 70°] × [.075 × .24 × ($t - t_o$)]

p = perimeter of window in feet. B.t.u. loss per hour per degree diff. = $p \times .60 \times 13 \times 0.147 \times .086 \times 0.24$ = 2.4 p for 1/16″ crack — Weather stripped sash = 0.15 p

Note: For this method use perimeters of windows on one side of Carpenter's Rule for calculating heat loss of buildings: [room only B.t.u. per hr. = $(G + 1/4 W + .02NC)(t - t_o)$ W = wall surface; C = cubic contents; G = glass surface; N = number of air changes per hr.

Note.—The volume of air leaking in is measured at a temp. of 70°.

TABLE 6 (Concluded). HEAT TRANSMISSION THROUGH WINDOWS AND SKYLIGHTS



Values given in Table 6 based upon the following authorities:

Reports of the Research Laboratory of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.

Bulletin No. 102, 1917, Engineering Experiment Station, University of Illinois, by A. C. Willard and L. C. Lichty.

Bulletin No. 24, 1918, Engineering Experiment Station, Pennsylvania State College, by R. B. Fehr.

Bulletin No. 30, 1920, Engineering Experiment Station, Pennsylvania State College, by Arthur J. Wood and E. F. Grundhofer.

Bulletin No. 3, 1923, Engineering Experiment Station University of Minnesota, by Frank B. Rowley.

ADDITIONAL COEFFICIENTS FROM ACTUAL TESTS

Based on inside and outside air temperatures with still air on inside and a wind velocity of approximately 15 miles per hr. on outside of walls, glass and roof.

NOTE—For a wind movement other than 15 miles per hr. the value of U must be computed by equations (7) or (8), using the proper value for K_2. See also Tables 3, 4 and 5.

TABLE 7. HEAT TRANSMISSION FOR FLOORS AND CEILINGS

SPECIAL NOTE—Values of U taken from pages 13-16 THE GUIDE 1924-25 appear in Tables 7-12 incl.

ASSUME THE GROUND TEMPERATURE TO BE 50° FAHR. CONSTRUCTION	B.T.U.
4" CONCRETE, GROUND	.31
4" CONCRETE, CINDER FILL, GROUND	.29
1" TILE, 4" CONCRETE, GROUND	.30
2½" BRICK, 4" CONCRETE, GROUND	.29
1½" WOOD FLOOR, WATERPROOFING, 3" CONCRETE, GROUND	.10
1½" WOOD FLOOR, 3" CONCRETE, CINDER FILL, GROUND, SLEEPERS	.07
1½" WOOD FLOOR, 5" CINDER FILL, GROUND, SLEEPERS	.11
1½" WOOD FLOOR, AIR SPACE, GROUND, SLEEPERS	.13

ASSUME TEMPERATURE OF UNHEATED AIR SPACE TO BE 35° FAHR. WITH AN OUTSIDE TEMPERATURE OF 0°. CONSTRUCTION	B.T.U.
Unheated Space, Joists, Lath, Plaster	.60
Floor, Joists, Lath, Plaster	.26
Floor, Joists, Metal Ceiling	.36
1" Floor, Joists	.40
Floor, Paper, Floor, Joists	.21
Floor, 4" Reinforced Concrete	.41
4" Reinforced Concrete	1.00
6" Reinforced Concrete	.86
8" Reinforced Concrete	.71
10" Reinforced Concrete	.56

TABLE 8. HEAT TRANSMISSION FOR ROOFS*

CONSTRUCTION	B.t.u. per Deg. Fahr. Difference 15 mi. per hr. wind
1" Wood, 5-Ply Paper, Tar and Gravel	0.30
1" Wood, Felt Roofing	0.36
1½" Wood, 5-Ply Paper, Tar and Gravel	0.26
2" Wood, 5-Ply Paper, Tar and Gravel	0.21
2½" Wood, 5-Ply Paper, Tar and Gravel	0.18
Tin on Wood Strips	1.60
Tin on Sheathing	0.60
Tin on Sheathing, with Paper	0.43
Shingles on Wood Strips	0.87
Shingles on Sheathing	0.43
Shingles, Paper, Sheathing, Strips	0.21
4" Hollow Tile, Paper, Tar and Gravel	0.30
6" Hollow Tile, Paper, Tar and Gravel	0.27
2" Concrete, Paper, Tar and Gravel	0.71
3" Concrete, Paper, Tar and Gravel	0.64
4" Concrete, Paper, Tar and Gravel	0.57
Flat Tile on Wood Strips	1.07
Flat Tile on Sheathing	0.64
Slate on Wood Strips	1.10
Slate on Paper and Sheathing	0.50
Corrugated Iron on Strips	1.50
Corrugated Iron, Sheathing	0.64

*Additional heat transmission constants B.t.u. per square foot per hour per degree temperature difference between inside air and outside air.

TABLE 9. HEAT TRANSMISSION FOR INTERIOR WALLS

CONSTRUCTION	B.t.u. per Deg. Fahr. Difference 15 mi. per hr. wind
Plaster, Lath, Studs, Lath and Plaster	0.34
Studs, Lath and Plaster	0.60
4" Hollow Tile, Plastered 1 Side	0.57
4" Hollow Tile, Plastered Both Sides	0.50
2" Gypsum Block, Plastered 1 Side	0.64
2" Gypsum Block, Plastered Both Sides	0.60

TABLE 10. HEAT TRANSMISSION FOR WOOD DOORS AND WOOD PARTITIONS

	B.t.u. per Deg. Fahr. Difference 15 mi. per hr. wind
¾" to 1" Thick Tongued and Grooved	= 0.65
1" " 1¼" " " " "	= 0.60
1¼" " 1½" " " " "	= 0.50
1½" " 2" " " " "	= 0.42
2" " 2½" " " " "	= 0.35
2½" " 3" " " " "	= 0.30

TABLE 11. HEAT TRANSMISSION FOR WALLS OF VARIOUS CONSTRUCTIONS

THICKNESS OF BOARD IN IN.	TWO BOARDS WITH PAPER BETWEEN	BOARD AND CORRUGATED IRON	BOARD AND SHEET IRON
	B.t.u. Deg. Fahr. Difference 15 mi. per hr. wind	B.t.u. Deg. Fahr. Difference 15 mi. per hr. wind	B.t.u. Deg. Fahr. Difference 15 mi. per hr. wind
½″	0.32	0.45	0.50
1″	0.24	0.36	0.40
1½″	0.19	0.30	0.33
2″	0.16	0.26	0.28
2½″	0.14	0.23	0.25

TABLE 12. HEAT TRANSMISSION FOR WALLS OF CLAPBOARD

CONSTRUCTION	B.t.u. per Deg. Fahr. Difference 15 mi. per hr. wind
Clapboard on Studs	0.62
Clapboard on Studs, Lath and Plaster	0.48
Clapboard, Paper, Studs, Lath and Plaster	0.34
Clapboard, Studs, 1″ Sheathing	0.57
Clapboard, Sheathing, Studs, Lath and Plaster	0.37
Clapboard, Paper, Sheathing, Studs, Lath and Plaster	0.30
Clapboard, Studs, Brick Fill	0.40
Clapboard, Studs, Brick Fill, Papered	0.36
Clapboard, Studs, Brick Fill, Lath and Plaster	0.31
Clapboard, Sheathing, Studs, Lath and Plaster with Sawdust Fill	0.21
Clapboard, Paper, Sheathing, Studs, Lath and Plaster with Sawdust Fill	0.15

AREAS WHERE HEAT LOSSES OCCUR

Heat is lost from a building by transmission through all of those surfaces which separate heated spaces from the outside air or from unheated colder spaces within the building. In general, five kinds of surfaces are involved: (1) outside walls, (2) outside glass, (3) inside walls or partitions next to unheated spaces, (4) ceilings of upper floors, either below a cold attic space or as the underside of a roof slab, and (5) floors of heated rooms above an unheated space. In most cases, only items (1) and (2), outside wall and glass surface, are considered. Failure to take account of the other heat losing surfaces, items (3), (4) and (5), when they exist in a building, has generally resulted in more or less dissatisfaction with the operation of the heating plant, as a result of failure to heat the rooms having such surfaces as indicated by items (3), (4) and (5).

The net outside wall surface is usually determined by reference to the scale plans and elevations of the building concerned. In some cases of course, the actual building may have to be measured. The total area of all outside openings which are occupied by windows and doors is accurately measured and listed as *glass*. The *glass* area is then deducted from the total outside wall area for each room and the difference is the net wall area. The outside wall areas for any floor should be based on the vertical floor to floor heights and the horizontal distance from center to center of partitions separating different rooms. If there are no partitions, measure from inside face of one wall to inside face of next wall. The areas of walls, ceilings and floors next to cold or unheated spaces are found, of

course, by taking the inside dimensions of such areas, measured on the heated side.

CALCULATIONS FOR HEAT TRANSMISSION LOSSES

The calculations for heat transmission losses are made by multiplying the area S in square feet of wall, glass, roof or floor through which the loss takes place, by the proper coefficient U for such construction (Tables 6 to 12, or by computation as described under Transmission Coefficients by Computation) and by the temperature difference between the inside air temperature t at the proper level (in many cases not the "breathing line") and the outside air temperature t_o. Therefore,

$$H_t = SU\,(t - t_o) \qquad (9)$$

where

H_t = B.t.u. per hr. transmitted through the material of the wall, glass, roof or floor.

S = area in sq. ft. of wall, glass, roof or floor, taken from building plans or actually measured. (Use the net inside or heated surface dimensions in all cases.)

U = coefficient of heat transmission or B.t.u. per hr. per sq. ft. per 1 deg. fahr. difference between the inside and outside air temperature for air conditions such as exist in the given locality in coldest weather.

$(t - t_o)$ = temperature difference between inside and outside air, in which t must always be taken at the proper level. Note that t may not be the "breathing line" temperature in many cases.

For examples showing application of equation (9) to practical examples see *Applications* at the end of this chapter, in which the heat requirements are computed for typical cases.

Wind Movement

The effect of wind on the heating requirements of any building should be given consideration under two heads:

1. Wind movement increases the heat transmission of walls, glass, and roof, affecting poor walls to a much greater extent than good walls.

2. Wind movement materially increases the infiltration (inleakage) of cold air through the cracks around doors and windows, and even through the building materials themselves, if such materials are at all porous.

It is entirely possible that a building may require more heat on a windy day with a moderately low outside temperature, than on a quiet day with a much lower outside temperature. It will therefore be evident that the wind movement in any locality must be given careful consideration in computing the probable heating requirements of a building, and for the purposes of calculation, not less than the average wind movement in any locality during December, January and February should always be provided for in computing (1) the heat transmission of a building, and (2) the heat required to take care of the infiltration of outside air.

The first condition is readily taken care of as already explained, by using a surface coefficient K_2 for the outside wall surface which is based on the proper wind velocity (Table 5). In case specific data are lacking for any locality, use an average wind velocity of approximately 15 miles per hour. In a similar manner, the heat allowance (Table 15) for infiltration (B.t.u. per hour per foot of crack required to raise the temperature

of the air leaking in through one degree) through cracks, must be based on the average wind velocity for a given locality, and is explained in the next subdivision of this chapter.

Wind movement involves both *direction* and *velocity*, and hence after transmission and infiltration losses have been computed, using coefficients which allow for average velocity, a further allowance must be made for the direction of the prevailing wind in any given locality. This shall be done by adding 15 per cent to the wall and glass transmission losses and the infiltration losses on the sides of the building exposed to the prevailing winds. Those walls which lie in the two adjacent sides of the building most nearly facing the prevailing wind are to be considered in making this correction. This is not necessarily the same as adding 15 per cent to the total heat loss of a room on the exposed sides of the building.

INFILTRATION RESULTING FROM WIND MOVEMENT

Reference has already been made to the fact that in addition to the heat transmission of the walls, glass and roof, consideration must always be given to the inleakage of cold outside air which must be heated to room temperature. This inleakage or infiltration is exclusive and independent of air that may be supplied for ventilation through ducts or flues of any sort. Calculation of the heat required for this purpose is a very simple matter if the volume of air leaking into the building per hour is known.

$$H_i = 0.24\ Q\ d\ (t - t_0) \qquad (10)$$

where

H_i = B. t.u. per hour required for heating air leaking into building from outside temperature t_0 to breathing line temperature t;
Q = cubic feet of air entering per hour at breathing line temperature, t.
d = density (lb. per cu. ft.) of air at breathing line temperature, t.
t = breathing line temperature;
t_0 = outside air temperature for which heating system is designed;
0.24 = specific heat of air.

The determination of Q, the amount of air leaking in per hour, may be arrived at in either of two ways: (1) by assuming a certain number of air changes per hour for each room, the number of changes assumed (Table 13) being dependent upon the type, use, and location of room, or (2) by computing the infiltration taking place through the cracks around windows and doors in that side of the room which has the greatest number of feet of such crack. In no case should the amount of crack used for computation be less than half of the total crack in the outside walls of the room. Thus, in a room with one exposed wall, take all the crack; with two exposed walls take the wall having the most crack; and with three or four exposed walls take the wall having the most crack, but in no case take less than half the total crack.

The linear feet of crack for a double hung sash is equal to the sash perimeter plus the meeting rail. For a standard type steel sash constructed of solid rolled sections (Fenestra, Lupton and others) the linear feet of crack consists of the perimeter of the ventilating section plus the linear feet of sash section in contact with steel work as, for example, vertical and horizontal mullion steel. The perimeter of sash properly grouted with cement mortar into brick work or concrete is not to be counted as crack.

Neither of these methods for estimating the infiltration is entirely satisfactory in view of the limited amount of data available, but for the purposes of calculation the second (infiltration) method is to be preferred and then checked against the first (air changes per hour) method. In no case use less than one-half an air change where outside doors and windows exist. The infiltration method based on recent tests by F. C. Houghten and C. C. Schrader, JOURNAL A. S. H. AND V. E., February, 1924; June, 1924; and January, 1925, and others may be conveniently adapted to calculation purposes.

Tables 14 and 15 as well as Figs. 4, 5, and 6 present values from the recent tests by Houghten and Schrader at the Research Laboratory of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS at

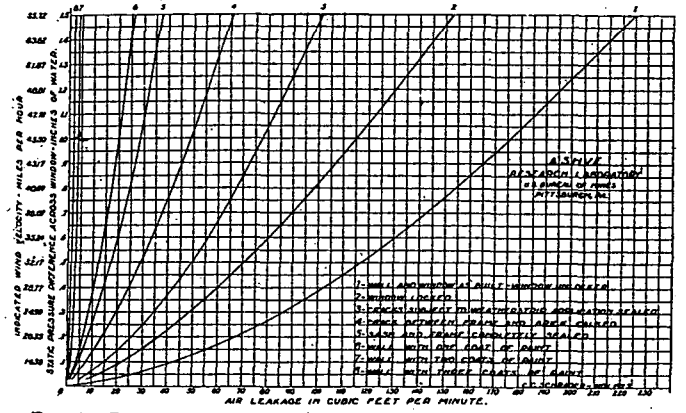


FIG. 4. RESULTS OF TESTS OF LEAKAGE THROUGH VARIOUS PARTS OF WINDOW AND FRAME

Pittsburgh. Table 14 and Fig. 4 based on the February, 1924, JOURNAL, while Table 15 and Figs. 5 and 6 are based on data presented in the June, 1924, JOURNAL of the Society.

TABLE 13. AIR CHANGES TAKING PLACE UNDER AVERAGE CONDITIONS EXCLUSIVE OF AIR PROVIDED FOR VENTILATION

Kind of Room or Building	Number of Air Changes Taking Place per Hour
Rooms, 1 side exposed	1
Rooms, 2 sides exposed	1½
Rooms, 3 sides exposed	2
Rooms, 4 sides exposed	2
Rooms with no windows or outside doors	½ to ¾
Entrance Halls	2 to 3
Reception Halls	2
Living Rooms	1 to 2
Dining Rooms	1 to 2
Bath Rooms	2
Drug Stores	2 to 3
Clothing Stores	1
Churches, Factories, Lofts, etc.	½ to 3

Table 14 gives the leakage through a 13 in. brick wall, between the frame and the brick, the leakage for a plain window not weather-stripped

TABLE 14. AIR LEAKAGE IN CUBIC FEET PER HOUR AND B.T.U. NECESSARY TO HEAT SUCH LEAKAGE FROM 0 TO 70 DEG. FAHR. FOR CRACKS INDICATED AND 1/64 IN. CLEARANCE, WINDOW UNLOCKED

	Wind Velocity Miles per Hour	Per Sq. Ft. of 13" Brick Wall; Plastered		Per Ft. of Uncalked Crack Around Frame		Per Ft. of Crack Around the Sash Including Meeting Rail					
						Plain Unstripped Wood Window		Weather Stripped Window			
								Average Results		Best Results	
		Leakage Cu. Ft. per Hour	B.t.u.	Leakage Cu. Ft. per Hour	B.t.u.	Leakage Cu. Ft. per Hour	B.t.u.	Leakage Cu. Ft. per Hour	B.t.u.	Leakage Cu. Ft. per Hour	B.t.u.
PART I Values actually determined by Laboratory tests.	5.0	0.666	0.845	1.76	2.22	49.1	62.5	3.75	4.76	3.27	4.15
	7.5	1.73	2.20	7.95	10.1	78.6	100.0	8.52	10.8	7.20	9.14
	10.0	3.07	3.90	14.1	17.9	106.0	134.0	14.7	18.7	13.1	16.6
	15.0	6.66	8.45	28.3	35.9	155.0	197.0	28.6	36.4	25.6	32.5
	20.0	10.7	13.5	38.8	49.3	201.0	256.0	43.6	55.4	38.6	49.0
	30.0	19.9	25.1	67.1	85.3	291.0	370.0	74.5	94.6	65.5	83.1
	40.0	31.5	40.0	95.0	121.0	386.0	491.0	110.0	139.0	98.2	125.0
	50.0	42.9	54.5	111.0	141.0	498.0	634.0	146.0	186.0	134.0	168.0
PART II Values for practical use; Average test values reduced by 20 per cent to allow for building up of pressure in room, etc.	5.0	.532	.676	1.41	1.77	39.3	50.0	3.0	3.80	.....	.....
	7.5	1.38	1.63	6.36	8.08	62.8	80.0	6.82	8.64	.....	.....
	10.0	2.46	3.12	11.3	14.3	84.9	107.0	11.7	14.9	.....	.....
	15.0	5.33	6.76	22.6	28.7	124.0	157.0	22.9	29.1	.....	.....
	20.0	8.54	10.8	31.1	39.4	161.0	204.0	34.9	44.3	.....	.....
	30.0	16.0	20.5	53.6	68.2	233.0	296.0	59.6	75.6	.....	.....
	40.0	25.2	32.0	76.0	96.5	309.0	392.0	87.8	111.0	.....	.....
	50.0	33.3	43.6	88.9	114.0	390.0	507.0	117.0	149.0	.....	.....

TABLE 15. LEAKAGE FOR DOUBLE HUNG UNLOCKED WINDOWS C. F. H. PER FOOT OF CRACK PER MILE WIND VELOCITY AND B.T.U. PER HOUR PER FOOT OF CRACK PER MILE WIND VELOCITY PER 70 DEGREES TEMPERATURE DIFFERENCE

Values Actually Determined by Test		Crack	Plain Window		Weather-Stripped Window							
			1/8"-1/4"		1/8"		1/8"		3/16"		1/4"	
		Clearance	Leakage	B.t.u.	Leakage	B.t.u.	Leakage	B.t.u.	Leakage	B.t.u.	Leakage	B.t.u.
PART I Best Results		1/32	....	.....	1.32	1.67	1.48	1.87	1.63	2.07	1.79	2.27
		1/16	....	.....	1.56	1.98	1.72	2.18	1.88	2.39	2.05	2.59
		3/32	....	.....	1.67	2.11	1.83	2.32	2.00	2.54	2.17	2.75
		1/8	....	.....	1.71	2.17	1.89	2.39	2.06	2.62	2.24	2.84
		3/16	....	.....	1.74	2.20	1.94	2.45	2.13	2.70	2.33	2.95
		1/4	....	.....	1.75	2.22	1.96	2.48	2.17	2.75	2.38	3.02
PART II Average Results		1/32	4.3	5.45	1.85	2.30	1.99	2.42	2.21	2.81	2.56	3.25
		1/16	6.6	8.36	2.04	2.58	2.21	2.70	2.46	3.12	2.80	3.55
		3/32	8.9	11.9	2.15	2.72	2.33	2.84	2.58	3.28	2.94	3.72
		1/8	11.2	14.2	2.19	2.78	2.39	2.91	2.66	3.37	3.04	3.84
		3/16	15.7	19.9	2.23	2.82	2.44	2.97	2.74	3.47	3.15	3.99
		1/4	20.2	25.6	2.24	2.84	2.47	3.00	2.79	3.53	3.24	4.10
PART III Values for practical use; Average test values reduced by 20 per cent to allow for building up of pressure in room, etc.		1/32	3.4	4.36	1.48	1.84	1.60	1.93	1.76	2.24	2.04	2.60
		1/16	5.2	6.68	1.63	2.06	1.76	2.16	1.96	2.49	2.24	2.84
		3/32	7.1	9.5	1.72	2.17	1.86	2.27	2.06	2.62	2.35	2.97
		1/8	8.9	11.3	1.75	2.22	1.91	2.32	2.12	2.69	2.43	3.07
		3/16	12.5	15.9	1.78	2.25	1.95	2.37	2.19	2.77	2.52	3.19
		1/4	16.1	20.4	1.79	2.27	1.97	2.40	2.23	2.82	2.59	3.28

and the leakage for the same window fitted with a good weather-strip for various wind velocities.

Table 15 gives the leakage in cubic feet per hour per foot of crack per mile wind velocity for a plain frame window and also for a frame window fitted with weather-stripping. The leakage is given for various cracks around the sash perimeter and also for various clearances (Fig. 5) between the sash and the stop and parting bead.

Tables 14 and 15 are both divided into two parts, the first part containing values based upon the original Research Laboratory test data, and the second part containing the same values reduced by 20 per cent in accordance with the suggestion from the authors. In these tables both the best laboratory results and the average of all laboratory results on weather-stripped windows are given.

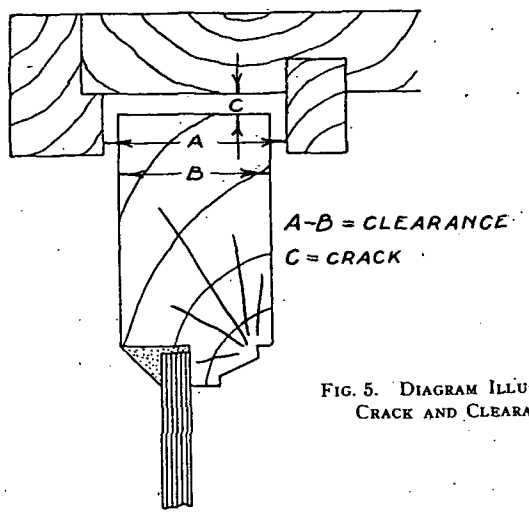


FIG. 5. DIAGRAM ILLUSTRATING CRACK AND CLEARANCE

Table 15 gives the leakage per mile wind velocity. This is based on the assumption that the leakage is proportional to the wind velocity, while this is practically true for a non weather-stripped window it is not so accurate for a weather-stripped window as indicated by the value for different velocities in Table 14. This accounts for the discrepancies in certain parts of the two tables. The two tables are, however, practically in agreement for a thirty mile wind velocity.

According to the authors of the paper: "The values given in the table are from the tests as made and are probably somewhat higher than those actually found in practice. They represent the leakage when the pressure drop through the window is a certain value which represents a definite wind velocity at right angles to the window. If the wind strikes the window at an oblique angle the component of the velocity at right angles to the window must be considered. Pressure difference between the outside and the inside surfaces of the window for an actual wind will

be slightly less for a given velocity because of a building up of pressure within the room before the air leaks out the opposite side of the building. Attention is called to the fact that air leaks in on the windward side of the building and out on the leeward side and, since wind will blow from various directions at different times, heating for any room having only one exposure must be based on the maximum loss. The heating plant, however, need not be figured on the sum of all maximum leakages, but in general only half of the total. However, the table gives accurate comparative figures which are probably not much too high for actual practice. In order to apply these values, a further study of the overall results as found in practice should be made, and the figures modified, if necessary, to fit practical conditions."

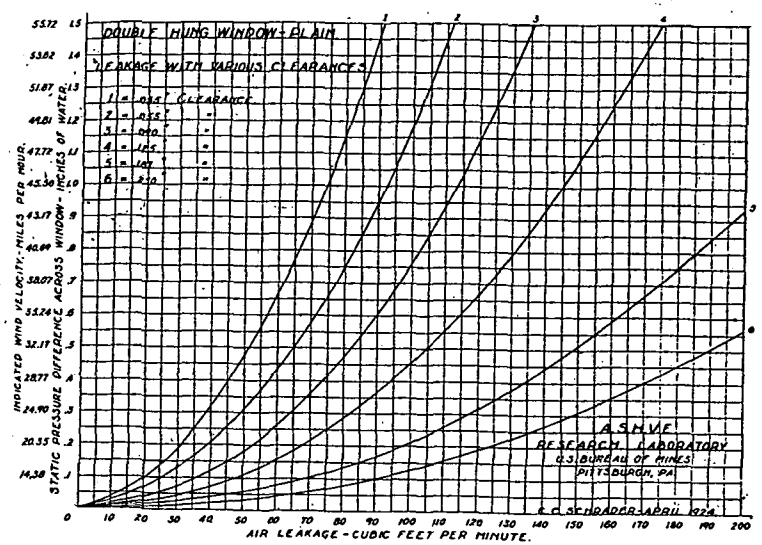


FIG. 6. LEAKAGE THROUGH PLAIN WINDOW WITH VARIOUS CLEARANCES

In their discussion of results as presented in the June, 1924 issue of the JOURNAL, the authors state:

"The principal facts brought out in the first report were that increasing the crack around the perimeter of a plain sash did not materially increase the leakage, and that weather-stripped sash, while permitting much less leakage, showed a small increase in leakage with increase in crack. These facts were established by making several hundred tests. The present report deals with the effect of increasing the width of the stile, that is, increasing the clearance.

"Fig. 5 illustrates what is meant by crack and clearance. The crack around the sash perimeter is equal to one half the difference between the width of the frame and the width of the sash, that is, the crack is the same on each side of the sash. The clearance is the difference between the width of the stile and the thickness of the sash. These terms are chosen arbi-

trarily to distinguish the two principal air passages which are found in double hung windows, and they will be used frequently throughout the report and should not be confused.

"Four sets of sash were fitted with cracks of $\frac{1}{16}$, $\frac{1}{8}$, $\frac{3}{16}$ and $\frac{1}{4}$ in. Each set was tested with clearances varying from $\frac{1}{32}$ to $\frac{1}{4}$ in. Each test was repeated a number of times because no two tests gave exactly the same leakage, and it was necessary to obtain average results. Before duplicating any test the window was opened and closed, and the stops were removed and then returned to as nearly the same position as possible. The weather-stripped sashes were tested in the same way.

Fig. 6 gives the results of tests on a plain window with various clearances. The tests proved that the size of the crack around the perimeter of the sash has no appreciable effect on the leakage. Therefore the results apply to any window of the type tested with a crack of from $\frac{1}{16}$ to $\frac{1}{4}$ in. In practice most new sashes are fitted with the crack at least $\frac{1}{16}$ in., and this crack becomes greater as the sash dries out and shrinks. It should be clearly understood that each curve is the average obtained from a number of tests, and the results of any one test may vary from the given curve by four or five per cent. The figure shows that the leakage increases rapidly with increase in clearance.

Calculations for Infiltrations

In order to arrive at the heat required for warming up the air entering by infiltration, the following procedure is necessary:

First, determine the average wind movement in miles per hour for the locality in question (Table 2);

Second, determine the inleakage of outside air per lineal foot of the given window or door crack in cubic feet per minute at the given wind velocity, Table 14 or 15;

Third, express the heat equivalent in B.t.u. per hour per foot of crack to heat this air 1 deg. fahr.

Thus, for a plain window having $\frac{1}{16}$ in. *crack* and $\frac{7}{64}$ in. *clearance* (see Fig. 5), which means the air channel around the edge of the sash is approximately $\frac{1}{16}$ in. wide, the heat equivalent of the air leaking in for a 0–70 deg. fahr. temperature difference is 157 B.t.u. per foot of crack per hour (Table 14, Part II). This value is found in the seventh column of the table. The computation for obtaining 157 is:

$$124 \times 0.075 \times 0.24 \times 70 = 157 \text{ B.t.u.},$$

where

124 = cubic feet of air per foot of crack per hour for a 15 mi. wind for $\frac{7}{64}$ in. clearance from the 6th column of Table 14.
0.075 = air density at 70 deg. fahr., pound per cubic foot.
0.24 = specific heat of air, and
70 = difference in temperature between inside and outside air.

The most convenient values for use in infiltration calculations are the coefficients of infiltration for the particular kind of crackage with a wind velocity of 15 miles per hour under average conditions, with $\frac{1}{16}$ in. *crack* and $\frac{7}{64}$ in. *clearance* reduced by 20 per cent (Table 14, Part II).

For a wind velocity other than 15 miles per hour, use the proper velocity for that locality in place of 15.

(1) Plain unstripped window:

$$124 \times 0.075 \times 0.24 = 2.23 \text{ B.t.u. per hour per foot of crack.}$$

(2) Weather-stripped window:

$$22.9 \times 0.075 \times 0.24 = 0.41 \text{ B.t.u. per hour per foot of crack.}$$

Hence, use the values 2.23, and 0.41 for the heat to be supplied in B.t.u. per hour, per foot of crack for an average wind velocity of 15 miles per hour for each of the two kinds of cracks respectively. In case of very good double hung plain windows use $\frac{2.23}{2} = 1.11$.

For special cases, select proper values from Table 14 or 15 and compute the B.t.u. per foot of crack as already shown for the average case, using the proper wind velocity in miles per hour.

HEAT SOURCES

Heat Available from Sources other than Heating Plant

The heat supplied by persons, lights, motors and machinery should always be ascertained in the case of theaters, assembly halls, and industrial plants, but allowances for such heat sources must be made only after careful consideration of all local conditions. In many cases, these heat sources should not be allowed to affect the size of the installation at all, although they may have a marked effect on the operation and control of the system later. In general, it is safe to say that where audiences are involved, the heating installation must have sufficient capacity to bring the building up to the stipulated inside temperature before the audience arrives. In industrial plants, quite a different condition exists, and heat sources, if they are always available during the period of human occupancy, may be substituted for a portion of the heating installation. In no case should the actual heating installation (exclusive of heat sources) be reduced below that required to maintain at least 40 deg. fahr. in the building. The following allowances may be made when required:

TABLE 16. HEAT GIVEN UP BY PERSONS AND LIGHTS

*PERSONS:	
Man at rest	400 B.t.u. per hr.
Man at work	500 B.t.u. per hr.
LIGHTS:	
Electric lamps, B.t.u. per hr. equals watts per lamp × number of lamps × 3.415	
Gas lighting:	
1 cu. ft. producer gas	150 B.t.u.
1 cu. ft. illuminating gas	700 B.t.u.
1 cu. ft. natural gas	1000 B.t.u.
A Welsbach burner averages 3 cu. ft. of gas per hour and a fish tail burner 5 cu. ft. per hour.	

*For more detailed information see Table 17, Heat Emitted by Persons per Hour at Different Room Temperatures.

Motors and the machinery which they drive, if both are located in the room, convert all of the electrical energy supplied into heat, which is retained in the room if the product being manufactured is not removed until its temperature is the same as the room temperature.

TABLE 17. HEAT EMITTED BY PERSONS PER HOUR AT DIFFERENT ROOM TEMPERATURES

H = Heat emitted by man at rest per hour.
Hl = Heat emitted by man at light labor per hour.
Ha = Heat emitted by man at average labor per hour.
Hh = Heat emitted by man at hard labor per hour.

HE = Heat Energy = $\left(\frac{\text{Foot-Pounds per hour}}{778}\right)$ = 84 B.t.u., 168 B.t.u. and 252 B.t.u. respectively for light, average and hard labor.

T = Room Temperature.

$H = 13.2\ (98.6 - T)$ Heat due labor = $\frac{T \times HE}{100}$

Hl, Ha, or Hh = 13.2 (98.6 − T) plus $\frac{T \times HE}{100}$

Room Temp. Deg. Fahr.	Heat Emitted by Man* B.t.u. per Hour at Rest	84 B.t.u. Light Labor	168 B.t.u. Average Labor	252 B.t.u. Hard Labor	Condition Required to Balance Excess and Shortage in Heat Emission
30	905	931	954	981	Increasing Humidity
40	773	807	838	874	Heavy Clothing for Reduction or Pre-
50	642	684	723	768	vention of Radiation
60	509	559	606	660	
68	404	461	518	575	Normal Condition
70	378	436	491	554	
75	312	375	438	501	Decreasing Humidity
80	246	313	375	447	Air Currents for Producing Evapora-
85	180	251	322	394	tion of Perspiration
90	114	189	259	342	

*For children use one-half of table values, February, 1911.

If power is transmitted to the machinery from the outside, then only the heat equivalent of the brake horsepower supplied is used. In the first case the B.t.u. supplied per hour = $\frac{\text{Motor horsepower}}{\text{Efficiency of motor}} \times 2546$, and in the second case B.t.u. per hr. = b.hp. × 2546, in which 2546 is the B.t.u. equivalent of 1 hp. hour. In high-powered mills this is the chief source of heating and is frequently sufficient to overheat the building even in zero weather, thus requiring cooling by ventilation the year round.

For intermittent heating allow 10 per cent additional for rooms heated in the day time only, and for longer intervals of several days or more, add 25 per cent in determining minimum heating requirements, and size of plant.

Application to Factory Heating[3] (See Fig. 6)

Lowest outside temperature for Philadelphia, Pa. = −6 deg. fahr. (Table 2), hence use (−6 + 10) = + 4 for heat loss computations. Average wind movement (Table 2) for December, January, February = 11.0 miles per hour from the Northwest. Long axis of building is north and south.

Inside breathing line temperature = 60 deg. fahr.

Walls: 9 in. concrete (stone), furred with 2 in. tile, plastered ½ in.

K_1 = 0.93 plaster in still air, Table 4.
K_2 = 3 × 1.3 concrete moving air, Tables 4 and 6.
c_1 = 8.3 for stone concrete, Table 5.
c_2 = for tile as shown use 0.99 (not per 1 in.), Table 5.

[3]In this example a design temperature only 10 deg. fahr. above lowest on record instead of 15 deg. fahr. above was used. Infiltration values were taken from Table 14 for a plain window.

$$U = \frac{1}{\frac{1}{K_1} + \frac{1}{K_2} + \frac{x_1}{c_1} + \frac{x_2}{c_2}} = \frac{1}{\frac{1}{0.93} + \frac{1}{3.9} + \frac{9}{8.3} + \frac{1}{0.99}} =$$

0.292 from equations (6) and (7).

The air temperature at the mean height of inside walls is greater than at breathing line. Mean height of walls is 16 ÷ 2 = 8 ft., which 8 − 5 = 3 ft. above breathing line. Allowing 2 per cent per foot above 5 ft., or 2 × 3 = 6 per cent, makes the mean air temperature 1.06 × 60 = 63.4 deg. fahr. The triangular areas in the end wall are practically at the mean height of the roof at which level the air temperature is 78 deg. fahr.

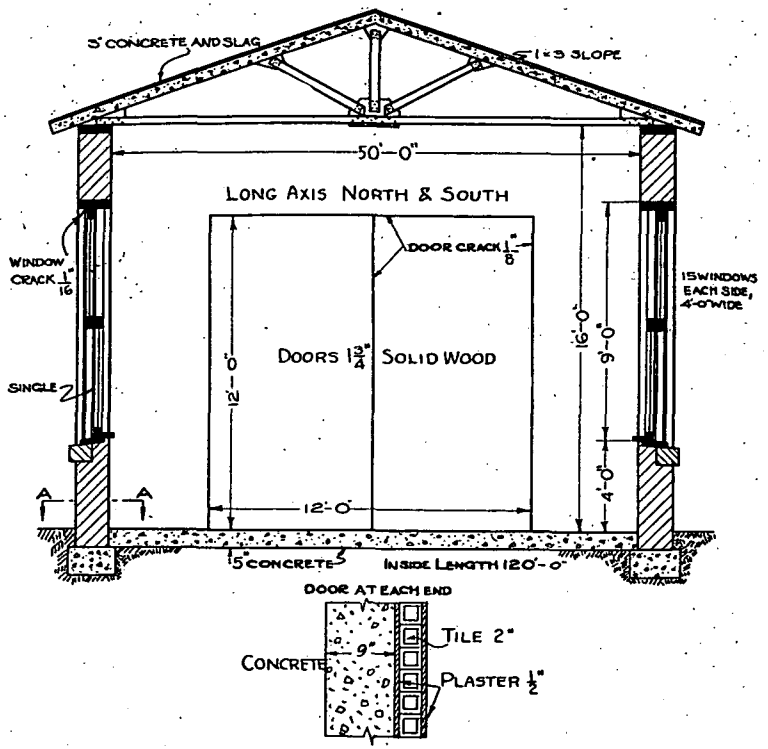


FIG. 7. ELEVATION OF FACTORY BUILDING

Roof: 3 in. concrete (stone), with ⅛ in. tar paper and slag.

$$U = \frac{1}{\frac{1}{K_1} + \frac{1}{K_2} + \frac{x_1}{c_1} + \frac{x_2}{c_2}} = \frac{1}{\frac{1}{1.3} + \frac{1}{4.2} + \frac{3}{8.3} + \frac{0.125}{0.40}} = 0.60$$

The air temperature just below roof is higher than that at the breathing line. Mean height of roof is 16 + 4 = 20 ft., or it is 20 − 5 = 15 ft.

above breathing line. Allowing 2 per cent per foot above 5 ft., or 2 × 15 = 30 per cent, makes the under roof temperature = 1.30 × 60 = 78 deg. fahr.

Floor: The 5 in. concrete floor is laid on the ground, and hence there is only one surface coefficient $K_1 = 1.3$ (Table 3).

$$U = \frac{1}{\frac{1}{1.30} + \frac{5}{8}} = 0.717$$

The air temperature at floor level = 60 − 5 = 55 deg. fahr.

Windows and Doors: Wood sash and doors with single thickness of glass. Take coefficient U for glass as 1.13 B.t.u. per sq. ft. per degree per hour for heat transmission (Table 6). Doors are solid wood 1¾ in. thick and coefficient $U = 0.37$ B.t.u. per sq. ft. per degree per hour (Table 6).

Infiltration: Window crack assumed $\frac{1}{16}$ in. and doors at $\frac{1}{16}$ in. By Table 14 (Part I) for a 10 mile wind velocity the leakage per foot of crack is 85 c.f. hr. for a plain window. The heat equivalent per hour, per degree is

$$85 \times .075 \times 0.24 = 1.53 \text{ B.t.u.}$$

and allowing for an 11 mile wind the factor becomes $1.53 \times \frac{11}{10} = 1.68$ (see preceding note). Allow twice this for door crack or 2 × 1.68 = 3.36.

CALCULATION SHEET
Entire Building
(See Fig. 7)

Building Material	Exposure	Width in Ft.	Height in Ft.	Area Sq. Ft. or Lin. Ft.	Coeffic. Trans. and Infilt.	Temp. Diff.	Net B.t.u.	Exposure Factor	Total B.t.u.
Concrete and Tile	N	½ × 50	8½	213	0.29	74.0	4,570	1.15	5,250
	N	50	16	656	0.29	59.4	11,300	1.15	13,000
Doors 1¾"	N	12	12	144	0.37	56	2,980	1.15	3,430
Crack ⅛"	N	1 pair doors		60	3.56	56	11,900	½* × 1.15	6,850
									28,530
Concrete and Tile	W	120	16	1380	0.29	59.4	22,900	1.15	26,300
Glass	W	15 × 4	9	540	1.13	59.4	36,200	1.15	41,600
Crack ⅛"	W	Double Hung Windows (15)		450	1.78	59.4	47,500	½* × 1.15	27,300
									95,200
South Wall	Same as N	See above		.....	.....	.....	30,750	½*	24,800
East Wall	Same as W	See above		.....	.....	.....	106,600	½*	82,850
Roof 3" Concrete and Slag	No Ceiling	52.5	120	6300	0.60	74	280,000	None	280,000
Floor 5" Stone Concrete	On Dirt	50	120	6000	0.717	5	21,510	None	21,510

Grand total of heat required for building in B.t.u. per hour at + 4° with 11-mile Southwest wind.. 532,890

*NOTES—(1) This building has no partitions and whatever air enters through the cracks on the windward side must leave through the cracks on the leeward side. Therefore, only one-half of the total crack will be used in computing infiltration for each side and each end of building.

(2) An exposure allowance of 15 per cent is also to be added to the wall and glass transmission losses and to the infiltration losses on the two adjacent sides of the building most nearly facing the prevailing wind as stated in paragraph 36.

(3) It is also possible to compute the heat required to take care of infiltration on the basis of ½ of an air change per hour as given in Table 13 for a factory with minimum conditions. Volume = 50 × 120 × 20 (mean height) = 120,000 cu. ft. and heat required per hour is

$$120{,}000 \times \tfrac{1}{2} \times 0.075 \times 0.24 \times 59.4 = 64{,}200 \text{ B.t.u.}$$

Based on infiltration through one-half the total crackage in all walls, the heat to be supplied per hour is from preceding table,

$$6{,}850 + 27{,}300 + 5{,}950 + 23{,}750 = 63{,}850 \text{ B.t.u.}$$

This value based on crackage should be used, but if building is to be heated intermittently, not less than one air change per hour should be allowed.

CHAPTER II

HEATING BY RADIATION

By R. V. FROST, Member

CALCULATING RADIATION

RADIATION can be classified as direct, semi-direct, and indirect, and is usually made of pipe or cast iron; when it is made of pipe it is termed *pipe coil*, and when made of cast iron it is termed column, wall, semi-indirect, or indirect radiation.

The unit of measure in figuring radiation is the square foot of heating surface, which is the external surface.

The amount of heat a square foot of heating surface (radiation) will give off depends upon the temperature of the heating medium (steam, or hot water), the temperature of the surrounding air, and the velocity at which the air passes over same.

Tables 18 to 24 on succeeding pages indicate the number of B.t.u. a given size column or wall radiator will transmit in 1 hr. with steam as the heating medium and Tables 26 to 30 give similar data with hot water as the heating medium. The ordinary practice in calculating the amount of radiation of various kinds to meet a variety of conditions will be briefly stated.

To determine the amount of direct radiation to heat a room, figure all of the heat losses, adding the proper amount for exposure, and refer to Tables 18 to 30 to find the proper size radiator.

If a radiator of more than 20 sections is required, multiply the value, B.t.u. per intermediate section, for the particular radiator, Tables 18–24, by the number of additional sections above 20 and add this amount to the value, *Total B.t.u. per hour*, for the 20 section radiator. This will give the total B.t.u. per hour for the required radiator.

Example.—What is the total B.t.u. per hour for a 30-section 32 in., single column radiator?

Solution.—626 B.t.u. × 10 sections = 6260 B.t.u.
6260 B.t.u. + 12,875 B.t.u. = 19,135 B.t.u. Total per hour for 30-section radiator.

The values, B.t.u. per square feet of intermediate section and B.t.u. per square feet of end surface, are given on the tables to show the relationship between the two. The greater exposure of the end surface on the radiator, obviously will give a greater emission per square feet of surface.

To determine the amount of semi-indirect (sometimes termed direct-indirect), radiation to heat a room, figure all the heat losses, adding the

proper amount for exposure add 40 per cent and refer to Tables 18–24 to find the proper size radiator.

Example.—The heat losses including allowance for exposure for a given size room is 17,200 B.t.u. + 40 per cent or 24,080 B.t.u., requiring a 19-section 45 in. 3-col. semi-indirect radiator.

Pipe coils should be of the header type, with provision made for expansion by a mitre piece. The steam supply should be at the mitre end and all coils should be securely anchored at the return header so as to throw the expansion toward the mitre end. The coils should be made of 1¼ or 1½ in. pipe and not over 60 ft. in length, not including the mitre, which should be at least one-tenth the length of the coil.

SELECTION OF RADIATION

It is usually necessary to select the type and location of radiation to conform to the conditions and space available in the room. In general it is usually most convenient and practical to locate the radiation on the exposed side of the room. The size of the radiator to take care of any particular heat loss can be best selected from the sheets compiled by the Society's Research Laboratory in cooperation with the U. S. Bureau of Mines Experiment Station, which are based on experiments by the late Director John R. Allen, and F. B. Rowley. As the heat emitted per square foot of radiation varies in radiators of different heights, widths and lengths, and also with the steam pressure and the temperature of the room, errors will occur if the same factor is used for all radiators.

Examples for the Use of Tables.—Assume that the heat loss from a room is 15,497 B.t.u. per hr., to heat the room to 70 deg. fahr. Two-column 38-in. radiators have been selected using steam at 1-lb. gage or approximately 215 deg. fahr.

Solution.—In Table 19 for two-column radiators, under 38 in., it will be found that a 17-section radiator will emit 15,960 B.t.u. Therefore a 17-section two-column 38-in. radiator will be required with a rated surface of 68 sq. ft.

If in the same example steam at 5-lb. pressure or approximately 227 deg. fahr. was used and the room was heated to only 60 deg. fahr. requiring 13,300 B.t.u. and three-column 26-in. radiators are selected the radiation would be estimated as follows:

Solution.—In Table 25 following down the first column to 5-lb. gage pressure and then over horizontally to 60 deg. fahr. room temperature the conversion factor 0.864 will be found. The heat loss 13,300 × 0.864 (the equivalent heat loss) = 11,480 B.t.u. In Table 20 for three-column radiators under the heading 26 in. it will be found that a 13-section radiator will supply 11,242 B.t.u. under standard conditions which is the closest to the amount required. Therefore a 13-section three-column 26-in. radiator will be required.

RESEARCH LABORATORY STANDARD DATA—AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS
Result of Cooperative Work With U. S. Bureau of Mines Experiment Station, Pittsburgh, Pa.
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TABLE 18. HEAT EMITTED BY DIRECT RADIATION—SINGLE-COLUMN RADIATORS

Steam Temperature at 215 deg. fahr. Room Temperature at 70 deg. fahr.

LENGTH INCHES	No. OF SECTIONS	38 IN.		32 IN.		26 IN.		23 IN.		20 IN.	
		Rated Surface sq. ft.	Total B.t.u. per hr.	Rated Surface sq. ft.	Total B.t.u. per hr.	Rated Surface sq. ft.	Total B.t.u. per hr.	Rated Surface sq. ft.	Total B.t.u. per hr.	Rated Surface sq. ft.	Total B.t.u. per hr.
	1			2.5	952	2	770	1.66	654	1.5	593
	2	3	1125	5.0	1589	4	1293	3.33	1112	3.0	982
5	3	6	1849	7.5	2217	6	1807	5.00	1555	4.5	1377
	4	9	2578	10.0	2845	8	2321	6.66	1997	6.0	1772
10	5	12	3307	12.5	3471	10	2835	8.33	2440	7.5	2168
	6	15	4035								
	7			15.0	4098	12	3348	10.00	2882	9.0	2562
15	8	18	4765	17.5	4725	14	3863	11.66	3324	10.5	2957
	9	21	5494	20.0	5354	16	4377	13.33	3767	12.0	3353
20	10	24	6223	22.5	5982	18	4891	15.00	4209	13.5	3748
	11	27	6950	25.0	6610	20	5404	16.66	4652	15.0	4143
25	12	30	7680								
	13			27.5	7236	22	5918	18.33	5095	16.5	4538
	14	33	8408	30.0	7863	24	6432	20.00	5538	18.0	4932
30	15	36	9137	32.5	8489	26	6947	21.66	5980	19.5	5327
	16	39	9867	35.0	9117	28	7459	23.33	6422	21.0	5723
35	17	42	10594	37.5	9744	30	7974	25.00	6865	22.5	6118
	18	45	11322								
	19			40.0	10372	32	8489	26.66	7309	24.0	6514
	20	48	12053	42.5	10999	34	9000	28.33	7752	25.5	6908
40	21	51	12781	45.0	11624	36	9515	30.00	8193	27.0	7304
	22	54	13511	47.5	12250	38	10028	31.66	8635	28.5	7698
45	23	57	14239	50.0	12875	40	10544	33.33	9080	30.0	8094
	24	60	14964								
50											
B.t.u. per Intermed. Section		728		....	626	....	514	.....	443	....	395
" " Sq. Ft. " "		243		....	250	....	257	.....	266	....	263
" " " End Surface		375		....	380	....	385	.....	394	....	395

Research Laboratory Standard Data—American Society of Heating and Ventilating Engineers
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Table 19. Heat Emitted by Direct Radiation—Two-Column Radiators

Steam Temperature at 215 deg. fahr. *Room Temperature at 70 deg. fahr.*

Length Inches	No. of Sections	45 In.		38 In.		32 In.		26 In.		23 In.		20 In.	
		Rated Surface sq. ft.	Total B.t.u. per hr.	Rated Surface sq. ft.	Total B.t.u. per hr.	Rated Surface sq. ft.	Total B.t.u. per hr.	Rated Surface sq. ft.	Total B.t.u. per hr.	Rated Surface sq. ft.	Total B.t.u. per hr.	Rated Surface sq. ft.	Total B.t.u. per hr.
	1	5	1892	4	1586	3.33	1237	2.66	1100	2.33	967	2	823
5	2	10	2975	8	2475	6.66	2121	5.33	1736	4.66	1520	4	1313
	3	15	4059	12	3373	10.00	2903	8.00	2373	7.00	2093	6	1810
10	4	20	5142	16	4272	13.33	3675	10.66	3010	9.33	2666	8	2304
	5	25	6225	20	5172	16.66	4452	13.33	3652	11.66	3239	10	2798
15	6	30	7308	24	6072	20.00	5220	16.00	4289	14.00	3809	12	3292
	7	35	8390	28	6972	23.33	5992	18.66	4920	16.33	4376	14	3786
20	8	40	9476	32	7869	26.66	6768	21.33	5560	18.66	4943	16	4279
	9	45	10562	36	8766	30.00	7539	24.00	6197	21.00	5510	18	4772
25	10	50	11645	40	9668	33.33	8323	26.66	6832	23.33	6081	20	5264
	11	55	12727	44	10567	36.66	9112	29.33	7471	25.66	6648	22	5753
30	12	60	13810	48	11467	40.00	9888	32.00	8109	28.00	7213	24	6245
	13	65	14892	52	12367	43.33	10662	34.66	8746	30.33	7780	26	6738
35	14	70	15974	56	13266	46.66	11436	37.33	9383	32.66	8346	28	7232
	15	75	17058	60	14164	50.00	12210	40.00	10020	35.00	8897	30	7728
40	16	80	18143	64	15062	53.33	12987	42.66	10662	37.33	9464	32	8221
	17	85	19227	68	15960	56.66	13764	45.33	11299	39.66	10032	34	8714
45	18	90	20311	72	16859	60.00	14538	48.00	11933	42.00	10601	36	9209
	19	95	21394	76	17758	63.33	15310	50.66	12570	44.33	11167	38	9703
50	20	100	22478	80	18656	66.66	16080	53.33	13211	46.66	11736	40	10196
B.t.u. per Intermed. Section			1083		900		776		638		565		493
" " Sq. Ft. " "			217		225		233		240		242		246
" " " End Surface			378		396		400		413		415		411

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Table 20. Heat Emitted by Direct Radiation—Three-Column Radiators

Steam Temperature at 215 deg. fahr. *Room Temperature at 70 deg. fahr.*

Length Inches	No. of Sections	45 In.		38 In.		32 In.		26 In.		22 In.		18 In.	
		Rated Surface sq. ft.	Total B.t.u. per hr.	Rated Surface sq. ft.	Total B.t.u. per hr.	Rated Surface sq. ft.	Total B.t.u. per hr.	Rated Surface sq. ft.	Total B.t.u. per hr.	Rated Surface sq. ft.	Total B.t.u. per hr.	Rated Surface sq. ft.	Total B.t.u. per hr.
	1	6	2241	5	1898	4.5	1665	3.75	1372	3	1138	2.25	878
5	2	12	3480	10	2955	9.0	2635	7.50	2195	6	1816	4.50	1430
	3	18	4720	15	4013	13.5	3605	11.25	3017	9	2496	6.75	1961
10	4	24	5959	20	5070	18.0	4674	15.00	3840	12	3174	9.00	2491
	5	30	7197	25	6128	22.5	5544	18.75	4661	15	3854	11.25	3020
15	6	36	8435	30	7185	27.0	6512	22.50	5485	18	4532	13.50	3553
	7	42	9677	35	8243	31.5	7481	26.25	6308	21	5211	15.75	4084
20	8	48	10915	40	9300	36.0	8453	30.00	7128	24	5890	18.00	4615
	9	54	12155	45	10358	40.5	9420	33.75	7952	27	6569	20.25	5146
25	10	60	13392	50	11415	45.0	10391	37.50	8775	30	7248	22.50	5679
	11	66	14632	55	12473	49.5	11360	41.25	9595	33	7927	24.75	6210
30	12	72	15872	60	13530	54.0	12328	45.00	10418	36	8608	27.00	6742
	13	78	17113	65	14587	58.5	13297	48.75	11242	39	9286	29.25	7273
35	14	84	18354	70	15645	63.0	14270	52.50	12065	42	9962	31.50	7803
	15	90	19593	75	16703	67.5	15242	56.25	12889	45	10643	33.75	8333
40	16	96	20832	80	17760	72.0	16207	60.00	13710	48	11323	36.00	8863
	17	102	22068	85	18817	76.5	17174	63.75	14531	51	12000	38.25	9398
45	18	108	23306	90	19872	81.0	18144	67.50	15353	54	12679	40.50	9931
	19	114	24544	95	20936	85.5	19118	71.25	16174	57	13361	42.75	10464
50	20	120	25776	100	21990	90.0	20088	75.00	16995	60	14040	45.00	10989
B.t.u. per Intermed. Section			1239		1057		969		822		679		531
" " Sq. Ft. " "			206		211		215		219		226		236
" " " End Surface			374		380		370		366		380		390

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Table 21. Heat Emitted by Direct Radiation—Four-Column Radiators

Steam Temperature at 215 deg. fahr. *Room Temperature at 70 deg. fahr.*

Length Inches	No. of Sections	45 In.		38 In.		32 In.		26 In.		22 In.		18 In.	
		Rated Surface sq. ft.	Total B.t.u. per hr.	Rated Surface sq. ft.	Total B.t.u. per hr.	Rated Surface sq. ft.	Total B.t.u. per hr.	Rated Surface sq. ft.	Total B.t.u. per hr.	Rated Surface sq. ft.	Total B.t.u. per hr.	Rated Surface sq. ft.	Total B.t.u. per hr.
	1	10	3092	8	2567	6.5	2166	5	1730	4	1430	3	1125
6	2	20	5000	16	4150	13.0	3513	10	2808	8	2320	6	1823
	3	30	6909	24	5730	19.5	4859	15	3887	12	3211	9	2522
12	4	40	8816	32	7315	26.0	6205	20	4964	16	4101	12	3218
	5	50	10725	40	8900	32.5	7550	25	6043	20	4992	15	3917
18	6	60	12636	48	10483	39.0	8896	30	7122	24	5882	18	4615
	7	70	14539	56	12069	45.5	10242	35	8198	28	6773	21	5313
24	8	80	16445	64	13651	52.0	11588	40	9276	32	7664	24	6011
	9	90	18360	72	15235	58.5	12934	45	10355	36	8554	27	6710
30	10	100	20270	80	16816	65.0	14281	50	11435	40	9444	30	7404
	11	110	22176	88	18396	71.5	15627	55	12513	44	10336	33	8103
36	12	120	24084	96	19978	78.0	16973	60	13592	48	11227	36	8802
	13	130	25987	104	21570	84.5	18320	65	14671	52	12118	39	9501
42	14	140	27902	112	23150	91.0	19665	70	15750	56	13009	42	10198
	15	150	29805	120	24732	97.5	21011	75	16827	60	13896	45	10895
48	16	160	31712	128	26330	104.0	22357	80	17904	64	14784	48	11592
	17	170	33626	136	27921	110.5	23702	85	18981	68	15675	51	12291
54	18	180	35537	144	29506	117.0	25049	90	20061	72	16567	54	12987
	19	190	37430	152	31084	123.5	26395	95	21140	76	17459	57	13685
60	20	200	39340	160	32652	130.0	27742	100	22220	80	18352	60	14382
B.t.u. per Intermed. Section			1908	...	1583	.....	1346	...	1078	..	890	..	698
" " Sq. Ft. " "			191	...	198	.....	207	...	216	..	222	..	233
" " " End Surface			309	...	321	.....	333	...	346	..	358	..	375

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Table 22. Heat Emitted by Direct Radiation—Hospital Radiators—Two Column

Steam Temperature at 215 deg. fahr. *Room Temperature at 70 deg. fahr.*

Length Inches	No. of Sections	45 In.		38 In.		32 In.		26 In.		23 In.		20 In.	
		Rated Surface sq. ft.	Total B.t.u. per hr.	Rated Surface sq. ft.	Total B.t.u. per hr.	Rated Surface sq. ft.	Total B.t.u. per hr.	Rated Surface sq. ft.	Total B.t.u. per hr.	Rated Surface sq. ft.	Total B.t.u. per hr.	Rated Surface sq. ft.	Total B.t.u. per hr.
	1	5	1966	4	1628	3.33	1391	2.66	1128	2.33	998	2	861
6	2	10	3118	8	2597	6.66	2219	5.33	1812	4.66	1606	4	1391
	3	15	4271	12	3558	10.00	3051	8.00	2498	7.00	2213	6	1921
12	4	20	5424	16	4520	13.33	3878	10.66	3179	9.33	2821	8	2448
	5	25	6575	20	5480	16.66	4710	13.33	3864	11.66	3429	10	2979
18	6	30	7725	24	6439	20.00	5538	16.00	4547	14.00	4036	12	3509
	7	35	8875	28	7400	23.33	6369	18.66	5228	16.33	4644	14	4038
24	8	40	10028	32	8362	26.66	7196	21.33	5913	18.66	5251	16	4568
	9	45	11183	36	9324	30.00	8025	24.00	6600	21.00	5859	18	5099
30	10	50	12335	40	10284	33.33	8856	26.66	7282	23.33	6468	20	5626
	11	55	13487	44	11242	36.66	9684	29.33	7966	25.66	7074	22	6156
36	12	60	14640	48	12206	40.00	10512	32.00	8650	28.00	7683	24	6686
	13	65	15789	52	13166	43.33	11341	34.66	9330	30.33	8290	26	7215
42	14	70	16940	56	14129	46.66	12169	37.33	10016	32.66	8899	28	7744
	15	75	18090	60	15084	50.00	13000	40.00	10696	35.00	9506	30	8274
48	16	80	19248	64	16045	53.33	13829	42.66	11378	37.33	10114	32	8803
	17	85	20400	68	17007	56.66	14658	45.33	12062	39.66	10722	34	9333
54	18	90	21551	72	17971	60.00	15486	48.00	12744	42.00	11327	36	9864
	19	95	22705	76	18932	63.33	16314	50.66	13425	44.33	11935	38	10393
60	20	100	23850	80	19888	66.66	17142	53.33	14111	46.66	12544	40	10920
B.t.u. per Intermed. Section			1152	...	960	.....	829	.....	683	.....	608	..	530
" " Sq. Ft. " "			230	...	240	.....	250	.....	256	.....	261	..	265
" " " End Surface			393	...	407	.....	418	.....	423	.....	428	..	430

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Table 23. Heat Emitted by Direct Radiation—Wall Radiators

Steam Temperature at 215 deg. fahr. *Room Temperature at 70 deg. fahr.*

No. of Sections	29 In.		22 In.		17 In.	
	Rated Surface sq. ft.	Total B.t.u. per hr.	Rated Surface sq. ft.	Total B.t.u. per hr.	Rated Surface sq. ft.	Total B.t.u per hr.
1	9	2853	7	2234	5	1658
2	18	5456	14	4281	10	3208
3	27	8059	21	6327	15	4758
4	36	10663	28	8372	20	6308
5	45	13266	35	10420	25	7860
6	54	15869	42	12466	30	9408
7	63	18472	49	14513	35	10959
8	72	21074	56	16559	40	12508
9	81	23676	63	18604	45	14063
10	90	26280	70	20650	50	15610
11	99	28888	77	22700	55	17160
12	108	31493	84	24746	60	18708
13	117	34094	91	26790	65	20261
14	126	36696	98	28832	70	21812
15	135	39299	105	30881	75	23363
16	144	41904	112	32928	80	24913
17	153	44508	119	34974	85	26461
18	162	47110	126	37019	90	28008
19	171	49715	133	39062	95	29560
20	180	52322	140	41118	100	31110
B.t.u. per Intermediate Section		2603	...	2046	...	1550
" " Sq. Ft. " "		289	...	293	...	310
" " " " End Surface		316	...	319	...	331

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Table 24. Heat Emitted by Direct Radiation—Window Radiators

Steam Temperature at 215 deg. fahr. *Room Temperature at 70 deg. fahr.*

Length Inches	No. of Sections	20 In.		16 In.		13 In.	
		Rated Surface sq. ft.	Total B.t.u. per hr.	Rated Surface sq. ft.	Total B.t.u. per hr.	Rated Surface sq. ft.	Total B.t.u. per hr.
	1	5	1708	3.75	1332	3	1082
6	2	10	2761	7.50	2156	6	1762
	3	15	3816	11.25	2979	9	2441
12	4	20	4872	15.00	3803	12	3119
	5	25	5930	18.75	4626	15	3798
18	6	30	6987	22.50	5450	18	4477
	7	35	8043	26.25	6274	21	5156
24	8	40	9098	30.00	7098	24	5836
	9	45	10152	33.75	7921	27	6516
30	10	50	11210	37.50	8745	30	7194
	11	55	12265	41.25	9570	33	7871
36	12	60	13320	45.00	10395	36	8550
	13	65	14378	48.75	11217	39	9227
42	14	70	15435	52.50	12038	42	9908
	15	75	16490	56.25	12864	45	10589
48	16	80	17544	60.00	13686	48	11266
	17	85	18598	63.75	14510	51	11944
54	18	90	19656	67.50	15336	54	12625
	19	95	20710	71.25	16160	57	13304
60	20	100	21770	75.00	16988	60	13986
B.t.u. per Intermediate Section.			1056	.....	.....	..	679
" " Sq. Ft. " "			211	.....	.....	..	226
" " " End Surface			342	.....	.....	..	361

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Table 25. Heat Emitted by Direct Radiation—Conversion Factors

Pressure		Temp. of Steam in deg. fahr.	Temperature of Room in deg. fahr.					
Vacuum In. Hg.	Lb. Absolute		80 deg. fahr.	75 deg. fahr.	70 deg. fahr.	65 deg. fahr.	60 deg. fahr.	50 deg. fahr.
23.4	3.71	150	2.188	2.053	1.934	1.828	1.733	1.572
19.7	4.75	160	1.898	1.795	1.701	1.621	1.546	1.412
15.3	5.99	170	1.669	1.590	1.517	1.451	1.391	1.285
12.3	7.51	180	1.488	1.425	1.364	1.311	1.261	1.175
8.7	9.33	190	1.339	1.287	1.239	1.195	1.155	1.081
6.5	11.52	200	1.215	1.172	1.135	1.095	1.060	0.999
Lb. Gage								
1	15.7	215	1.064	1.029	1.000	0.971	0.943	0.894
2	16.8	219	1.030	1.000	0.970	0.941	0.915	0.870
3	17.8	222	1.004	0.976	0.947	0.921	0.897	0.851
4	18.9	225	0.982	0.954	0.929	0.902	0.878	0.835
5	19.6	227	0.964	0.936	0.909	0.887	0.864	0.822
6	20.8	230	0.943	0.917	0.892	0.869	0.847	0.806
8	22.8	235	0.907	0.883	0.860	0.839	0.818	0.781
10	24.9	240	0.875	0.853	0.831	0.810	0.791	0.756

These conversion factors multiplied by the heat loss from any radiator, operating under the indicated conditions, give the heat loss by the same radiator operating at 215 deg. fahr. in a room at 70 deg. fahr.

Table 26. Heat Emission of Direct Cast Iron Radiation for Hot Water—Single Column Radiators

Mean Water Temperature at 170 deg. fahr. — *Room Temperature at 70 deg. fahr.*

Length Inches	Number of Sections	45 In.		38 In.		32 In.		26 In.		23 In.		20 In.	
		Rated Surface Sq. Ft. S	Total B.t.u. per Hr. SR	Rated Surface Sq. Ft. S	Total B.t.u. per Hr. SR	Rated Surface Sq. Ft. S	Total B.t.u. per Hr. SR	Rated Surface Sq. Ft. S	Total B.t.u. per Hr. SR	Rated Surface Sq. Ft. S	Total B.t.u. per Hr. SR	Rated Surface Sq. Ft. S	Total B.t.u. per Hr. SR
	1	....	.....	3	740	2.5	630	2	510	1.66	430	1.5	390
5	2	....	.....	6	1220	5.0	1045	4	850	3.33	725	3.0	650
	3	....	.....	9	1700	7.5	1460	6	1190	5.00	1015	4.5	910
10	4	....	.....	12	2180	10.0	1875	8	1530	6.66	1310	6.0	1170
	5	....	.....	15	2660	12.5	2290	10	1870	8.33	1605	7.5	1430
15	6	....	.....	18	3140	15.0	2705	12	2210	10.00	1900	9.0	1690
	7	....	.....	21	3620	17.5	3120	14	2550	11.66	2190	10.5	1950
20	8	....	.....	24	4100	20.0	3535	16	2890	13.33	2485	12.0	2210
	9	....	.....	27	4580	22.5	3950	18	3230	15.00	2780	13.5	2470
25	10	....	.....	30	5060	25.0	4365	20	3570	16.66	3075	15.0	2730
	11	....	.....	33	5540	27.5	4780	22	3910	18.33	3360	16.5	2990
30	12	....	.....	36	6020	30.0	5195	24	4250	20.00	3650	18.0	3250
	13	....	.....	39	6500	32.5	5610	26	4590	21.66	3945	19.5	3510
35	14	....	.....	42	6980	35.0	6025	28	4930	23.33	4235	21.0	3770
	15	....	.....	45	7460	37.5	6440	30	5270	25.00	4530	22.5	4030
40	16	....	.....	48	7940	40.0	6855	32	5610	26.66	4825	24.0	4290
	17	....	.....	51	8420	42.5	7270	34	5950	28.33	5120	25.5	4550
45	18	....	.....	54	8900	45.0	7685	36	6290	30.00	5415	27.0	4810
	19	....	.....	57	9380	47.5	8100	38	6630	31.66	5710	28.5	5070
50	20	....	.....	60	9860	50.0	8515	40	6970	33.33	6000	30.0	5330
						Two-Column Radiators							
	1	5	1250	4	1050	3.33	860	2.66	725	2.33	640	2	540
5	2	10	1965	8	1640	6.66	1375	5.33	1145	4.66	1020	4	865
	3	15	2680	12	2230	10.00	1890	8.00	1565	7.00	1380	6	1195
10	4	20	3395	16	2820	13.33	2405	10.66	1985	9.33	1760	8	1520
	5	25	4110	20	3420	16.66	2920	13.33	2410	11.66	2135	10	1850
15	6	30	4825	24	4010	20.00	3435	16.00	2830	14.00	2515	12	2170
	7	35	5540	28	4600	23.33	3950	18.66	3250	16.33	2885	14	2500
20	8	40	6255	32	5190	26.66	4465	21.33	3670	18.66	3260	16	2825
	9	45	6970	36	5780	30.00	4980	24.00	4080	21.00	3635	18	3150
25	10	50	7685	40	6375	33.33	5495	26.66	4500	23.33	4015	20	3475
	11	55	8400	44	6970	36.66	6010	29.33	4930	25.66	4380	22	3800
30	12	60	9115	48	7560	40.00	6525	32.00	5350	28.00	4760	24	4120
	13	65	9830	52	8150	43.33	7040	34.66	5770	30.33	5130	26	4440
35	14	70	10545	56	8740	46.66	7555	37.33	6190	32.66	5500	28	4770
	15	75	11260	60	9330	50.00	8070	40.00	6610	35.00	5870	30	5100
40	16	80	11975	64	9930	53.33	8585	42.66	7030	37.33	6250	32	5420
	17	85	12690	68	10520	56.66	9100	45.33	7450	39.66	6620	34	5750
45	18	90	13405	72	11110	60.00	9615	48.00	7870	42.00	7000	36	6080
	19	95	14120	76	11710	63.33	10130	50.66	8290	44.33	7360	38	6410
50	20	100	14835	80	12300	66.66	10645	53.33	8710	46.66	7750	40	6730

Table 27. Heat Emission of Direct Cast Iron Radiation for Hot Water—Three-Column Radiators

Mean Water Temperature at 170 deg. fahr. — *Room Temperature at 70 deg. fahr.*

Length Inches	Number of Sections	45 In. Rated Surface Sq. Ft. S	45 In. Total B.t.u. per Hr. SR	38 In. Rated Surface Sq. Ft. S	38 In. Total B.t.u. per Hr. SR	32 In. Rated Surface Sq. Ft. S	32 In. Total B.t.u. per Hr. SR	26 In. Rated Surface Sq. Ft. S	26 In. Total B.t.u. per Hr. SR	22 In. Rated Surface Sq. Ft. S	22 In. Total B.t.u. per Hr. SR	18 In. Rated Surface Sq. Ft. S	18 In. Total B.t.u. per Hr. SR
	1	6	1480	5	1250	4.5	1100	3.75	905	3	750	2.25	600
5	2	12	2295	10	1950	9.0	1740	7.50	1450	6	1200	4.50	945
	3	18	3115	15	2645	13.5	2380	11.25	1990	9	1645	6.75	1295
10	4	24	3930	20	3345	18.0	3020	15.00	2525	12	2095	9.00	1640
	5	30	4750	25	4040	22.5	3660	18.75	3070	15	2540	11.25	1990
15	6	36	5560	30	4740	27.0	4300	22.50	3620	18	2990	13.50	2340
	7	42	6380	35	5430	31.5	4940	26.25	4170	21	3435	15.75	2695
20	8	48	7200	40	6130	36.0	5580	30.00	4710	24	3885	18.00	3045
	9	54	8020	45	6830	40.5	6220	33.75	5250	27	4335	20.25	3395
25	10	60	8830	50	7540	45.0	6860	37.50	5790	30	4780	22.50	3750
	11	66	9650	55	8225	49.5	7500	41.25	6310	33	5230	24.75	4100
30	12	72	10470	60	8930	54.0	8140	45.00	6855	36	5680	27.00	4450
	13	78	11390	65	9625	58.5	8780	48.75	7400	39	6125	29.25	4800
35	14	84	12100	70	10320	63.0	9420	52.50	7950	42	6575	31.50	5150
	15	90	12920	75	11010	67.5	10060	56.25	8500	45	7025	33.75	5500
40	16	96	13750	80	11700	72.0	10700	60.00	9050	48	7475	36.00	5850
	17	102	14570	85	12400	76.5	11340	63.75	9600	51	7920	38.25	6200
45	18	108	15380	90	13100	81.0	11980	67.50	10130	54	8360	40.50	6550
	19	114	16200	95	13800	85.5	12620	71.25	10670	57	8810	42.75	6900
50	20	120	17000	100	14500	90.0	13260	75.00	11200	60	9260	45.00	7250
						Four-Column Radiators							
	1	10	2040	8	1690	6.5	1430	5	1140	4	945	3	740
6	2	20	3300	16	2740	13.0	2320	10	1850	8	1530	6	1205
	3	30	4560	24	3780	19.5	3205	15	2565	12	2120	9	1665
12	4	40	5810	32	4820	26.0	4090	20	3275	16	2705	12	2120
	5	50	7075	40	5870	32.5	4980	25	3985	20	3300	15	2580
18	6	60	8330	48	6910	39.0	5870	30	4700	24	3880	18	3045
	7	70	9600	56	7960	45.5	6760	35	5410	28	4470	21	3505
24	8	80	10850	64	9000	52.0	7650	40	6120	32	5060	24	3965
	9	90	12100	72	10050	58.5	8530	45	6830	36	5640	27	4425
30	10	100	13350	80	11100	65.0	9420	50	7540	40	6230	30	4885
	11	110	14600	88	12130	71.5	10310	55	8250	44	6820	33	5350
36	12	120	15900	96	13180	78.0	11200	60	8960	48	7410	36	5810
	13	130	17150	104	14230	84.5	12190	65	9675	52	8000	39	6270
42	14	140	18400	112	15280	91.0	12980	70	10390	56	8580	42	6073
	15	150	19650	120	16320	97.5	13870	75	11100	60	9170	45	7190
48	16	160	20900	128	17370	104.0	14760	80	11810	64	9750	48	7650
	17	170	22200	136	18410	110.5	15650	85	12525	68	10340	51	8110
54	18	180	23450	144	19460	117.0	16530	90	13240	72	10930	54	8570
	19	190	24700	152	20500	123.5	17410	95	13950	76	11520	57	9030
60	20	200	25950	160	21550	130.0	18300	100	14700	80	12100	60	9490

Table 28. Heat Emission of Direct Cast Iron Radiation for Hot Water Hospital Radiators—Two-Column

Mean Water Temperature at 170 deg. fahr. — *Room Temperature at 70 deg. fahr.*

Length Inches	Number of Sections	45 In. Rated Surface Sq. Ft. S	45 In. Total B.t.u. per Hr. SR	38 In. Rated Surface Sq. Ft. S	38 In. Total B.t.u. per Hr. SR	32 In. Rated Surface Sq. Ft. S	32 In. Total B.t.u. per Hr. SR	26 In. Rated Surface Sq. Ft. S	26 In. Total B.t.u. per Hr. SR	23 In. Rated Surface Sq. Ft. S	23 In. Total B.t.u. per Hr. SR	20 In. Rated Surface Sq. Ft. S	20 In. Total B.t.u. per Hr. SR
	1	5	1300	4	1075	3.33	920	2.66	745	2.33	660	2	570
6	2	10	2060	8	1710	6.66	1470	5.33	1195	4.66	1061	4	920
	3	15	2820	12	2345	10.00	2010	8.00	1645	7.00	1462	6	1270
12	4	20	3580	16	2980	13.33	2560	10.66	2095	9.33	1863	8	1620
	5	25	4340	20	3615	16.66	3105	13.33	2545	11.66	2264	10	1970
18	6	30	5100	24	4250	20.00	3655	16.00	3000	14.00	2665	12	2320
	7	35	5860	28	4885	23.33	4205	18.66	3450	16.33	3066	14	2670
24	8	40	6620	32	5520	26.66	4750	21.33	3900	18.66	3567	16	3020
	9	45	7380	36	6155	30.00	5295	24.00	4350	21.00	3868	18	3370
30	10	50	8140	40	6790	33.33	5840	26.66	4800	23.33	4269	20	3720
	11	55	8900	44	7425	36.66	6390	29.33	5255	25.66	4670	22	4070
36	12	60	9660	48	8060	40.00	6940	32.00	5705	28.00	5071	24	4420
	13	65	10420	52	8695	43.33	7485	34.66	6155	30.33	5472	26	4770
42	14	70	11180	56	9330	46.66	8035	37.33	6605	32.66	5873	28	5120
	15	75	11940	60	9965	50.00	8580	40.00	7055	35.00	6274	30	5470
48	16	80	12700	64	10600	53.33	9125	42.66	7510	37.33	6675	32	5820
	17	85	13460	68	11235	56.66	9670	45.33	7960	39.66	7076	34	6170
54	18	90	14220	72	11870	60.00	10220	48.00	8410	42.00	7477	36	6520
	19	95	14980	76	12505	63.33	10765	50.66	8860	44.33	7878	38	6870
60	20	100	15740	80	13140	66.66	11310	53.33	9315	46.66	8280	40	7220
						Wall and Window Radiators							
		Wall 29 In.		22 In.		17 In.		20 In.		*Window* 16 In.		13 In.	
....	1	9	1880	7	1475	5	1095	5	1125	3.75	880	3	715
....	2	18	3595	14	2825	10	2115	10	1825	7.50	1425	6	1165
	3	27	5310	21	4175	15	3140	15	2520	11.25	1970	9	1610
	4	36	7025	28	5525	20	4160	20	3220	15.00	2515	12	2060
	5	45	8740	35	6875	25	5185	25	3915	18.75	3060	15	2505
....	6	54	10455	42	8225	30	6210	30	4610	22.50	3600	18	2955
....	7	63	12170	49	9575	35	7235	35	5310	26.25	4145	21	3405
....	8	72	13885	56	10925	40	8260	40	6005	30.00	4690	24	3850
....	9	81	15600	63	12275	45	9280	45	6700	33.75	5235	27	4300
....	10	90	17315	70	13625	50	10305	50	7400	37.50	5780	30	4745
....	11	99	19030	77	14975	55	11325	55	8095	41.25	6320	33	5195
....	12	108	20745	84	16325	60	12350	60	8800	45.00	6860	36	5640
....	13	117	22460	91	17675	65	13370	65	9495	48.75	7405	39	6090
....	14	126	24175	98	19025	70	14395	70	10190	52.50	7950	42	6535
....	15	135	25890	105	20375	75	15415	75	10885	56.25	8490	45	6980
....	16	144	27605	112	21725	80	16440	80	11580	60.00	9030	48	7435
....	17	153	29320	119	23075	85	17460	85	12280	63.75	9575	51	7880
....	18	162	31035	126	24425	90	18485	90	12975	67.50	10120	54	8330
....	19	171	32750	133	25775	95	19505	95	13670	71.25	10660	57	8780
....	20	180	34465	140	27125	100	20540	100	14365	75.00	11200	60	9230

TABLE 29. HEAT EMISSION OF DIRECT PIPE COIL RADIATION FOR STEAM

Steam Temperature at 240 deg. fahr.—Pressure 10 lb. per sq. in.—Room Temperature at 60 deg. fahr.

WALL COILS—Coils Placed Vertical—Pipes Horizontal

B.t.u. per Lineal Ft. of Coil per Hour. (Not Lineal Ft. of Pipe.)

Size of Coil	1"	1¼"	1½"
Single Row	175	215	245
Two	335	413	462
Four	584	724	816
Six	752	930	1050
Eight	864	1064	1200
Ten	970	1200	1350
Twelve	1075	1330	1500

WALL COILS—Coils Placed Vertical—Pipes Vertical

Emission varies in inverse ratio of the height of the coil. Use 133 B.t.u. per lineal ft. of pipe as an average for 1¼ in. coil, 10 ft. high.

CEILING COILS—Coils Placed Horizontal—Pipes Horizontal

Emission is equal to that of a single row coil.

Allowance must be made however, if the coil is at the ceiling in a higher temperature.

In this case use 167 B.t.u. per lineal ft. of pipe for 1 in. coils.
206 " " " " " " 1¼ in. coils.
231 " " " " " " 1½ in. coils.

Note.—This Table has been developed by a method of deduction from the available data on such experimental work on pipe coils as has been recorded, and does not represent definite results of tests as in Tables 17 to 30. The values are therefore approximate only but can be used with assurance that they are more accurate than those obtained by the usual method for calculating pipe coil surface.

TABLE 30. HEAT EMISSION OF DIRECT PIPE COIL RADIATION FOR HOT-WATER

Water Temperature at 180 deg. fahr. Room Temperature at 60 deg. fahr.

WALL COILS—Coils Placed Vertical—Pipes Horizontal

B.t.u. per Lineal Ft. of Coil per Hour. (Not Lineal Ft. of Pipe.)

Size of Coil	1"	1¼"	1½"
Single Row	105	131	147
Two	198	248	276
Four	352	432	488
Six	456	558	630
Eight	520	640	720
Ten	583	720	810
Twelve	645	800	900

WALL COILS—Coils Placed Vertical—Pipes Vertical

Emission varies in inverse ratio to the height of coil. Use 80 B.t.u. per lineal ft. of pipe as an average for 1¼ in. Coil 10 ft. high.

CEILING COILS—Coils Placed Horizontal—Pipes Horizontal

Emission is equal to that of a single row coil.

Allowance must be made however, if the coil is at the ceiling where the temperature is higher.

In this case use 100 B.t.u. per lineal ft. of pipe for 1 in. coils.
125 " " " " " " 1¼ in. coils.
138 " " " " " " 1½ in. coils.

Note.—See note under Ceiling Coils for Steam.

RADIATION FOR ROOM TEMPERATURES

The following table from the Establishment of Standard Methods of Proportioning Direct Radiation, by James A. Donnelly (TRANSACTIONS, Vol. 21, p. 535) gives the proportionate heat losses from buildings, the proportionate transmission from direct radiators, and the proportionate radiation required (with steam at 210 deg.) for various room temperatures, when the outside temperature is zero:

TABLE 31. EFFECT OF ROOM TEMPERATURE ON HEAT LOSS AND SIZE OF RADIATOR

Room Temperature	Proportionate Loss in B.t.u.	Difference in Temperature Between Radiator and Room	Proportionate Transmission in B.t.u.	Room Temperature	Proportionate Surface Required Sq. Ft.
35	0.50	175	1.34	35	0.37
40	0.57	170	1.29	40	0.44
45	0.64	165	1.24	45	0.52
50	0.71	160	1.19	50	0.60
55	0.79	155	1.14	55	0.69
60	0.86	150	1.09	60	0.78
65	0.93	145	1.05	65	0.89
70†	1.00†	140†	1.00†	70†	1.00†
75	1.07	135	0.95	75	1.12
80	1.14	130	0.91	80	1.26
85	1.21	125	0.87	85	1.40
90	1.29	120	0.82	90	1.56
95	1.36	115	0.78	95	1.74
100	1.43	110	0.74	100	1.93
105	1.50	105	0.70	105	2.15
110	1.57	100	0.66	110	2.39
115	1.64	95	0.62	115	2.66
120	1.71	90	0.58	120	2.95

† Standard Conditions.

Assuming that the rate of heat loss from a building varies directly with the difference between the outside temperature and the building temperature, and considering the heat loss for zero outside, 70 deg. inside as the standard, or 100 per cent; the second column shows the proportionate loss of heat from a building when the outside temperature is zero, and the inside temperature is as given in the first column.

Assuming that the rate of transmission from a direct radiator to the air of a building is in proportion to their difference in temperature, with a variation in the rate of transmission of 2 per cent, greater or less, for each 10 deg. increase or decrease in their temperature difference, and considering 140 deg. difference in temperature (steam 210 deg., building 70 deg.) as standard, or 100 per cent transmission, the second column shows the proportionate transmission when the difference in temperature is as given in the first column.

Assuming that under standard conditions of outside temperature zero, building temperature 70 deg., and radiator temperature 210 deg. (or 140 deg. difference between the radiator and room) the amount of radiation necessary is 100 per cent, the proportionate amounts of radiation given in the second column are those necessary to heat a building to the temperatures given in the first column, when the outside temperature is zero.

Note.—The amount of surface required for heating is always obtained by dividing the heat loss from the building by the amount of heat transmitted per square foot of radiation. Therefore, as may be seen from the above tables, the proportionate amount of surface required for heating is obtained by dividing the proportionate heat loss from the building by the proportionate transmission of the radiator, in each case.

The preceding table may be used to find the proportionate amount of radiation necessary to heat a room to any desired inside temperature, other than 70 deg., when the outside minimum temperature is other than zero, and with a radiator temperature other than standard. Find the difference between the outside temperature and the room temperature in the first column; divide the proportionate heat loss opposite this amount,

in the second column, by the proportionate transmission opposite the difference in temperature between the radiator and the room, as given in the fourth column, and the result will be the proportionate amount of radiation required.

Example.—What is the proportionate amount of radiation required to heat a room to 90 deg., with a temperature of 20 deg. below zero outside, and a steam temperature of 240 deg.

Solution.—The difference in temperature between 20 deg. below outside, and 90 deg. inside, is 110 deg. Opposite 110, the proportionate heat loss or 1.57 is found in the second column. The difference in temperature between the radiator and the room (steam 240 deg., room 90 deg.) is 150 deg. Opposite this, the proportionate transmission 1.09 is found in the fourth column. Divide 1.57 by 1.09 and the quotient, 1.44 is the proportionate amount of radiation required.

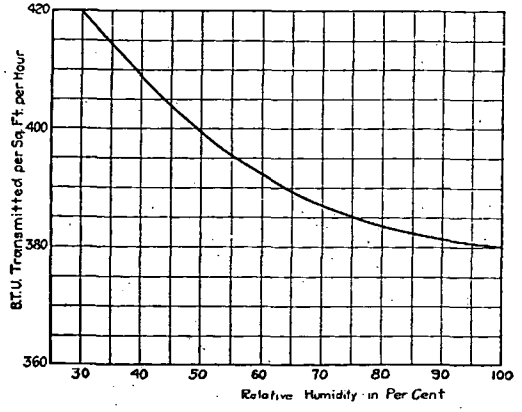


FIG. 8. EFFECT OF HUMIDITY ON HEAT TRANSMISSION

The late John R. Allen, while Director of the Society's Research Laboratory, submitted a paper as a report (A. S. H. V. E. JOURNAL, January, 1920), which in addition to the treatise on the heat emitted by various types of radiation, from which the preceding tables were calculated gives other data from which the following is taken.

EFFECT OF HUMIDITY

Fig. 8 shows the effect of increasing the humidity upon the heat transmission. It will be noted that with extreme change of humidity there is a slight change in the heat transmission, the heat transmission reducing slightly as the humidity increases. Humidity can have very little, if any effect upon radiation, and the effect of humidity must therefore change the convected heat lost by the radiator. This change of convected heat is probably due to the change in the density of the air passing over the radiator.

EFFECT OF AIR CIRCULATION

The amount of heat given off by a radiator may also be increased by increasing the velocity of the air over the surface of the radiator. This increase in velocity will increase the amount of heat carried off by convection. No exact data are available on the effects that may be introduced by increasing these velocities over radiator surfaces, but in rooms with moving machinery the heat transmission is increased approximately 10 per cent.

WARMING THE RADIATOR

It is often very important to know the maximum condensation that occurs in a radiator when steam is turned on. Fig. 9 shows the condensation rate in pounds per hour for the time elapsing after steam is turned into the radiator. It will be noticed that the maximum condensation occurs 10 min. after steam is turned on, and in that

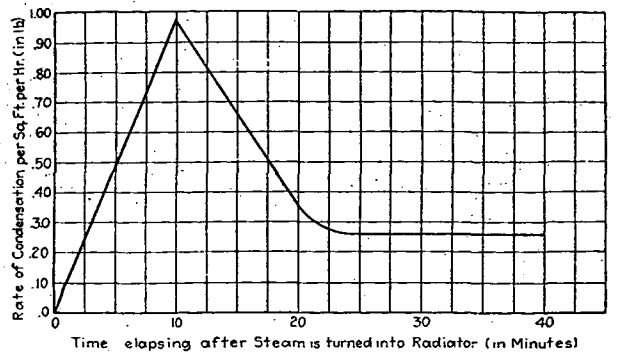


FIG. 9. CHART SHOWS DEMAND UPON BOILER FOR HEATING-UP PLANT

case it amounts to about three and one-half times normal condensation. After the end of 25 min., the radiator had reached a normal rate of condensation. This curve was made from observations at intervals of 10 min. so that the intermediate points between the 10 min. points are not known, and the form of the curve is not exact. It shows, however, that in starting a plant, the demand made upon the boiler may be very much higher than the normal demand.

EFFECT OF PAINTING

The effect of painting was originally determined by experiments made with a cast iron rectangle; and in applying these to radiators of standard type, corrections must be made to allow for the difference between the area of the radiating and convecting surfaces. The effect of painting is to change the radiation constant of the radiating surface and has practically no effect upon the heat lost by convection. It is, therefore, a surface effect and it makes no difference what paints are placed on the radiator as a priming coat, the results are always dependent upon the last coat of paint put upon the radiator. In radiators having a large proportion of radiating surface such as pipe coils or wall coils, the effect of painting will be more marked than in four-column radiators having a comparatively small radiating surface in proportion to convecting surface. All finely ground materials have about the same radiation constant. Therefore all paints having finely ground pigments will give about the same effect. Metals have a poor radiating effect so that any paint involving flake metal, such as the bronze, will have a low radiating constant. The following Table 32 shows the heat loss from a two-column 38-in. radiator, 10 sections long, when painted with different kinds of paints:

TABLE 32. EFFECT OF PAINTING ON TWO-COLUMN 38-IN. RADIATOR, STEAM TEMPERATURE 215 DEG., ROOM TEMPERATURE 70 DEG. FAHR.

CONDITION OF SURFACE	Per Cent	CONDITION OF SURFACE	Per Cent
Cast iron bare	240	Painted with white enamel	242
Painted with aluminum bronze	200	" " maroon Japan	240
" " gold bronze	205	" " white zinc paint	242
Painted with no-lustre green enamel	230		

EFFECT OF ENCLOSING THE RADIATOR

It is very often desirable to partly enclose or conceal a radiator by means of screens or grills. All such enclosures in general reduce the heat transmission from the radiator, the effect being both to reduce the radiant heat and the convected heat. As in most radiators, the convected heat is at least two-thirds of the heat transmission, these enclosures or screens largely affect the convected heat. It is therefore very desirable that the current of air passing over and through the radiator should be restricted as little as possible. There has been some experimental work done, particularly abroad, with reference to these screens. There are, however, so many different cases that may arise that it will not be possible to discuss all of them but only to take up typical ones.

Case No. 1.—In this case, Fig. 10, the radiator is enclosed in a box with a screen in front and at the bottom, and a screen at the top, these screens extending the full length of the radiator. This arrangement reduces the heat transmission of the radiator from 7 to 10 per cent and in all cases, the spaces between the radiator and the wall and the spaces between the casing and the radiator should be at least 2½ in. The reduction of heat transmission will be more in narrow radiators than in wide radiators. Experiments show that the best results are obtained when the opening at the top has twice the width of the opening at the bottom, and for radiators of ordinary type the width of opening at the bottom should be 5 in. and the opening at the top, 10 in.

Case No. 2.—It is sometimes desirable to place a screen in front of the radiator, leaving the top entirely open with an opening at the bottom in front for the cold air to enter the radiator, as in Fig. 11. In a case of this kind the effect of the screen is to produce a strong current of air and if this screen is high enough it may even produce a chimney effect which will increase heat transmission from the radiator due to increased circulation. The effect of such screens depends entirely upon their height. Professor Brabbee states that, with a screen 72 in. high and a 49-in. radiator, the heat transmission will be increased 12 per cent.

Case No. 3.—Radiators often have placed over them a flat shelf, as shown in Fig. 12. In such case, they should be provided with a deflector as shown. The effect of the shelf very largely depends upon the height of the shelf above the radiator. When the distance *D*—that is the height of the shelf above the radiator—is 5 in. or over, the effect of the shelf may be neglected. When the distance *D* is reduced to 4 in., the heat effect may be reduced by 4 per cent.

Case No. 4.—Radiators are often enclosed in boxes with a grill in front or recessed in the wall with a grill placed in front of them as in Fig. 13. In such cases, the height, *D*, is very important. With *D* equal to 2½ in., the heat transmission will be reduced 20 per cent, and with *D* equal to 6 in., the heat transmission is reduced 10 per cent. It is assumed in this case that the entire front of the box is provided with an open grill.

Case No. 5.—Sometimes a grill, as shown in Case 4, is partly replaced by a solid panel with openings above and below as in Fig. 14. With the openings the full length of the radiator and 6 in. in height and with *D* not less than 4 in., the heat transmission will be reduced 25 per cent. As *D* is reduced in height, the heat transmission will also be reduced and with *D*, 2½ in., the reduction will be 40 per cent.

Case No. 6.—Radiators are often placed under seats as in Fig. 15. In this case the distance between the top of the radiator and the bottom of the seat becomes very important and should be not less than 3 in. and if possible it should be made 6 in. Under favorable conditions, when *D* is at least 3 in. and *A* is equal to 6 in., the heat transmission will be reduced from 15 to 20 per cent. When *D* is small, however, say 2 in., and *A* is reduced to 4 in., this reduction may be 35 or 40 per cent.

In tests[1] by Prof. K. Brabbee will be found other cases than those cited above.

[1] Reported by George Stumpf, Jr., in *Heating and Ventilating Magazine*, May 1914, p. 23.

EFFECT OF POSITION

The effect of position on heat transmitted by a radiator is a subject that has been investigated to a very limited extent. Experiments that are now available show the heat loss from a radiator is about the same whether it is placed on the floor, at the ceiling or in the middle of the

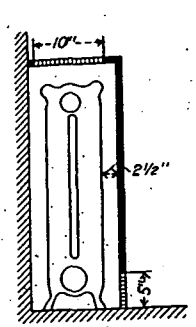


FIG. 10

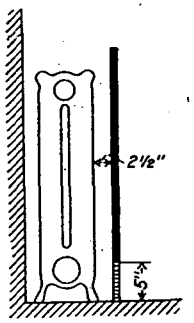


FIG. 11

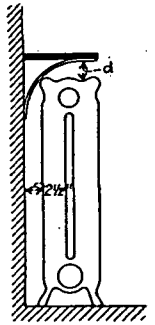


FIG. 12

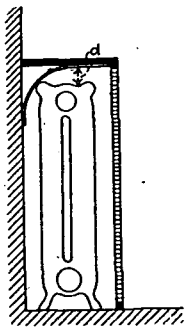


FIG. 13

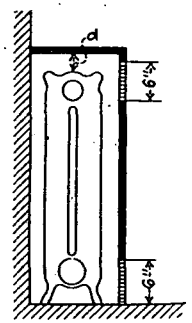


FIG. 14

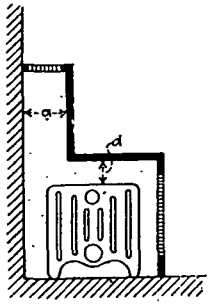


FIG. 15

DIFFERENT ARRANGEMENTS OF RADIATORS IN ENCLOSURES

room, air temperatures being the same. It seems to make very little difference whether it is placed near the wall or near the middle of the room, as far as condensation is concerned. There is, however, a considerable difference in the heat of the room and the maintaining of a warm floor. This is particularly the case in rooms in which there is very little circulation of air, due to mechanical means. Many factories that were effectively heated with ceiling radiation when belt drives were used have found it necessary to relocate the radiation at the floor, when direct motor drives were installed on machines. It has been found under these conditions that high temperatures prevail at the ceiling while low tem-

peratures prevail in the working space. Not only operators have been affected under these conditions but also the output of the individual machines. Best results are obtained when the radiators are placed under the windows and adjacent to doors to the outside. The air heated by the radiators under the windows, rises, mixes with the cold infiltrating air from the windows, circulates across the ceiling, gradually settles to the floor, is drawn up by the radiator and the cycle continues. The advantage of placing radiators adjacent to the door is that the infiltration at this point is compensated for, the infiltrating air being warmed before it enters the heated space.

Placing a radiator close to an outside wall heats the wall immediate behind the radiator, but the infiltrating air through this wall absorbs this heat in part, the rest being used to compensate for the transmission losses through the wall.

SPECIFICATION CLAUSES

Specifications for radiation should contain the following clauses:

1. Manufacturers must guarantee that the heat emission per radiator shall not fall below the values given in Tables 18 to 30.

2. Radiation must be free from flaws on surface and leaks at nipple connections, and guaranteed to stand a hydrostatic test of not less than 100 lb. per sq. in.

3. Radiation must be thoroughly cleaned of all core sand, and if for vapor or modulation steam systems must be washed out and the openings plugged before shipment.

4. Radiation must not be placed where dirt can get into the interior and if to be placed in the weather or damp location must be given a priming coat of paint before shipment or immediately upon delivery at location.

5. Long or low radiators should be crated, and the crating not removed until placed in final location.

6. Radiators supported from the wall or ceiling shall be supported on steel or wrought iron hangers.

CHAPTER III

STEAM HEATING SYSTEMS

PIPING systems for steam heating are broadly classified as one-pipe, two-pipe, vapor, and vacuum systems, with either gravity or mechanical circulation.

One-pipe systems have but one connection to the radiator, the air being ejected through air valves on the end opposite this connection. In this system the condensation from the radiators returns to the boiler through the supply risers and either through the steam main, Fig. 16 or through a wet return receiving the drip from the heel of each riser or radiator connection, Fig. 17.

Two-pipe systems have two connections to the radiators, one for steam, the other for condensation, air being ejected through air valves as in the one-pipe system. Fig. 18 shows a two-pipe gravity return system.

Vacuum systems employ a vacuum return pump to produce a vacuum in the system and return the condensation to the boiler. This system is thus essentially, a mechanical circulation system.

Vapor or *air return systems* are two-pipe systems in which all the air is returned from the radiator through a dry return to a central point from which it is ejected from the system. This system may or may not use thermostatic traps on the return end of the radiators and the pressure used is generally not over a few ounces. Graduated supply valves on the radiators may or may not be required. Fig. 19 shows a two-pipe return line vacuum and vapor systems, which may operate either as a return line vacuum system, an automatic return line vapor system or as a gravity return vapor system and shows the principle of connecting up any one of these three types.

This system has many variations, employing various specialties which are usually patented, and determine the name of the patented system. Owing to their specialized nature, none are illustrated here but catalogue data on several systems are given in this volume.

Gravity circulation is the term used to indicate any system where the condensation returns to the boiler by natural flow. Wherever this is the case a certain differential must be allowed between the water line in the boiler and the low point of the steam main and the dry return in order to allow for pressure drop in the piping system. This differential is usually from 18 to 30 in.

Mechanical circulation indicates any system where the condensation is returned to the boiler by means of a pump. It is used where some of

Material for this section compiled by Perry West and R. V. Frost.

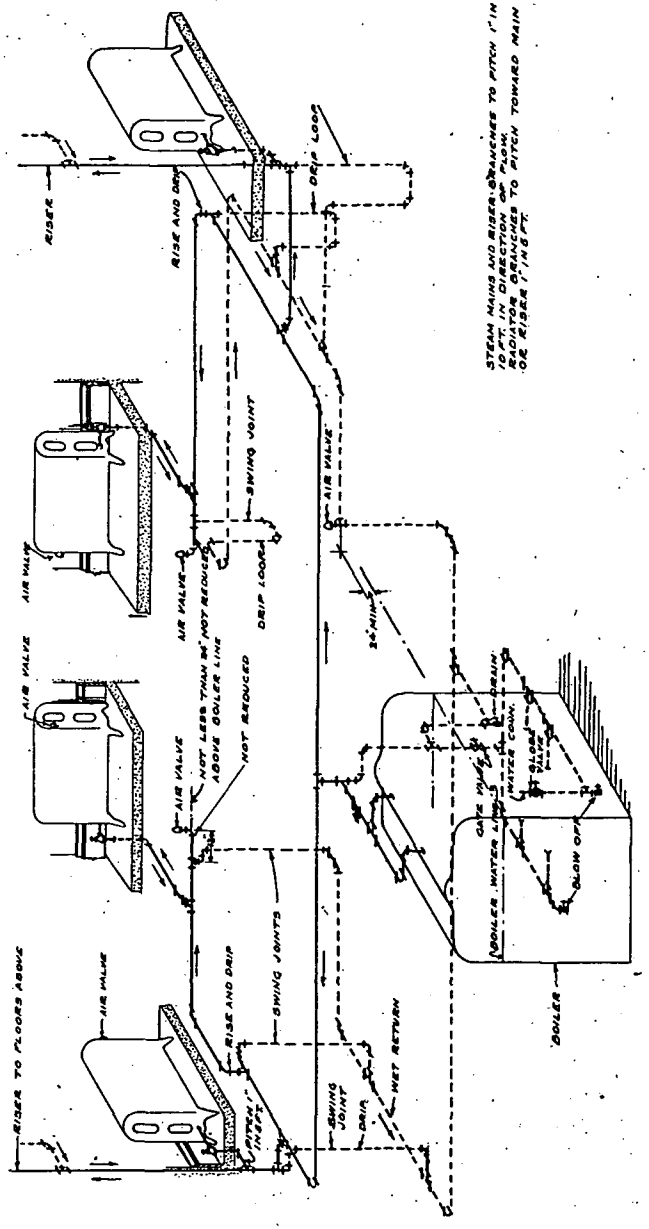


FIG. 16. ONE-PIPE RELIEF GRAVITY RETURN SYSTEM

the radiation is below the water line of the boiler, where the distance between the boiler and the radiation is very great or where high pressure boilers are used. All four systems may employ mechanical circulation, but it is infrequently used in a one-pipe plant. Pumps for producing mechanical circulation are discussed in Chapter VIII.

There are two broad divisions that may be very definitely made in the subject of steam main sizes as proposed by James A. Donnelly in Code of Minimum Requirements for the Heating and Ventilation of Buildings. The first covers the distribution of the steam, and the second its use. The conveyance of steam for any considerable distance is a problem by itself, needing separate analysis and altogether different handling from any of the problems concerning the use of the steam after it has arrived at the building to be heated. Steam flow tables should be used for distribution, and tables giving the capacities of steam mains and branches, radiator connections, etc., under standard and average conditions of use should be applied for sizing the pipes within the buildings.

For this reason, data may be divided into two classes or groups: (1) *transmission mains;* (2) *service piping.*

Transmission mains are those that have to do with the conveying of steam for a distance of considerable extent, through or between buildings and for collecting and returning the water of condensation from the several sections or buildings.

Service piping is that part of the apparatus by which the radiating units are connected to the transmission mains.

The velocities of flow used in the distribution of steam are only limited by the available or allowable drop in pressure, while the velocities within the buildings where the steam is used are limited by the critical velocities or the velocities which will allow of sufficient separation of the condensation so that defective circulation or water hammer will not occur.

STEAM HEATING PIPE SIZES

In using tables for steam heating pipe sizes, it is frequently hard to determine the length of run upon which they are based. Usually some allowance is made for one or more such items as: condensation in the pipe, equivalent length of fittings, and valves, etc., but it is generally hard to determine what factors have been allowed for, and what percentage of allowance has been made. In compiling the tables and other data for THE GUIDE, 1925-26 every attempt has been made to eliminate such indefinite and conflicting factors.

The three principal factors upon which the determination of pipe sizes for steam heating depends are:

1. The equivalent length of the run from the boiler, or source of steam supply, to the farthest radiator.

2. The total pressure drop, which may be allowed, between the source of supply and the end of the return system.

3. The peculiar conditions surrounding the particular plant in question.

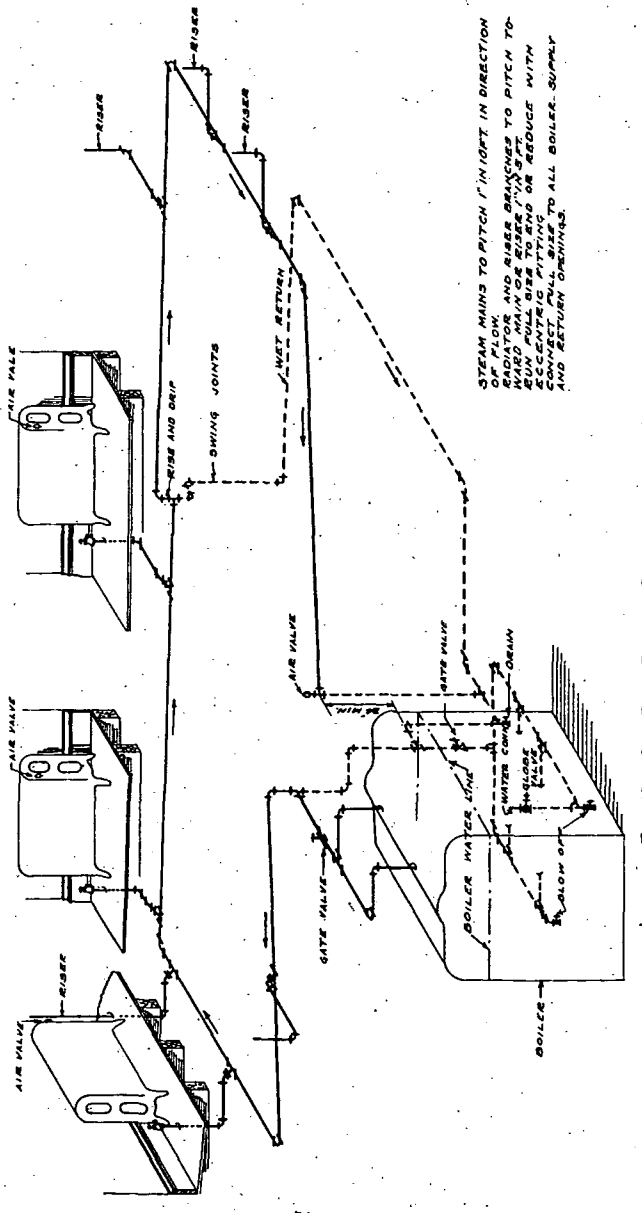


FIG. 17. ONE-PIPE CIRCUIT GRAVITY RETURN SYSTEM

Length of Run

The length of run must not only include the actual linear feet of straight pipe, but also the proper allowance for fittings, valves and other items which cause drop in pressure.

Pressure Drop

In the matter of pressure drop there are, theoretically, several factors to be considered, including: the initial pressure, the pressure required at the end of the line, fluctuations in the initial pressure, the distance between the bottom of the lowest radiator and the water line of the boiler (where the condensation is to be returned by gravity), the extra load on the system during heating-up periods, and the critical velocity of the steam (especially in risers and branches where the steam and condensate flow in opposite directions), and in other lines where high velocities are objectionable from the standpoint of noise, or the entrainment of condensate.

With a high initial pressure it is theoretically possible to allow much greater drops in pressure if there is sufficient distance between the lowest radiator and the water line of the boiler in a gravity system or if the condensate is returned to the boiler by mechanical means. In attempting any very great drops in pressure, the following practical difficulties present themselves:

1. If the system is designed to secure the same drop in pressure for each unit of radiation (including those nearest, as well as those farthest from the source of supply) the velocity necessary to equalize these drops in the shorter runs will be so high that serious trouble will be encountered from noise and the entrainment of the condensate.

2. If the system is so designed as not to equalize these pressures, the condensate returning from radiators near the source of supply will be at a correspondingly higher temperature than that from radiators farthest from the source of supply, thus causing re-evaporation and pressures in the return system with consequent backing-up from one radiator to another, the holding-up of the return and the filling of the return lines, with too large a percentage of steam instead of condensate.

It has been found, therefore, that while it may be theoretically possible to design a system for relatively large pressure drops, it is generally more satisfactory to design all steam heating systems on the basis of a low initial pressure and reasonably low total drops in pressure. The matter of fluctuations in pressure should be taken into consideration wherever the steam is to be supplied directly from the boiler, to the radiators at boiler pressure and the system should be designed to operate properly with the lowest pressure under which the boiler may operate.

The extra load which the system is required to carry during heating-up periods depends somewhat upon the actual length of time through which the building will be allowed to cool between the heating periods, but more largely upon the length of time which will be allowed for heating the building up at the beginning of each of these periods. In any case, the rapidity with which air is removed from the radiation either by free venting to the atmosphere or by mechanical return line systems will largely determine the rapidity with which steam must be supplied. With reasonably free venting, the steam supply requirements during the heating-up period may run as high as 300 per cent of the normal maxi-

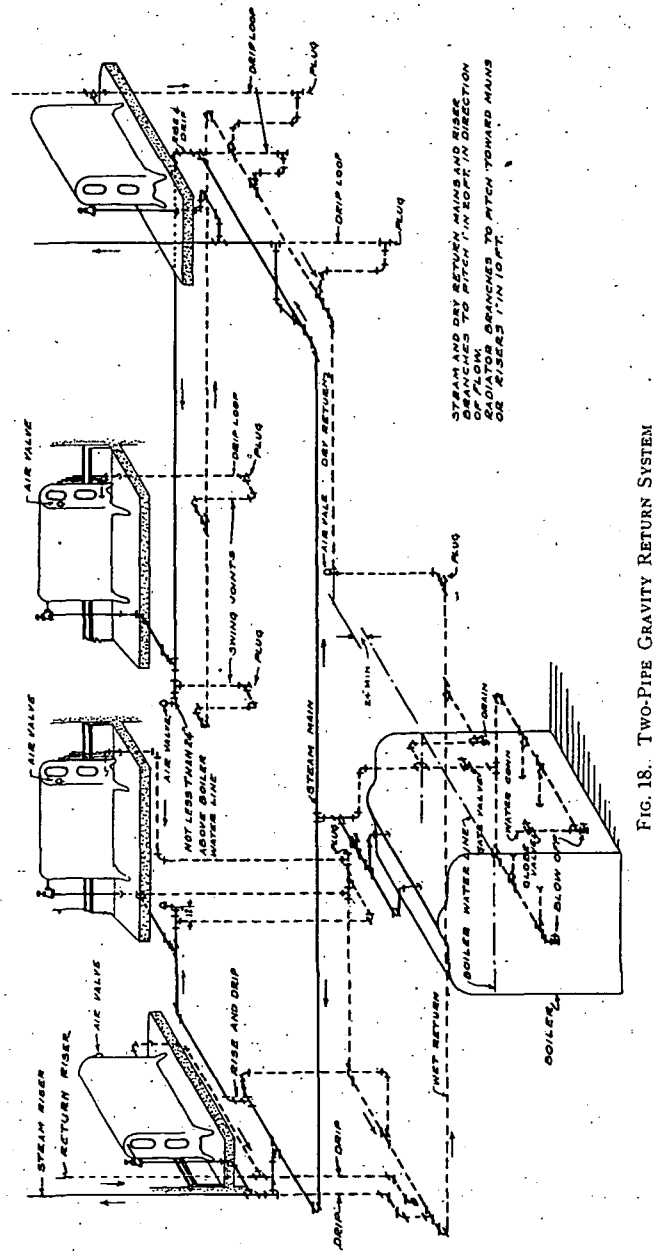


FIG. 18. TWO-PIPE GRAVITY RETURN SYSTEM

mum load under running conditions. Allowances should be made for this extra demand, but inasmuch as the steam supply and the demand are somewhat self-regulating, so that if the demand is greater than the supply the pressure will drop and the supply be automatically reduced, the allowance generally made is considerably under 300 per cent. It is more economical to allow for a certain amount of overloading of the system during the heating-up periods and to allow a little more time for heating up than would otherwise be required.

In the matter of initial pressure and return conditions it is undoubtedly true that with a constant initial pressure (such as is produced by a high pressure supply by means of a pressure reducing valve, or from the boiler direct where the pressure is maintained constant), somewhat higher drops in pressure and correspondingly smaller pipe may be successfully used. It is also undoubtedly true that, with a mechanical return line system where a constant vacuum of any desired degree of from 5 to 15 in. of mercury may be maintained, the factor of fluctuations in initial pressure and the difficulties from high velocities and re-evaporation are reduced, so that the pressure drops may also be higher and the pipe sizes smaller.

Unusual Conditions

Under this heading are the character and class of the building, the periodicity of use and the degree of normal temperature to be attained at the beginning of each period of use.

In public buildings, schools, offices, places of assemblage, and such buildings (where the occupants are normally at rest) the building should be heated to its normal temperature at the beginning of each period of use. In some buildings (especially offices, schools and public buildings), the time between heating periods is relatively short; whereas, in others (such as churches, places of assemblage, etc.), these periods are comparatively long. In commercial buildings such as factories, warehouses, etc., where the occupants are normally exercising, it is not necessary for the building to be heated to normal temperature at the beginning of its period of use. These facts should be taken into consideration in the matters of allowances which are to be made in the capacity of the system.

GENERAL DATA ON PIPE SIZE TABLES

The following pipe size tables have been compiled for use in designing steam heating systems, and may be used, by those experienced in the profession, with satisfactory results. The following general principals should be observed:

1. The initial pressure should not exceed 16 oz. gage.

2. The drop in pressure in the mains and riser to the farthest radiator should not exceed 1 oz. per 100 ft. of straight pipe or its equivalent length, with a lower rate of drop for systems with long runs.

3. The total drop in pressure from the source of supply to the farthest radiator, should not exceed 2 oz. to 8 oz. and should not exceed one-half the boiler pressure.

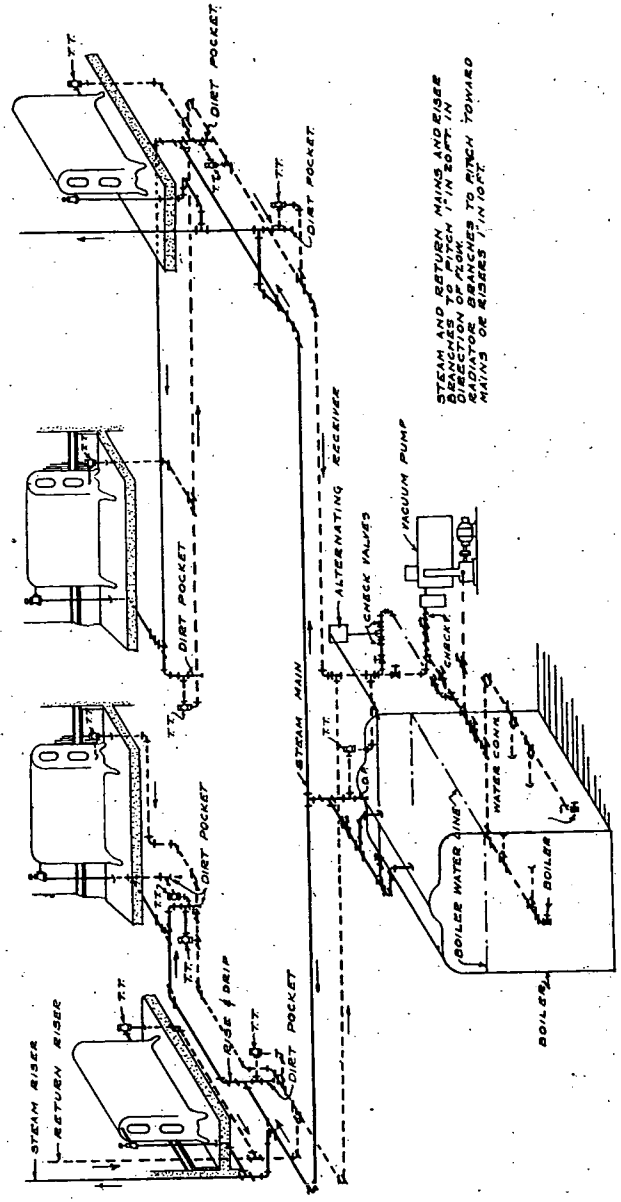


FIG. 19. VACUUM AND VAPOR SYSTEM

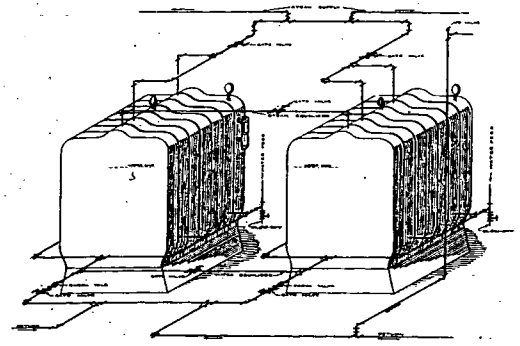


FIG. 20. CONNECTING TWO BOILERS USING CHECK VALVES AND EQUALIZERS IN RETURNS

4. In small installations, such as residences, where the longest actual run is seldom over 200 ft., and where the firing periods extend over several hours, resulting in boiler pressure, fluctuating from zero to about 1 lb., the total pressure drop should not exceed 2 oz. In larger buildings, where boilers are under the constant care of a fireman, a uniform boiler pressure is maintained, and where the water line difference will permit, the total drop in pressure may range from 2 to 8 oz., depending upon the equivalent length of the longest run. If the equivalent length of the longest run were 600 ft. the total pressure drop would be 6 oz., a rate of 1 oz. per 100 ft. The total drop in pressure between the boiler and the farthest radiator, even in a sky scraper, should not exceed 8 oz. If the main and riser to the farthest radiator had an equivalent run of 1600 ft., it would be laid out on a ½ oz. drop basis per 100 ft., total drop of 8 oz. in 1600 ft.

5. The total allowable drop in pressure depends upon (*a*) the water line difference, (*b*) the equivalent length of main and riser from the boiler to the farthest radiator, and (*c*) the regularity of the pressure maintained at the boiler or source of steam supply.

6. The water line difference or distance between the water line of the boiler and the low point of steam main or dry return main should not be less than 24 in., because of the heavy drop in pressure from condensation in heating up a cold system. This difference should be increased 2 in. for every ounce pressure drop in the system. If the total pressure drop were 6 oz., the water line difference should be $6 \times 2 + 24$ or 36 inches.

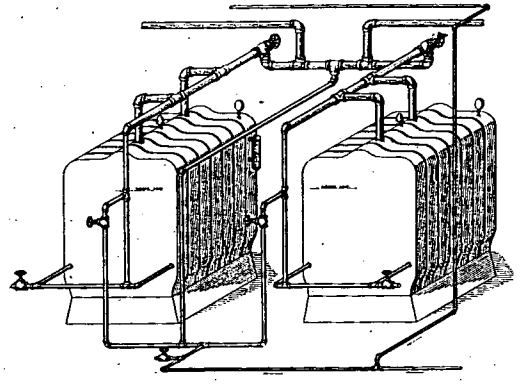


FIG. 21. CONNECTING TWO BOILERS USING THE HARTFORD RETURN LOOP

7. There should be a uniform drop in pressure between the source of steam supply and the farthest radiator on every riser. With a boiler pressure of 16 oz. and a maximum total pressure drop of 8 oz., the steam pressure at the supply valve of the farthest radiator on each riser should be 8 oz. The riser whose farthest radiator is 100 ft. from the main would be sized on a drop of 8 oz. per 100 ft. minus the drop in the main to this riser connection; while one, 200 ft. from the main would be sized on a drop per 100 ft. —one-half of the difference between the drop of 8 oz. and the drop in the main to the riser connection.

The total drop, minus the drop in the main to the point of connection to any riser, divided by the equivalent length of the riser from the main to the farthest radiator in hundreds of feet, gives the drop per 100 ft. in the riser. For a total drop 6 oz., with the farthest radiator on riser No. 4, 200 ft. equivalent from the main and this riser

TABLE 33. FLOW OF STEAM IN PIPES

P = Loss in pressure in lb.
d = Inside diameter of pipe in inches
L = Length of pipe in feet
D = Weight of 1 cu. ft. steam
W = Lb. of steam per min.

$$W = 87.0\sqrt{\frac{P\,D\,d^5}{\left(1+\frac{3.6}{d}\right)L}}$$

$$P = 0.000132\left(1+\frac{3.6}{d}\right)\frac{W^2\,L}{D\,d^5}$$

Pressure Loss in Oz.	Col. 1 $87.0\sqrt{\frac{P}{100}}$	Inside Dia. Pipe	Col. 2 $\sqrt{\frac{d^5}{1+\frac{3.6}{d}}}$	Steam Pressure By Gage	Col. 3 $\sqrt{D}$	Length Pipe in Feet	Col. 4 $\sqrt{\frac{100}{L}}$
1	2.175	1	0.522	0.0	0.193	20	2.240
2	3.076	1¼	1.177	0.3	0.195	40	1.580
3	3.767	1½	1.828	1.3	0.201	60	1.290
4	4.350	2	3.709	2.3	0.207	80	1.120
5	4.863	2½	6.109	5.3	0.223	100	1.000
6	5.328	3	11.183	10.3	0.248	120	0.912
7	5.754	3½	16.705	15.3	0.270	140	0.841
8	6.152	4	23.630	20.3	0.290	160	0.793
10	6.878	4½	32.098	30.3	0.326	180	0.741
12	7.532	5	43.719	40.3	0.358	200	0.710
14	8.138	6	69.718	50.3	0.388	250	0.632
16	8.700	7	105.35	60.3	0.415	300	0.578
20	9.727	8	150.33	75.3	0.452	350	0.538
24	10.655	9	205.37	100.3	0.507	400	0.500
28	11.509	10	271.16	125.3	0.557	450	0.477
32	12.290	12	437.51	150.3	0.603	500	0.447
40	13.756	14	733.90	175.3	0.645	600	0.407
48	15.069	16	925.19	200.3	0.685	700	0.378
80	19.454	.....	.....	.....	.....	800	0.354
160	27.512	.....	.....	.....	.....	900	0.333
320	38.863	.....	.....	.....	.....	1000	0.316
480	47.652	.....	.....	.....	.....	1400	0.267

Column 1 × 2 × 3 × 4 = lb. steam per min. will flow through a straight pipe for a given condition.

Example.—1 oz. drop — 2-in. pipe — 1.3 lb. press. — 100 ft. long. — 2.175 × 3.709 × 0.201 × 1 = 1.615 lb. per min., then 1.615 × 60 — 20 per cent = 77.28 lb. per hr.

Preceding table does not allow for entrained water in low-pressure steam, condensation in covered pipe and roughness in commercial pipe, therefore reduce calculated capacities approximately 20 per cent.

connection 100 ft. from the source of supply, this riser would be sized on a basis of $\frac{6-1}{2}$ or 2½ oz. drop per 100 ft. of riser.

In using this method experience indicates that no pipe carries a velocity above the critical value of 20 ft. per second where steam and condensate flow in opposite directions, or above 50 ft. per second elsewhere on account of noise and entrainment difficulties.

8. In order to get uniform distribution of steam throughout the entire system, it is necessary to control the flow by reducing the riser sizes nearer the boiler. The nearer the riser is to the boiler, the greater will be its drop in pressure per 100 ft., since the total drop at the top of all risers should be practically the same.

9. Pipe sizes are figured on a pressure drop basis for undirectional flow or on a critical velocity basis for counterflow, depending upon whether the steam and water flow in the same or in opposite directions.

10. Due to the high rate of condensation in heating up a cold system the critical velocity should be figured at not over 20 ft. per second which will give velocities considerably below the critical velocity once the system is heated.

PIPE SIZES

Table 33 gives the numerical value of the four factors of the Babcock formula for various sizes and lengths of pipe and various initial pressures and pressure drops. By multiplying together the four factors for any set of conditions the pounds of steam per minute which will flow through the pipe may be found, as illustrated in the example below the table.

Table 34 is a basic table giving the theoretical capacities of pipe in square feet of direct cast iron radiation (based on ¼ lb. steam per hour per square foot) for various pressure drops in ounces per 100 ft. length of pipe or equivalent length and with an initial steam pressure of 1 lb. gage. This table does not allow a factor of safety for variation in pipe size, condensation in the pipe or other variables and should not be used without taking these factors into consideration.

Table 35 is the same as Table 34 except that it allows a 20 per cent factor of safety to take care of condensation within the pipe itself, variation in size and roughness in the pipe due to blisters, scaled corrosion and other factors. This table is recommended for general use.

In determining the length of pipe used in any system, the actual length must be increased for the various fittings, and values in determining the equivalent length before applying any of the tables given. Table 36 gives the length in feet to be added to the actual length of pipe for various fittings and values in determining the equivalent length. If it is desired to determine the capacity of a pipe for any other length than 100 ft. or for any initial pressure other than 1 lb. such capacity may be found from either Table 34 or 35, by multiplying the capacities found in those tables by constants given in Table 37.

Example.—What is the capacity of a 150 ft. 4 in. pipe with an initial pressure of 1 lb. and pressure drop of 2 oz. in the 150 ft.?

Solution.—From Table 35 it is found that the capacity of a 100 ft. 4 in. pipe with 1 lb. initial pressure and 2 oz. pressure drop, is 2780 sq. ft. Multiplying this value by 0.817 the constant for a 150 ft. length as given in Table 37 gives 2271 the capacity for the given conditions.

Example.—What is the capacity of a 100 ft. 4 in. pipe with 2 lb. initial pressure and pressure drop of 1 oz.?

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TABLE 34. PRESSURE LOSSES WITH LOW PRESSURE STEAM

PRESSURE LOSS IN OUNCES PER 100 FT.		PIPE SIZE														
		1"	1¼"	1½"	2"	2½"	3"	3½"	4"	4½"	5"	6"	7"	8"	10"	12"	16"
1	No allowance for condensation in pipe or constriction due to scale corrosion or other factors	54	122	187	386	635	1163	1737	2407	3338	4545	7250	11,208	15,630	28,194	45,496	96,205
2		75	173	268	546	898	1644	2456	3475	4742	6428	10,250	15,492	22,105	39,876	64,342	136,070
3		94	212	328	668	1100	2013	3078	4256	5781	7872	12,557	18,972	27,071	48,832	78,799	166,630
4		109	245	379	771	1271	2325	3474	4914	6676	9091	14,499	21,909	31,261	56,390	90,992	192,410
5		121	274	424	862	1420	2599	3883	5492	7462	10,162	16,207	24,487	34,941	63,019	101,707	215,170
6		133	300	464	945	1556	2848	4255	6019	8176	11,139	17,758	26,833	38,289	69,068	111,450	235,670
7		144	324	501	1020	1681	3075	4595	6500	8830	12,027	19,179	28,979	41,350	74,590	120,360	254,510
8		153	346	535	1089	1796	3288	4913	6950	9445	12,858	20,505	30,984	44,210	79,750	128,700	272,125
10		172	387	600	1217	2007	3675	5490	7768	10,552	14,371	22,920	34,629	49,413	89,135	143,823	304,148
12		188	424	657	1335	2199	4026	6015	8509	11,559	15,741	25,106	37,934	54,129	97,640	157,550	333,170
14		203	460	710	1443	2377	4349	6497	9191	12,486	17,002	27,127	40,974	58,466	105,466	170,186	359,961
16		217	490	759	1542	2541	4650	6948	9829	13,352	18,181	28,999	43,816	62,522	112,790	181,910	384,830
20		243	547	848	1725	2841	5199	7768	10,988	14,917	20,327	32,422	48,989	69,902	126,090	203,470	430,250
24		265	600	929	1889	3112	5695	8509	12,037	16,352	22,267	35,515	53,661	76,570	138,140	222,880	471,300

TABLE 35. PRESSURE LOSSES WITH LOW PRESSURE STEAM

	Twenty per cent allowed for condensation in pipe, in addition to reduction in size of pipe due to constriction, scale corrosion and other factors																
1		43	97	149	309	508	930	1389	1926	2670	3636	5800	8966	12,504	22,555	36,396	76,964
2		60	138	214	437	718	1315	1965	2780	3793	5142	8200	12,393	17,684	31,900	51,473	108,856
3		76	169	262	534	880	1610	2460	3405	4624	6297	10,045	15,177	21,656	39,065	63,039	133,304
4		87	196	303	617	1017	1860	2779	3931	5341	7272	11,599	17,527	25,008	45,112	72,793	153,928
5		96	219	339	690	1136	2079	3106	4393	5969	8129	12,965	19,589	27,952	50,423	81,366	172,136
6		106	240	371	756	1244	2278	3404	4815	6540	8911	14,206	21,466	30,631	55,254	89,160	188,536
7		115	259	400	816	1345	2460	3676	5200	7064	9621	15,343	23,183	33,080	59,672	96,288	203,608
8		122	276	428	871	1437	2630	3930	5560	7556	10,286	16,404	24,787	35,368	63,800	102,960	217,700
10		137	309	480	973	1605	2940	4392	6214	8441	11,496	18,336	27,703	39,530	71,308	115,058	243,318
12		150	339	525	1068	1759	3221	4812	6807	9247	12,592	20,085	30,347	43,303	78,112	126,040	266,536
14		162	368	568	1154	1902	3479	5197	7352	9989	13,601	21,701	32,779	46,772	84,372	136,149	287,968
16		173	392	607	1233	2033	3720	5558	7863	10,681	14,544	23,199	34,952	50,017	90,232	145,528	307,864
20		194	437	678	1380	2273	4159	6214	8790	11,933	16,261	25,937	39,191	55,921	100,872	162,576	344,200
24		212	480	743	1511	2489	4556	6807	9629	13,081	17,813	28,412	42,928	61,256	110,504	178,304	377,040

Capacities of pipes for various pressure losses in ounces per 100 ft. straight pipe or its equivalent, and 1 lb. initial pressure, steam and condensation flowing in same direction, given in terms of square feet of direct radiation based on ¼ lb. condensation per sq. ft. per hr.

For capacities of pipes other than 100 ft. long, multiply the capacities given by the factor for required length as given in Table 33, Column No. 4.

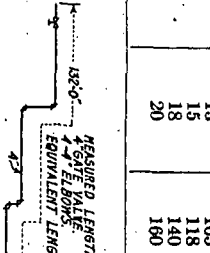
To determine the pressure loss in a pipe of given size, length and capacity: Multiply pressure loss in ounces per 100 ft. by length of pipe divided by 100.

For capacity with initial pressures other than 1 lb. multiply the capacities given in this table by factor for required pressure in Table 37, Column 2.

TABLE 36. LENGTH IN FEET OF PIPE TO BE ADDED TO ACTUAL LENGTH OF RUN TO OBTAIN EQUIVALENT LENGTH

SIZE OF PIPE	ST'D. ELBOW	SIDE OUTLET TEE	GATE VALVE	GLOBE VALVE	ANGLE VALVE
	Length in Feet to be Added in Run				
2"	5	16	2	18	9
2½"	7	20	3	25	12
3"	10	26	3	33	16
3½"	12	31	4	39	19
4"	14	35	5	45	22
5"	18	44	7	57	28
6"	22	50	9	70	32
7"	26	55	10	82	37
8"	31	63	12	94	42
9"	35	69	13	105	47
10"	39	76	15	118	52
12"	47	90	18	140	63
14"	53	105	20	160	72

Example of length in feet of pipe to be added to actual length of run.



MEASURED LENGTH = 132'-0"
EQUIVALENT LENGTH = 193'-0"

TABLE 37. CONSTANTS FOR VARIOUS INITIAL PRESSURES AND LENGTHS

STEAM PRESSURES GAGE LBS.	CONSTANT BY WHICH TO MULTIPLY CAPACITY OF ANY PIPE FOR 1 LB. GAGE STEAM PRESSURE TO OBTAIN CAPACITY OF SAME PIPE FOR PRESSURE IN COL. 1	LENGTH OF PIPE FT.	CONSTANT BY WHICH TO MULTIPLY CAPACITY OF 100 FT. PIPE TO OBTAIN CAPACITY OF SAME SIZED PIPE WITH SAME PRESSURE, AND LENGTH AS GIVEN IN COL. 3
Col. 1	Col. 2	Col. 3	Col. 4
0	0.92	20	2.240
1	1.00	40	1.580
2	1.03	60	1.290
5	1.11	80	1.120
10	1.24	100	1.000
15	1.35	120	0.912
20	1.45	140	0.841
30	1.63	160	0.793
40	1.79	180	0.741
50	1.94	200	0.710
60	2.08	250	0.632
75	2.26	300	0.578
100	2.54	350	0.538
125	2.79	400	0.500
150	3.02	450	0.477
175	3.23	500	0.447
200	3.44	600	0.407
....	....	700	0.378
....	....	800	0.354
....	....	900	0.333
....	....	1000	0.316
....	....	1400	0.267

TABLE 38. CAPACITY OF PIPE IN SQUARE FEET OF DIRECT RADIATION FOR VARIOUS PARTS OF VARIOUS SYSTEMS, WHEN PRESSURE DROP IS NOT OVER 1 OZ. PER 100 FT. OF EQUIVALENT LENGTH OF RUN.

Initial Steam Pressure 1 lb. Gage — *Capacity in Sq. Ft. of Radiation*

A	B	C	D		E	F						
			Branches to Two-Pipe Radiator, Steam and Condensate Flowing in Opposite Direction			Dry Drip Main		Two-Pipe Steam Radiator Valves		One-Pipe Steam Radiator Valves
Commercial Pipe Sizes Inches	Supply Main, Branch to Risers (Dripped) Down Feed Risers, Steam and Condensate Flowing Same Direction	Supply Main, Branch (Not Dripped) Up-Feed Risers, Steam and Condensate Flowing Opposite Direction. 16 Ft. per Sec. Vel.	1 in. Pitch per 10 ft. 16 Ft. per Sec. Vel.	¼ in. Pitch per 10 ft. 12 ft. per Sec. Vel.	Wet Drip Main	Not Exceeding 400 ft. in Length. Graded no less than 1 in. in 30 ft.		Supply	Returns	
¾	...	...	...	...	.....	180		40	40	...
1	43	40	40	...	800	420		60	80	24
1¼	97	60	60	40	1,800	900		100	160	60
1½	149	100	100	63	3,000	1,500		200	320	100
2	309	210	200	90	6,000	3,000		300	...	200
2½	508	300	300	100	10,000	4,900		...	...	...
3	930	490	...	220	18,000	9,000		...	...	...
3½	1,389	630	...	...	26,000	13,000		...	...	...
4	1,926	800	...	...	37,000	18,500		...	...	...
4½	2,670	...	...	...	Drips for Risers			...	...	...
5	3,636	...	...	...		Drips to Returns	Steam Risers	Drips to Returns		...
6	5,800	...	...	...		Wet	Dry	Wet	Dry	...
7	8,966	...	1	1¼	¾	¾	2½	1	1¼	...
8	12,504	...	1¼	1½	¾	¾	3	1	1¼	...
10	22,555	...	1½	2	1	1	3½	1¼	1½	...
12	36,396	...	2	...			4	1¼	1½	...

Note.—Up-feed two-pipe supply risers may be sized same as supply mains and down-feed risers up to velocities of from 50 ft. to 100 ft. per second corresponding to pipe sizes from 1 in. to 4 in.

TABLE 39. CAPACITY OF PIPE IN SQUARE FEET OF DIRECT RADIATION AND PRESSURE DROPS IN OUNCES PER 100 FT. OF EQUIVALENT LENGTH OF PIPE FOR VARIOUS VELOCITIES OF STEAM

Initial Steam Pressure 1 Lb. Gage.

Size of Pipe	12 Ft. per Sec.		16 Ft. per Sec.		20 Ft. per Sec.		25 Ft. per Sec.		30 Ft. per Sec.		40 Ft. per Sec.	
	Sq. Ft.	P. D.*	Sq. Ft.	P. D.*	Sq. Ft.	P. D.*	Sq. Ft.	P. D.*	Sq. Ft.	P. D.*	Sq. Ft.	P. D.*
¾"	25	1.0	35	2.4	45	3.9	55	6.0	65	8.0	90	16.0
1"	40	0.8	60	2.0	70	2.7	85	3.8	102	5.6	138	10.0
1¼"	63	0.4	90	0.8	115	1.2	145	2.4	172	3.2	235	5.8
1½"	90	0.4	120	0.6	152	0.9	195	1.6	235	2.5	312	4.2
2"	150	0.2	210	0.3	260	0.7	325	1.3	400	1.7	530	3.0
2½"	220	0.18	300	0.3	370	0.5	460	0.7	560	1.2	750	2.7
3"	340	0.17	490	0.25	590	0.4	750	0.7	900	0.9	1210	1.8
3½"	440	0.16	630	0.2	780	0.3	960	0.4	1150	0.6	1550	1.5
4"	650	0.15	800	0.19	1000	0.2	1260	0.3	1500	0.5	2000	1.0

*P. D. = Pressure drop in ounces.

TABLE 40. CAPACITIES OF RETURN MAINS IN SQUARE FEET

Size of Pipe	1"	1¼"	1½"	2"	2½"	3"	3½".
*Length 300′	600	1,200	3,000	8,200	15,000	28,500	40,000
" 800′	375	750	1,875	5,200	9,700	17,000	25,000
" 1,750′	.....	600	1,300	3,750	6,700	12,000	18,000
" 2,500′	.....	.....	1,125	3,000	5,600	9,425	15,000

*Length equals measured distance from vacuum pump to end of riser.

TABLE 41. CAPACITIES OF RETURN RISERS IN SQUARE FEET

Size of Pipe	¾"	1"	1¼"				
**Length 200′	700	1,400	3,150	.....	.....	.....	.....
" 400′	560	1,120	2,480	.....	.....	.....	.....
" 600′	420	840	1,750	.....	.....	.....	.....
" 1,000′	350	700	1,470	.....	.....	.....	.....
" 2,000′	230	460	1,050	.....	.....	.....	.....

**Length equals measured distance from boiler or pressure reducing valve to end of riser.
Capacities as given in Tables 40 and 41, include allowances for elbows, tees, etc.

TABLE 42. RADIATOR CONNECTIONS

Capacity in Sq. Ft. Radiation	Supply			Return		
	Size of Inlet Valve	Vertical Pipe to Inlet Valve	Horizontal Runout to Vertical Inlet Pipe	Size Trap	Stub to Trap	Horizontal Runout to Stub
1 to 60	¾"	¾"	1"	½"	½"	¾"
61 to 100	1"	1"	1¼"	½"	½"	¾"
101 to 200	1¼"	1¼"	1½"	¾"	¾"	¾"
201 to 350	1½"	1½"	2"	¾"	¾"	¾"

Radiators to be water pattern tapped or bushed top and bottom opposite ends.
Steam pattern radiators can be used when tapped of bushed eccentric opposite ends with supply bushing turned up and return bushing turned down.

TABLE 43. FLOW OF STEAM IN POUNDS PER MINUTE THROUGH STANDARD PIPES AND PRESSURE DROP IN POUNDS PER 100 FT.—VELOCITY, 4000 FT. PER MINUTE*

Pipe Size Inches	GAGE PRESSURE IN POUNDS PER SQUARE INCH—STANDARD PIPE																
	1	3	5	10	15	25	35	50	75	100	125	150	175				
¼	0.340	0.381	0.420	0.518	0.614	0.805	0.993	1.270	1.727	2.175	2.620	3.072	3.515	Flow			
	2.733	3.100	3.384	4.180	4.955	6.500	8.030	10.25	13.93	17.54	21.22	24.82	28.42	Drop			
¾	0.597	0.668	0.737	0.908	1.077	1.411	1.740	2.225	3.029	3.814	4.593	5.382	6.160	Flow			
	1.610	1.803	1.990	2.452	2.900	3.805	4.700	6.000	8.190	10.29	12.37	14.53	16.66	Drop			
1	0.968	1.083	1.195	1.473	1.746	2.287	2.821	3.608	4.908	6.182	7.448	8.730	9.990	Flow			
	1.061	1.190	1.310	1.516	1.913	2.492	3.090	3.956	5.385	6.775	8.165	9.385	10.99	Drop			
1¼	1.675	1.873	2.068	2.548	3.023	3.958	4.882	6.241	4.490	10.70	12.88	15.11	17.28	Flow			
	0.657	0.734	0.811	1.000	1.185	1.555	1.915	2.448	3.330	4.190	5.045	5.938	6.796	Drop			
1½	2.281	2.551	2.816	3.471	4.113	5.388	6.650	8.500	11.57	14.457	17.56	20.56	23.53	Flow			
	0.503	0.566	0.624	0.770	0.910	1.194	1.472	1.883	2.564	3.222	3.889	4.555	5.222	Drop			
2	3.760	4.208	4.641	5.721	6.782	8.880	10.96	14.02	19.06	24.02	28.92	33.90	38.80	Flow			
	0.334	0.376	0.412	0.509	0.602	0.788	0.976	1.243	1.690	2.160	2.562	3.110	3.448	Drop			
2½	5.365	6.000	6.621	8.155	9.680	12.68	15.64	20.00	27.20	34.26	41.28	48.36	55.35	Flow			
	0.250	0.280	0.309	0.382	0.452	0.592	0.713	0.933	1.270	1.598	1.926	2.260	2.585	Drop			
3	8.280	9.260	10.22	12.60	14.93	19.57	24.13	30.85	42.00	52.88	63.70	74.62	85.45	Flow			
	1.77	0.199	0.220	0.272	0.322	0.421	0.520	0.664	0.905	1.138	1.370	1.610	1.840	Drop			
4	14.26	15.96	17.61	21.70	25.73	33.70	41.58	53.15	72.33	91.10	109.8	128.6	147.2	Flow			
	0.118	0.133	0.146	0.181	0.214	0.279	0.345	0.441	0.600	0.755	0.911	1.068	1.235	Drop			
5	22.43	25.08	27.68	34.12	40.45	52.96	65.32	83.60	113.7	143.2	172.4	202.2	231.3	Flow			
	0.085	0.096	0.106	0.130	0.154	0.202	0.249	0.318	0.433	0.546	0.656	0.768	0.883	Drop			
6	32.36	36.22	39.95	49.25	58.38	76.48	94.30	120.7	164.2	206.7	249.0	291.8	334.0	Flow			
	0.066	0.074	0.082	0.101	0.119	0.156	0.193	0.247	0.336	0.422	0.508	0.597	0.683	Drop			
8	57.30	64.10	70.72	87.15	103.4	135.4	166.9	213.6	291.0	365.9	440.8	516.6	591.0	Flow			
	0.045	0.051	0.056	0.069	0.082	0.107	0.131	1.67	0.229	0.287	0.346	0.406	0.465	Drop			
10	90.40	101.1	111.6	137.6	163.1	213.6	263.4	336.8	458.5	577.2	695.0	815.0	932.8	Flow			
	0.034	0.038	0.042	0.052	0.061	0.080	0.098	0.126	0.171	0.214	0.258	0.304	0.348	Drop			
12	128.6	143.8	158.8	195.7	232.0	303.9	374.6	479.3	652.0	821.5	989.0	1159.0	1327.0	Flow			
	0.027	0.031	0.034	0.042	0.049	0.064	0.079	0.101	0.137	0.172	0.208	0.280	0.313	Drop			

*Courtesy Crane Company.

Solution.—From Table 35 find, 1926, the capacity of this pipe with a 1 lb. initial pressure. Multiplying this by 1.03 for a 2 lb. initial pressure as given in Table 37 gives 1984 the capacity for the given condition. By using the capacities given in Table 34 rather than Table 35 in examples 1 and 2, the capacities for the given conditions without allowing for a factor of safety of 20 per cent may be obtained.

Table 38 gives the capacities of various sized pipes for parts of systems based upon stated conditions. Column B gives the capacities of various sizes, of supply mains, branches to risers which are dripped, down-feed risers, or any other part of any system where steam and the condensation either from radiation or from the pipe itself flow in the same direction, based upon 1 lb. initial pressure and a drop of 1 oz. per 100 ft. and allowing a 20 per cent factor of safety. These capacities apply particularly to two-pipe steam and two-pipe vapor systems.

Column C gives the capacity of supply mains, branches to risers not dripped, up-feed risers, or any other part of any system where steam and condensate flow in opposite directions, based upon a steam velocity of 16 ft. per second. These capacities apply particularly to a one-pipe system and those parts of any two-pipe system where the condensate from radiators or from the pipe itself are expected to flow in the opposite direction to the steam.

Column D gives the capacity of branches to radiators based upon steam velocities of 12 and 16 ft. per second respectively for such branches with ¼ in. and 1 in. pitch per 10 ft. length.

Table 39 gives the capacity in square feet and pressure drop in ounces for various sized pipe and various steam velocities ranging from 12 to 40 ft. per second.

Tables 40, 41 and 42 give the capacities of return mains, return risers and radiator connections, for vacuum systems. The capacity of supply mains and risers for vacuum systems may be taken directly from Table 35 if the allowable pressure drop is greater than 1 oz. per 100 ft. or from Table 38, Column B, if a pressure drop of only 1 oz. per 100 ft. is to be allowed.

Table 43 gives the pounds of steam which will flow per minute through standard pipe at 4000 ft. velocity, and the resulting pressure drop in pounds per 100 ft. equivalent length. This table is particularly applicable to transmission mains and should not be used without particular consideration in designing distribution systems.

Either capacity of a pipe in any part of a system is limited either by the allowable pressure drop along the pipe, or by the steam velocity through the pipe or both. If condensate, either from radiation supplied or from the pipe itself, is to return counter to the flow of steam the velocity of the steam must not exceed certain critical values. If the velocity exceeds the critical value the system may continue to operate, but will be noisy. If the velocity exceeds a higher maximum value the condensate will cease to return counter to the steam and will be carried along with it clogging the radiator if it has a one-pipe connection, or passing through the radiator if it has a two-pipe connection.

RESULTS OF LABORATORY EXPERIMENTS

The Research Laboratory of the AMERICAN SOCIETY HEATING AND VENTILATING ENGINEERS has investigated this subject[1], and has found the critical velocity for quiet operation to be about 22 in. per second for the sizes of pipe investigated and apparently increasing with the size of pipe. The maximum velocity, however, with counter flow of condensate where noise is not objectionable is considerably higher and increases rapidly with size of pipe. In the case of horizontal runs both the critical velocity for quiet operation and the maximum velocity where noise is not objectionable, depend upon the pitch of the pipe. The maximum capacity and velocity where noise is not objectionable for horizontal pipes with various pitches are given in Table 44.

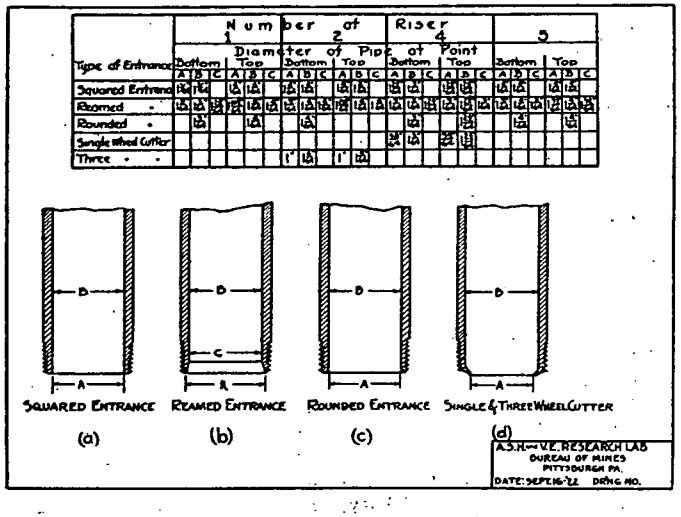


FIG. 22. EFFECT OF REAMING ENTRANCE TO ONE-PIPE RISERS

Where the velocity of steam is the limiting factor of the capacity of a pipe, care must be taken that this velocity is not exceeded in any part of the pipe or fittings by a constriction, since the velocity at any one constriction will limit the whole system. For this reason, particular care must be taken to ream such pipe and guard against dope constricting it at joints. Iron pipe should also be examined for constricting blisters, Fig. 22 and Table 46, from the Laboratory reports already mentioned show the importance of these factors.

[1]Reports by Houghten & Ehin, JOURNAL AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, September, 1922; March, 1923; February, 1924; June, 1924; February, 1925.

TABLE 44. MAXIMUM CAPACITY OF ONE-PIPE LINES AT VARIOUS PITCHES
Pitch of Pipe in Inches per 10 Ft.

PITCH OF PIPE—¼ IN.			½ IN.		1 IN.		1½ IN.		2 IN.		3 IN.		4 IN.		5 IN.	
Pipe Size	Sq. Ft. Rad. Based on 240 B.t.u.	Max. Vel.	Sq. Ft. Rad. Based on 240 B.t.u.	Max. Vel.	Sq. Ft. Rad. Based on 240 B.t.u.	Max. Vel.	Sq. Ft. Rad. Based on 240 B.t.u.	Max. Vel.	Sq. Ft. Rad. Based on 240 B.t.u.	Max. Vel.	Sq. Ft. Rad. Based on 240 B.t.u.	Max. Vel.	Sq. Ft. Rad. Based on 240 B.t.u.	Max. Vel.	Sq. Ft. Rad. Based on 240 B.t.u.	Max. Vel.
¾"	25.0	12	30.3	14	37.3	18	40.4	19	42.5	20	46.1	21	47.5	22	49.3	23
1"	45.8	12	52.6	15	63.0	17	70.0	20	75.2	22	83.0	23	87.9	25	90.2	26
1¼"	104.9	18	117.2	20	133.0	23	144.5	25	154.0	27	165.0	28	172.6	29	178.2	31
1½"	142.6	18	159.0	21	181.0	23	196.5	25	209.3	27	224.0	28	234.8	30	242.6	31
2"	236.0	19	263.5	20	299.5	23	325.5	25	346.5	27	371.5	28	388.4	29	401.1	30

TABLE 45. RESULTS OF TESTS ON ANGLE AND GLOBE VALVES

NOMINAL SIZE OF PIPE IN.	AREA OF PIPE SQ. IN.	AREA VALVE SEAT OPENING SQ. IN.	PER CENT OF AREA OF PIPE	MAXIMUM PIPE AND VALVE	CAPACITY PIPE ALONE	PER CENT OF CAPACITY OF PIPE ALONE
¾	0.537	0.4418	82.2	9.68	13.52	71.6
1	0.835	0.822	98.4	22.10	23.30	95.0
1¼	1.459	1.258	86.2	30.00	47.5	63.1
1½	1.927	1.773	92.2	46.13	68.5	67.4

NOMINAL SIZE IN.	VALVE STEM—VERTICAL		VALVE STEM—HORIZONTAL	
	Capacity of Pipe and Valve Lb. per Hr.	Per Cent of Capacity of Pipe Alone	Capacity of Pipe and Valve Lb. per Hr.	Per Cent of Capacity of Pipe Alone
¾	1.38	11.8	8.83	76.3
1	7.73	35.7	14.06	66.1
1¼	13.20	31.2	22.88	54.3
1½	18.81	33.0	32.00	56.7

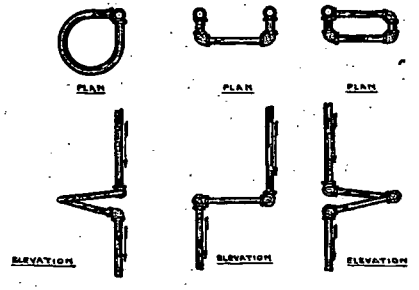
The capacity of risers with various shaped entrances is very important and those shown in Fig. 22 gave the following maximum capacities:—

		Per Cent Decrease
Reamed entrances	24.7 lb. per hr.	0.0
Rounded entrances	23.9 lb. per hr.	3.2
Squared entrances	22.2 lb. per hr.	10.1
Three wheel cutter	19.2 lb. per hr.	22.2
Single wheel cutter	17.6 lb. per hr.	28.7

Table 46 shows variation in capacity of a pipe as affected by variation of size and smoothness of pipe generally found on the market. The maximum and minimum results were obtained by picking out very smooth and very rough pipe from the stock room of a large manufacturer.

TABLE 46. PER CENT DIFFERENCE IN CAPACITY DUE TO VARIATION OF PIPE SIZE AND SMOOTHNESS

	MAXIMUM CONDENSATION, LB. PER HR.			
Capacity of Pipe	¾"	1"	1¼"	1½"
Minimum	14.00	24.89	45.42	70.50
Maximum	15.20	30.08	52.08	82.00
Per Cent Variation	8.6	20.8	14.7	16.3



Note.—Allowance for expansion must be made in long runs of mains both vertical and horizontal. One expansion joint or swing should be installed in any run over 100 ft. 0 in. long and one for each additional 100 ft. 0 in. of run. All branch connections should be made so as to allow a swing both at the main and the other end connections.

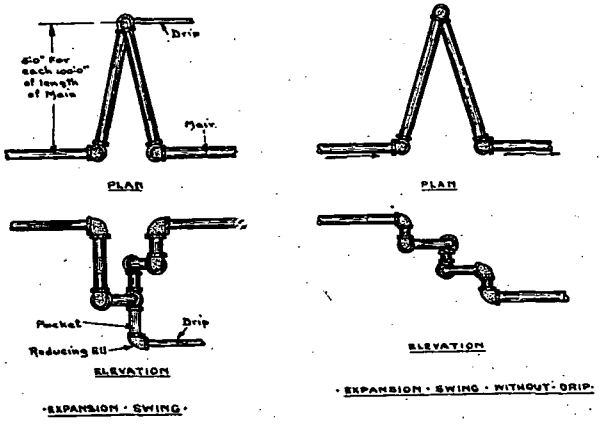


FIG. 23. TYPICAL EXPANSION CONNECTIONS FOR RISERS

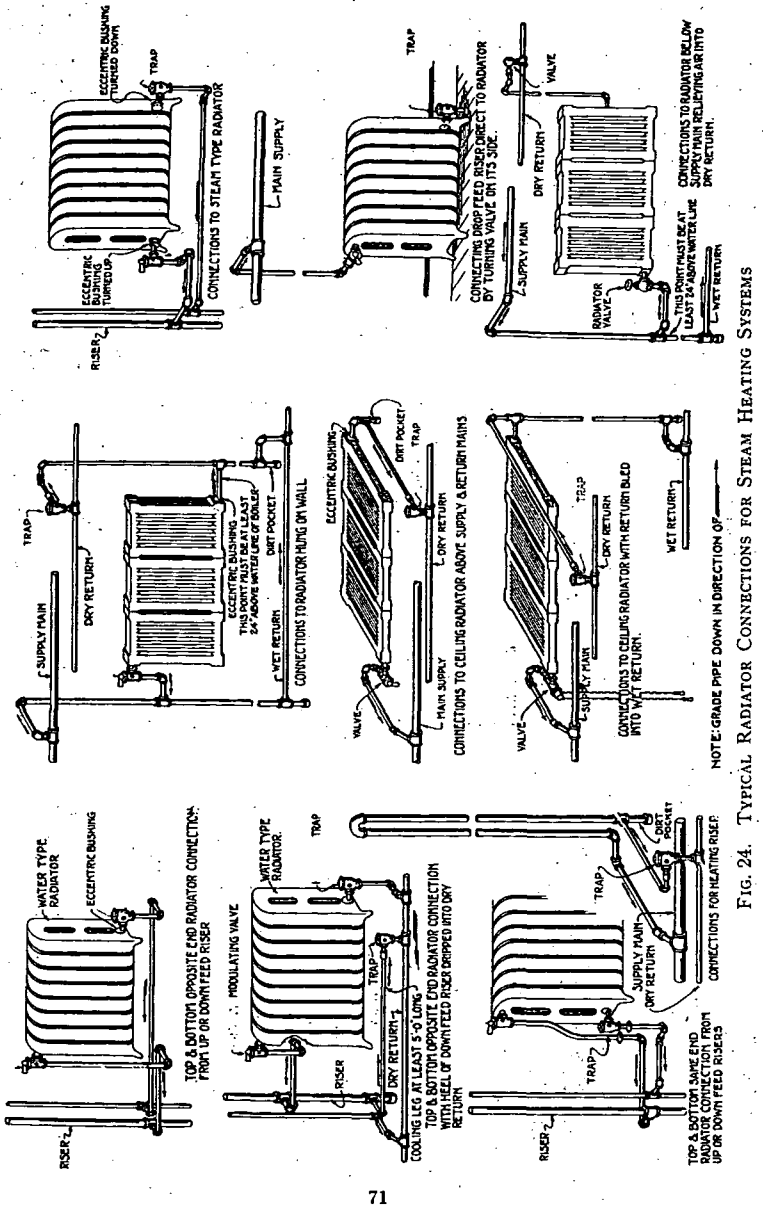


FIG. 24. TYPICAL RADIATOR CONNECTIONS FOR STEAM HEATING SYSTEMS

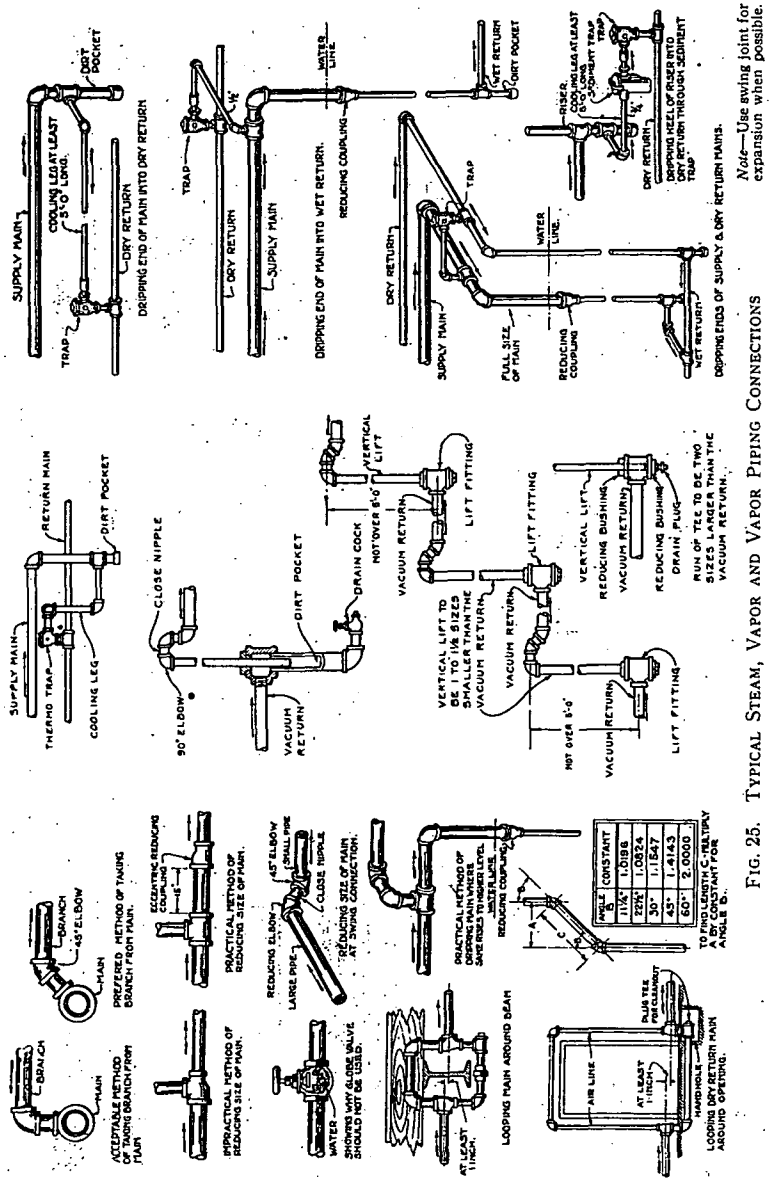


FIG. 25. TYPICAL STEAM, VAPOR AND VAPOR PIPING CONNECTIONS

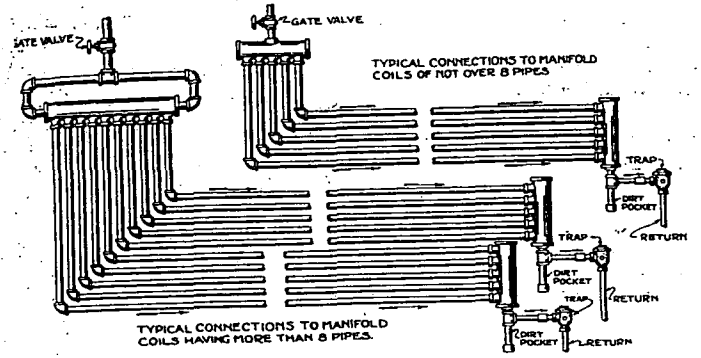
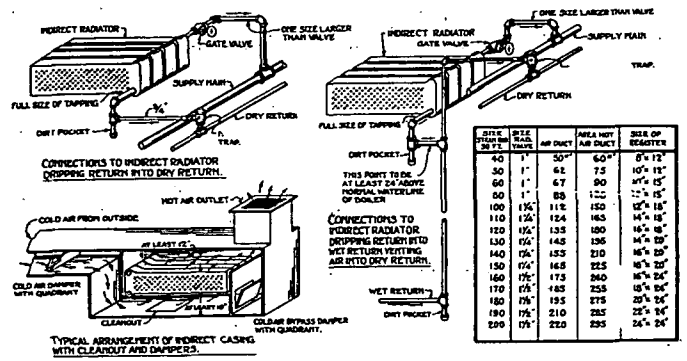


FIG. 26. TYPICAL CONNECTIONS TO MANIFOLD COILS HAVING MORE THAN 8 PIPES



DIFF. TEMP. BET. AIR & SURF. °F.	SIZE MAIN VALVE	AIR DUCT	AREA NOT AIR DUCT	SIZE OF REGISTER
40	1"	50"	60"	8"×12"
50	1"	62	75	10"×12"
60	1"	67	90	12"×12"
80	1"	88	110	12"×15"
100	1¼"	112	150	15"×15"
110	1¼"	124	165	15"×18"
120	1¼"	135	180	15"×20"
130	1¼"	145	195	18"×20"
140	1¼"	155	210	18"×24"
150	1¼"	168	225	20"×24"
160	1¼"	175	240	20"×24"
170	1¼"	185	255	20"×24"
180	1¼"	195	270	24"×24"
190	1¼"	210	285	24"×24"
200	1¼"	220	295	24"×24"

FIG. 27. INDIRECT RADIATOR CONNECTIONS

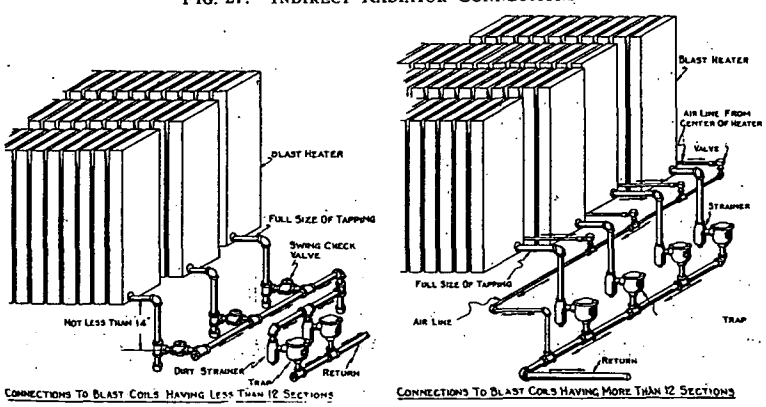


FIG. 28. RETURN CONNECTIONS TO BLAST COILS

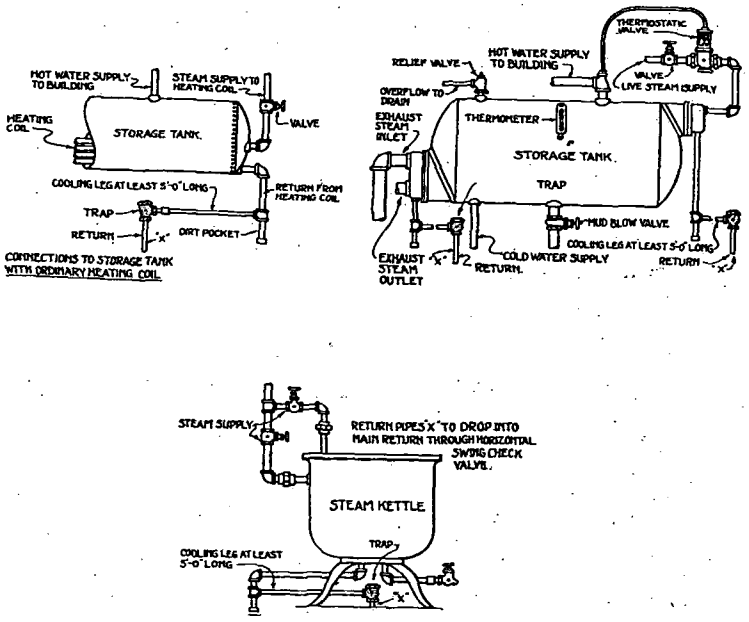


FIG. 29. CONNECTIONS TO COILS IN TANKS

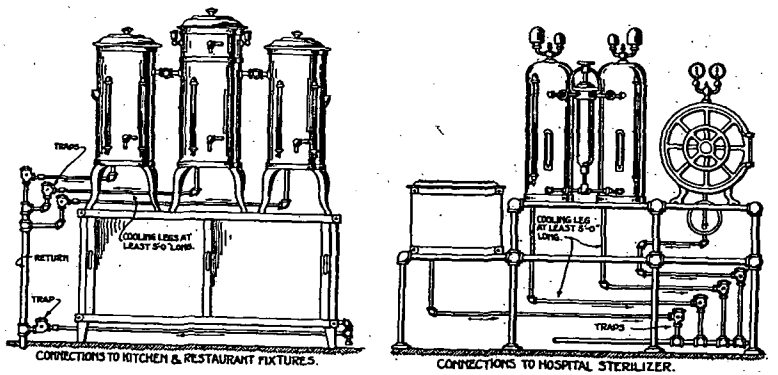


FIG. 30. TYPICAL CONNECTIONS TO KITCHEN AND HOSPITAL EQUIPMENT

CHAPTER IV

SYSTEMS AND PIPING FOR HOT WATER HEATING

By F. E. GIESECKE, Member

A HOT WATER HEATING SYSTEM consists essentially of heaters, radiators, and a connecting system of pipe through which water circulates while conveying heat from the heater to the radiators.

The connecting pipe lines should be arranged and proportioned so that every radiator will receive its proper share of heat when the total quantity of heat required by all the radiators is being delivered to the water at the heater. There are a large number of systems or methods of arranging the pipe lines in a hot water system. A few are indicated in Fig. 31.

The force maintaining circulation is either that of gravity, which acts because the water in the return risers is heavier than the water in the supply risers, or the force supplied by a pump placed in the return main near the heater. When circulation is due to gravity, it is called a *Gravity System;* when circulation is produced by a pump, it is called a *Forced-Circulation System.*

OPEN AND CLOSED SYSTEMS

Hot water heating systems may be either open or closed. Open systems have expansion tanks vented to the atmosphere. Closed systems are operated under pressures higher than atmospheric.

In designing the pipe lines for a *Closed System* the same methods and formulas are used to determine the pressure heads and friction heads as are used in designing an *Open System.*

The principal difference between a closed system and an open system is that, in a closed system, the pressure on the water in the system can be regulated by a set of valves whereas, in an open system, the pressure on the water is only that due to the atmosphere and the column of water extending from the expansion tank to the point where the pressure is measured. In general, the pressure on the water is higher in a closed system than in an open system and, consequently, the water can be heated to a higher temperature in the former without boiling. As the temperature of the water in a heating system is increased, the size of the radiation and of the pipe lines, necessary to supply a given quantity of heat, is decreased. An open system can be made the equivalent of a closed system in this respect by elevating the expansion tank to a sufficient height. For example, if, in a closed system, a pressure of

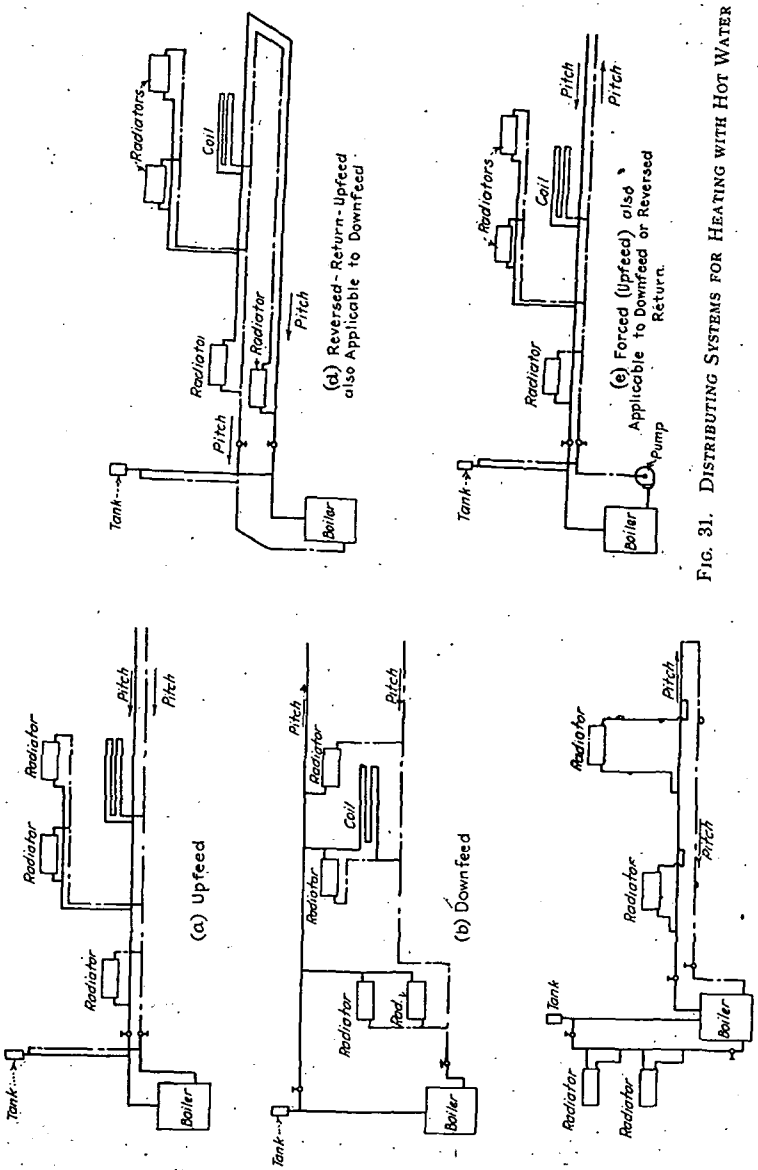


FIG. 31. DISTRIBUTING SYSTEMS FOR HEATING WITH HOT WATER

15 lb. per square inch is maintained in the highest radiator and if, in an open system, the expansion tank is located 15 x 2.4 or 36 ft. above the highest radiator, the two systems will be alike so far as pressure and boiling points are concerned.

Since water is only very slightly compressible (a change in pressure of 10 lb. per square inch will produce a change in volume of about 1 in 33,000) its density and its coefficient of friction may be considered independent of pressure and hence the laws governing pressure heads and friction heads are also independent of pressure and are the same for closed systems as for open systems.

PRESSURE HEAD

The force maintaining circulation is sometimes expressed in pounds per square inch but more generally in terms of the height of a column of water which would produce this pressure, *i. e.* in feet of water, millinches of water, etc. The height of such a column of water is the *Pressure Head.*

FRICTION HEAD

The forces resisting circulation are the frictional resistances in the heater, the radiators, the pipe lines, the several fittings and valves, and in the water itself. These resisting forces are also expressed in terms of water column. The height of this column is the *Frictional Head.*

Tests by Professor F. E. Giesecke, demonstrate that the friction head for new commercial black iron pipe of American manufacture is

$$h = 83\ V^{1.88\,d\ -\ 0.04\,d\ -\ 1.275}$$

where

h = friction head, per foot of pipe, in millinches of water,
V = velocity, in ft. per sec.
d = actual internal diameter of pipe, in inches.

It has been found by experiment that the friction of water in commercial black iron pipe varies, approximately, as the 1.8 power of the velocity and that the friction in fittings, valves, and in radiator and heater inlets and outlets varies, approximately, as the square of the velocity of the water in a pipe having the same nominal size as such fitting, valve, etc. It is, therefore, impossible, to express with accuracy the friction in a pipe fitting in terms of the friction in the pipe. For example, if the friction in an elbow is equal to the friction in 3 ft. of pipe, when the velocity of the water is 1 ft. per second, the friction in the elbow will be equal to that in 4.1 ft. of pipe when the velocity is 5 ft. per second, and equal to that in 2.2 ft. of pipe when the velocity is 1/5 ft. per second.

It is possible, however, to express, with sufficient accuracy, the friction in one pipe-fitting in terms of the friction in any other pipe-fitting or in any valve. For example, if the friction in one open globe valve is equal to that in twelve elbows, when the velocity is 1 ft. per second, the same relation will exist at all other velocities, if the friction varies as the

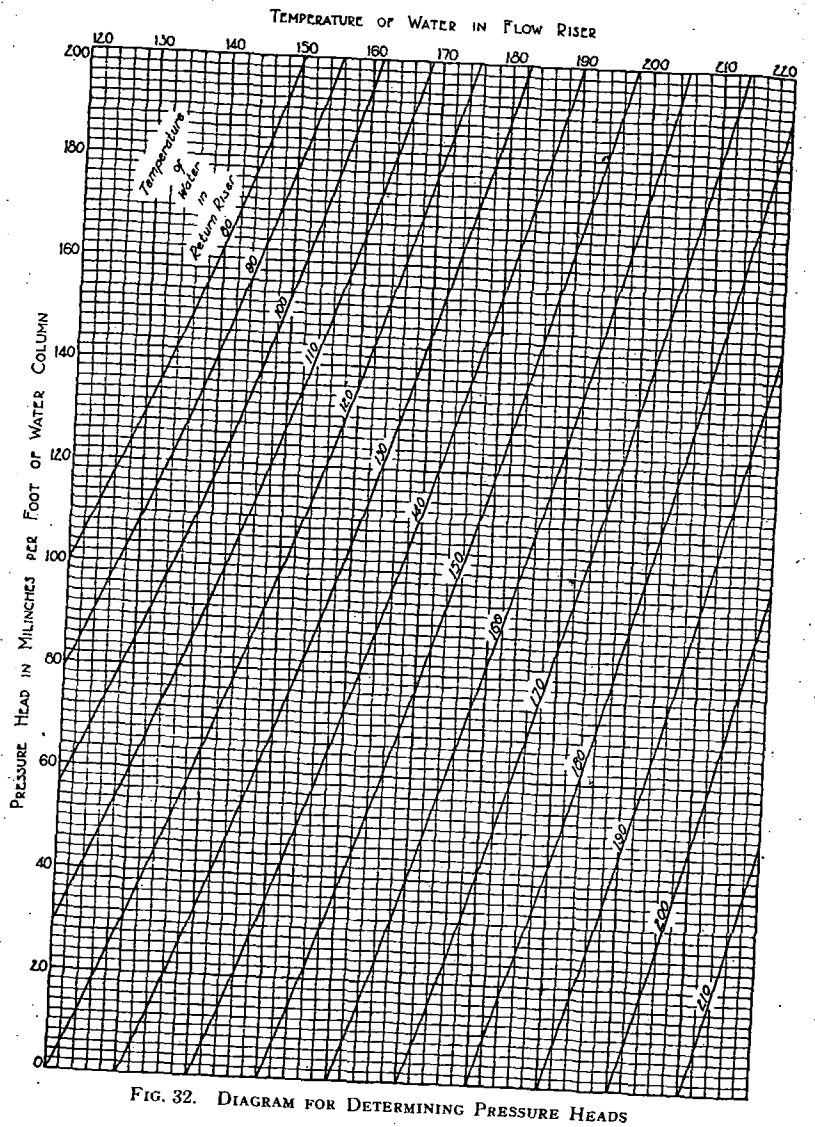


FIG. 32. DIAGRAM FOR DETERMINING PRESSURE HEADS

square of the velocity in both cases. Since more 90 deg. elbows are used in hot water heating systems than any other type of fitting or any valve, all fittings, valves, and other obstructions, found in radiator circuits, shall be expressed in terms of elbow equivalents, for the determination of their friction heads. For this purpose the following table of equivalents may be used:[1]

1 90 deg. elbow	1.0	1 Open globe valve	12.0
1 45 deg. elbow	0.9	1 Angle radiator valve	2.0
1 Open return bend	1.0	1 Radiator	3.0
1 Tee	2.2	1 Heater	3.0
1 Open gate valve	0.5		

To avoid friction head calculations by complicated formulae, the diagram of Fig. 33 may be used to find the friction head in one foot of pipe, as the diagram of Fig. 34 is used to find the friction head in one elbow.

GRAVITY SYSTEM

The pressure head for any radiator or group of radiators, in a gravity-flow system, shall be determined by calculating the maximum difference in the pressures caused by the water in the flow and return risers and dividing this difference by the density of water whose temperature is the mean of the temperatures of the water in the flow and return risers. To illustrate: If a radiator is located above the flow main so that its risers are 12 ft. high, and if the temperature of the water in the flow and return risers is, respectively, 180 and 160 deg., and if the density of water at 180, 170 and 160 deg. is, respectively, 60.58, 60.80, and 61.00 lb. per cu. ft., the maximum difference in the pressures caused by the water in the two risers is 12 (61.00 − 60.58) or 5.24 lb. per sq. ft.; the corresponding pressure head is 5.24/60.80, or 0.0829 ft., or 995 m.i. of 170 deg. water.

Instead of calculating the pressure head, it may be determined, with sufficient accuracy, from Fig. 32. To illustrate: For the example cited, find 180 on the upper margin of the diagram; from there traverse vertically downward to the intersection with the inclined 160 deg. line; from there, horizontally to the left margin and read 82 m.i. per foot of water column; multiply by 12, the height of the risers in feet, and find 984 m.i. of 170 deg. water, which differs only by about 1 per cent from the head calculated previously.

After the general arrangement of the pipe lines has been decided upon, the pipe sizes are determined so that, for any radiator or group of radiators, the friction head is equal to the pressure head when the system is operating at a uniform or constant rate.

The friction head for any radiator or group of radiators should be determined by calculating and adding together the friction heads in the heater, radiator, pipes, pipe fittings, and valves which constitute the circuit for that radiator or group of radiators.

[1]These values are based, with slight modifications suggested by later research, on experimental determinations by F. E. Giesecke and published in *Domestic Engineering*, November, 1912. A record of these tests is shown in Harding and Willard, *Heating and Ventilating*, p. 259 and in Marks, *Machine Design*, pp. 239–240.

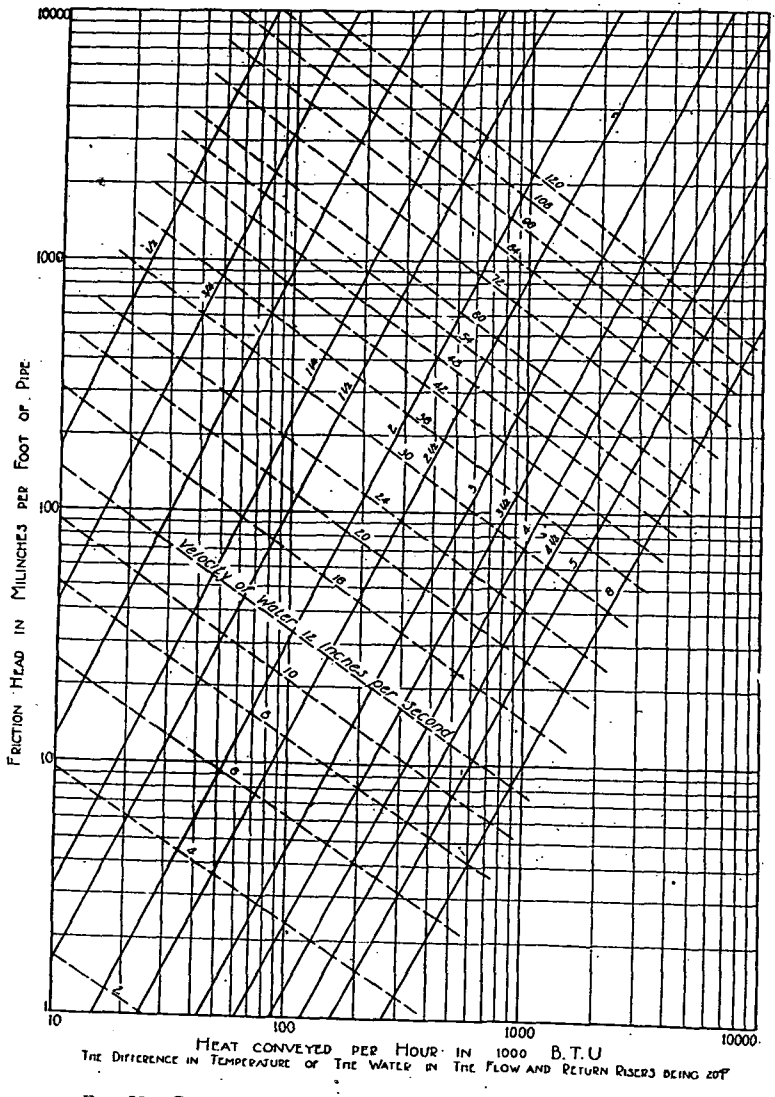


Fig. 33. Chart for Finding Friction Head Per Foot of Pipe

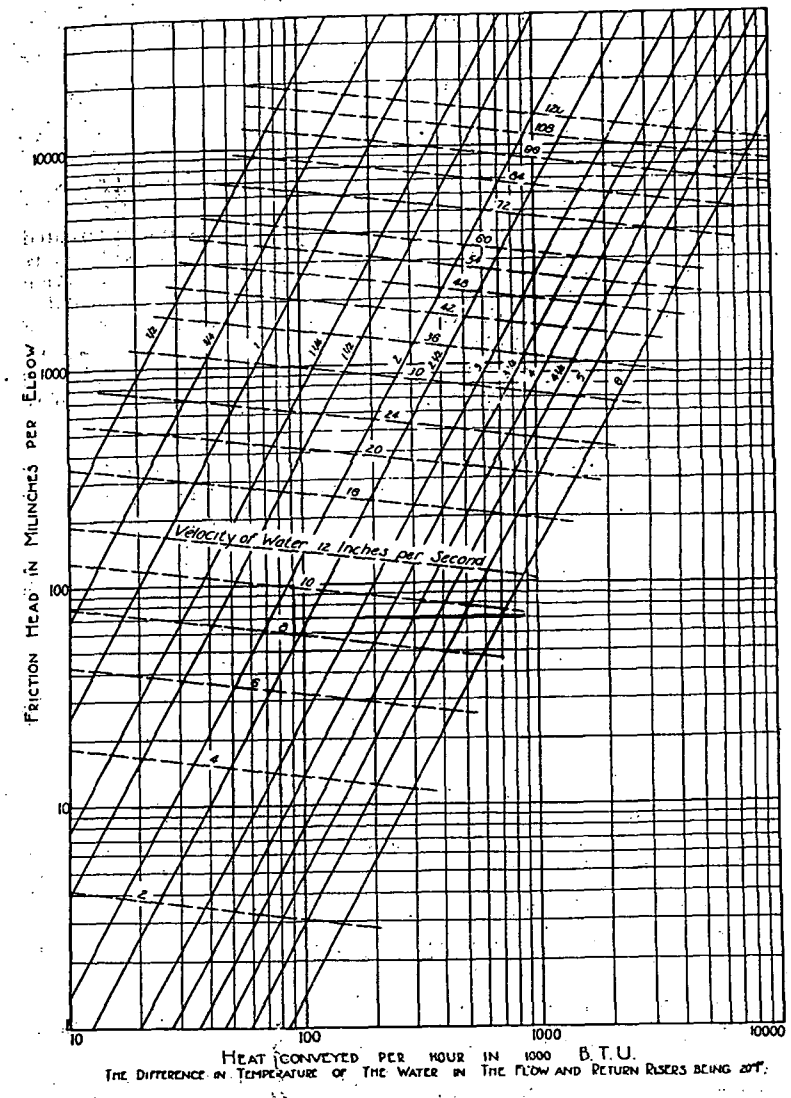


Fig. 34. Chart for Finding the Friction Head Per Elbow

Gravity hot water heating systems may be designed for even circulation at any range of water temperature difference between flow and return, within practical limits. Small differences in temperature result in large pipe sizes, uneconomical both in cost of installation and operation, and slowness to respond to outside temperature changes. Large differences in temperature result in undesirable small piping and difficulty in balancing for circulation. While gravity systems have been designed and installed on as low as 10 deg. and as high as 60 deg. difference, best results are obtained for difference between 20 and 30 deg. with 20 deg. difference applicable to most conditions.

The calculations of pipe sizes to the radiator most unfavorably situated on the basis of one or more different temperature differences will usually make the best practical temperature difference evident. The criterion which determines whether one radiator is more unfavorably or favorably situated than another is the value of the quotient when the height of the center of the radiator above the center of the boiler in feet is divided by the total travel of the water through the radiator in question.

In selecting approximate pipe sizes the following Table 47 may be used:

TABLE 47. APPROXIMATE PIPE SIZES FOR GRAVITY CIRCULATION FOR A TEMPERATURE DROP OF 20 DEG. AND FOR VELOCITIES RANGING FROM 2 TO 6 IN PER SECOND

Pipe Size	Capacity in 1000 B.t.u.
½″	1.5 to 4.6
¾″	2.7 " 8.1
1″	4.4 " 13.1
1¼″	7.6 " 22.7
1½″	10.3 " 30.9
2″	16.9 " 50.8
2½″	24.2 " 72.5
3″	37.3 " 111.8
3½″	49.9 " 149.6
4″	64.3 " 192.9
4½″	80.7 " 242.0
5″	102.0 " 306.0
6″	146.0 " 438.0

The capacities shown in the table vary directly with the temperature drop and the velocity. Since the velocity depends on the pressure head and on the friction head it cannot be predicted or estimated accurately before the system is designed and, consequently, Table 47 must be used only for very approximate determinations of pipe sizes.

A much better approximate determination of pipe sizes may be made by the following method:

1. Determine the equivalent length of the circuit by adding the length of the pipe in the circuit to the equivalent length of the elbow equivalents, placing each elbow equivalent equal to a pipe whose length is equal to 24 diameters.

2. Determine from Fig. 32 the pressure head for the circuit and divide it by the equivalent length of the circuit to find the average friction head of the circuit in millinches per foot of pipe.

3. Determine from Fig. 33 which pipe size has that particular unit friction head when the given quantity of heat is being conveyed.

To illustrate the application to practice, let it be required to determine the sizes of a few of the pipes for the hot-water heating system shown in Fig. 35.

This system is intended for a three-story building in which all rooms are to be heated to 70 deg. The first floor radiator is to dissipate 10,000 B.t.u., the second floor radiator, 8000 B.t.u., and the third floor radiator, 12,000 B.t.u., per hour.

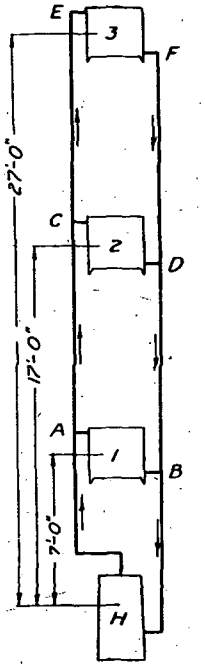


FIG. 35. GENERAL ARRANGEMENTS OF HEATING SYSTEM

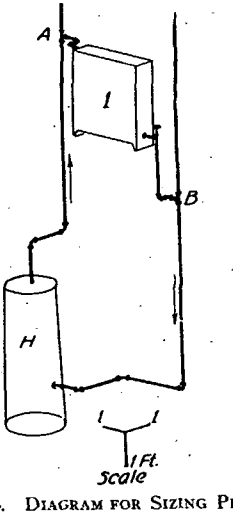


FIG. 36. DIAGRAM FOR SIZING PIPES

The system is piped so that water, leaving the heater, may take any one of three paths, through Radiator, 1, 2 or 3. The correct solution of the problem requires that the three paths be so proportioned that the proper quantity of water will flow through each of the three radiators.

Proceed with the design as follows:

1. Divide the three circuits of the system into sections so that every section will contain only one pipe size and only one rate of flow of heat. For example, the circuit of Radiator I should be divided into four sections; the first section extending from *H* to *A*; the second from *A* to 1; the third from 1 to *B*; and the fourth from *B* to *H*. The point *A* must be the

division point of two sections because the Section *H-A* conveys the heat for all three radiators, whereas Section *A*-1 carries only the heat for Radiator 1.

For a similar reason *B* must be a division point. The reason for selecting 1 as a division point is that it is often necessary to select a different pipe size for Section *A*-1 than for Section 1-*B*, in order to secure the proper friction head for Radiator 1. If it were certain that the pipe size for Section *A*-1 could be the same as that for Section 1-*B* the pipe line from *A* to *B* could be called one section; since it is impossible to know in advance what the pipe sizes leading to and from the radiator must be, it is best to make the radiator the division point of two sections.

2. Having divided the several circuits into sections prepare a table, like Table 48, and record there the designations of the several sections, the quantity of heat conveyed by each section, and the number of feet of pipe and the number of elbows or elbow equivalents in each section. All of this information should be obtained from the plans for the heating system. In Fig. 35 is shown only a diagrammatic representation of the system to illustrate the general arrangement. In this case a number of elbows, valves, air valves, and the expansion tank are omitted in order to simplify the drawing. For the actual design, a complete drawing, such as that shown in Fig. 36, must be available or the designer must be sufficiently familiar with the proposed installation to be able to insert the correct pipe length and the correct number of elbows or elbow equivalents in the description of each section, as recorded in Table 48.

3. Calculate the pressure head available for the circuit by means of Fig. 32 and record it in the table.

4. Calculate the pipe sizes for the several sections by means of Figs. 33 and 34 so that the sum of the friction heads in all the sections composing any one circuit is equal, to the pressure head available for that circuit.

TABLE 48. CIRCUIT I*

Pressure head = 7 × 90 = 630 *m.i.*

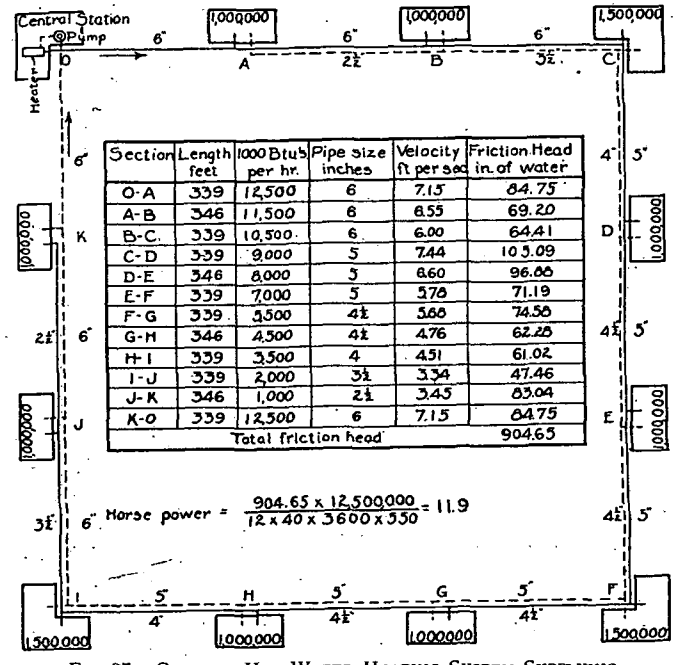
SECTION	B.T.U.	FEET ELBOWS	ASSUMED DIAMETER IN.	UNIT FRICTION	TOTAL FRICTION	SELECTED DIAMETER IN.	UNIT FRICTION	TOTAL FRICTION
H-A	30,000	8.67	1½	12	104	1½	.....	104
		3.5			122			122
A-1	10,000	1.2	1¼	35	4	1¼		4
		5.5		3.5	41			41
1-*B*	10,000	2.67	1	7.5	33	1¼	3.5	9
		7.5		12.5	183		7.5	56
B-H	30,000	10.7	1½	24.5	128	1½	.....	128
		4.5		12	167			157
				35				
Total					772			621

*The calculations for Circuits II and III are made and recorded in a similar manner.

FORCED CIRCULATION

In designing the pipe lines for forced-circulation systems, the same methods and formulas are used to determine pressure heads and friction heads which are used in the design of gravity-flow systems, with the one exception that in forced-circulation systems the force producing the necessary pressure head is supplied partly or entirely by a pump.

The designing engineer should determine, in every case, what portion, if any, of the force necessary to produce the required pressure head will be supplied by gravity. For example, in a central heating system,



Section	Length feet	1000 Btu's per hr.	Pipe size inches	Velocity ft per sec	Friction Head in. of water
O-A	339	12,500	6	7.15	84.75
A-B	346	11,500	6	6.55	69.20
B-C	339	10,500	6	6.00	64.41
C-D	339	9,000	5	7.44	105.09
D-E	346	8,000	5	6.60	96.66
E-F	339	7,000	5	5.76	71.19
F-G	339	5,500	4½	5.66	74.56
G-H	346	4,500	4½	4.76	62.25
H-I	339	3,500	4	4.51	61.02
I-J	339	2,000	3½	3.34	47.46
J-K	346	1,000	2½	3.45	83.04
K-O	339	12,500	6	7.15	84.75
Total friction head					904.65

FIG. 37. CENTRAL HOT WATER HEATING SYSTEM SUPPLYING GROUP OF ELEVEN BUILDINGS

the pump may supply the entire pressure head for the distributing mains while gravity may supply all or part of the pressure head for the service lines in the several buildings.

In forced-circulation systems, the pressure head caused by the difference in density of the water, and which maintains circulation in gravity-flow systems, is generally small when compared with the pressure head produced by the pump. It may be neglected in the design if it is less than 20 per cent of that produced by the pump.

To illustrate, let it be required to determine the pipe size for the central hot-water heating system shown in Fig. 37.

The system is to supply 12,500,000 B.t.u. per hour to a group of eleven buildings with a temperature drop of 40 deg. The system is provided with a reversed return. The pipe sizes are selected so that the friction heads in the eleven circuits are practically equal. The velocity of the water varies from 3⅓ to 7½ ft. per second. The theretical horsepower required to circulate the water through the main is

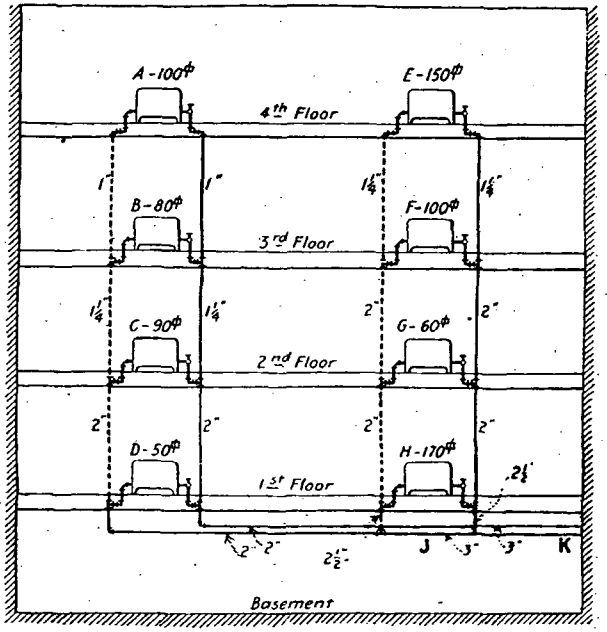


FIG. 38. LAYOUT FOR SIZING HOT WATER MAINS

11.9. The table in Fig. 37 shows the calculations for one of the eleven circuits.

If the circulation within the buildings is maintained by the pump, the power required therefore must be added to that already calculated. Each flow and return pipe, connecting a building and the mains, should be provided with a gate valve and a thermometer and the gate valves should be adjusted so that the temperature drop in each of the eleven buildings is 40 deg.

SIMPLE RULE FOR SMALL GRAVITY SYSTEMS

In designing a hot-water system for a residence or other small buildings the following simplified method by N. S. Thompson and C. A. Fuller gives good results for the usual two-pipe basement main system.

Determine the size of radiator tapping and connection from Table 49 and the size of riser and main from Table 50.

To illustrate assume the layout in Fig. 38. The radiator connections determined from Table 49 are as follows:

A = 1 in.	E = 1¼ in.
B = 1 in.	F = 1¼ in.
C = 1¼ in.	G = 1 in.
D = 1 in.	H = 1½ in.

Where one radiator only is supplied the riser and mains are sized the same as the radiator connection. Where more than one radiator is supplied the pipe size is determined from Tables 49 and 50 as follows:

A = 1 in. = 10 Equivalent carrying capacity
B = 1 in. = 10 " "

20 = 1¼ in. pipe between D and C

C = 1¼ in. = 20 Equivalent carrying capacity

40 = 2 in. pipe between D and C

D = 1 in. = 10

50 = 2 in. pipe between J and D

Proceeding in like manner the other sections of pipe are found to be as follows:

E to F = 1¼ in.	H to Mains = 2½ in.
F to G = 2 in.	J to K = 3 in.
G to H = 2 in.	

TABLE 49. HOT WATER SYSTEM PIPE SIZES AND CONNECTIONS

PIPE SIZE	FIRST FLOOR	SECOND FLOOR	THIRD FLOOR	FOURTH FLOOR
¾"	40	50	60	70
1"	70	80	90	100
1¼"	110	120	135	150
1½"	180	195	210	230
2"	300	350	400	500

In connection with Table 49, the following equalizing Table 50, should be used to determine the size of risers and basement mains.

TABLE 50. EQUALIZING TABLE FOR SIZING RISERS AND MAINS

SIZE OF PIPE	EQUIVALENT CARRYING CAPACITY	SIZE OF PIPE	EQUIVALENT CARRYING CAPACITY
½"	2	3"	175
¾"	5	3½"	260
1"	10	4"	380
1¼"	20	5"	650
1½"	30	6"	1050
2"	60	7"	1600
2½"	110	8"	2250

GREENHOUSE HEATING BY HOT WATER*

Generally speaking greenhouses are heated by either hot water or steam systems though the former method is the older, simpler and more common method.

Although the same tables, formulae or other data that are used to estimate the heating requirements of systems in the usual type of buildings are applicable to greenhouse heating systems, there are many differences that must be kept in mind so that due allowance may be made in the specification of the plant.

For instance, the highest temperatures are required at night, whereas with residence systems the maximum temperatures are required in the day time. Greenhouse fires are banked during the day and fuel consumption is heaviest at night in contrast to practically all other types of buildings where the fires are banked at night. Greenhouse radiation is almost exclusively made up of piping. The temperatures demanded are almost always below 70 deg. and with lower temperatures and radiating surface giving a higher rate of heat emission, special care must be given to the selection of the boiler.

TABLE 51. TEMPERATURE REQUIRED FOR DIFFERENT PURPOSES

HOUSE	TEMP. REQUIRED, DEG. FAHR.
General Purposes	55 to 60
Cool Greenhouse (Show)	45 " 60
Forcing House	60 " 65
Tropical, or Stove H	65 " 70
Conservatory (General Collection) (Winter Garden)	60 " 65
Palm House	60 " 65
Tropical Palm House	65 " 70
Cool Palm House	50 " 55
Orchid House	65 " 70
Cool Orchid House	50 " 55
Rose House	55 " 60
Carnation House	45 " 55
Violet House	40 " 45
Propagating House	55 " 60
Camelias and Azaleas	45 " 50
Cool Vinery	Cool and Damp
Early Vinery (Start January and February)	65 to 70
Second Vinery (Start February and March)	65 " 70
Late Vinery	65 " 70
Cool Peach House (Cold Damp Weather), Early Peach House (Start January and February)	65 " 70
Second Peach House (Start February and March), Late Peach House (Ripen November and December)	65 " 70
Tomato and Cucumber House	65 " 70
Lettuce House	40 " 45
Mushroom House	55 " 60
Fern House	60 " 65

*Greenhouse heating section prepared by F. P. Elder.

The matter of levels also effects the design and proportions of the heating mains. In many greenhouse ranges the walk levels are not more than 2 ft. 6 in., or 3 ft., above the top of the boiler and where all of the radiating surface is made up of pipe coils on a level not higher than 1 ft. 6 in. above the floor, especially if there are short benches requiring short coils under them, special care is necessary to avoid short circuiting, or interference with the flow through low temperature drops in the short coils.

The temperatures required in houses are given in Table 51.

ESTIMATING HEATING REQUIREMENTS

Heating requirements, i.e., the amounts of radiation for greenhouses, are not obtained by scientific calculation or intricate formulae; at least, they are not so obtained by greenhouse specialists. In this calculation only the exposed glass surfaces and other exposed surfaces reduced to the equivalent of glass surfaces are considered. The loss of heat by conduction through the glass is, of course, by far the greatest loss, but there is another considerable loss which it is very difficult, if not absolutely impossible to calculate, that is, the loss by air leakage between the lights of glass at the laps. These two make up practically all of the losses. The only other losses are those through open doors and through vents. The latter are generally intentional, and used to reduce the greenhouse to the required temperature; but a change of air is necessary for plant growth, so the vents are not opened except for reducing the inside temperature.

Modern greenhouses are glazed almost exclusively with double-thick glass in lights 16 in. wide and 24 in. long. The glazing bars, or ribs, are then usually 16½ in. center to center. The *lap* of the glass is ⅜ in. by eye measurement. Sometimes 24 x 24 in. glass is used, but not often, and with this size, the bow, or spring, of the glass when the wind blows is greater, and the heat loss through the laps may accordingly be greater as a consequence.

The cubic contents in ratio to the surrounding glass surface, the size and the shape are, of course, more or less factors, but as previously stated, only the glass and glass equivalent enter into the calculation for the quantities of radiating surface. The engineer may modify somewhat the quantities so obtained because of the ratio of the contents to the enclosing glass, or the size or shape of the structure, or because of its geographical position or its elevation, or because the greenhouse is in a particularly exposed position. The calculation is merely that of dividing the glass and the equivalent surface by the proper divisor.

WATER TEMPERATURE

The average temperature of the water in a gravity hot-water heating system is assumed to be about 150 deg. fahr., and the average coefficient

of transmission of the radiating surface is assumed to be 2, and as previously stated, only the glass and other exposed surfaces reduced to the equivalent of glass are considered in the calculation. The factors, or divisors, for glass surfaces are derived from the following formula:

$$R = \frac{(T - t) \times G}{(150 - G) \times 2}$$

where

T = temperature desired, fahr.:
t = temperature out of doors (0 deg. fahr.);
150 = temperature of water in radiating surface, fahr.:
G = glass and glass equivalent surface;
2 = coefficient of transmission;
R = radiating surface.

From the above formula the divisors in the table following are derived:

TABLE 52. FACTORS FOR GLASS SURFACES

For 70 to 75 deg. divide sq. ft. of glass and equivalent by 2.0
For 65 to 70 deg. divide sq. ft. of glass and equivalent by 2.28
For 60 to 65 deg. divide sq. ft. of glass and equivalent by 2.62
For 55 to 60 deg. divide sq. ft. of glass and equivalent by 3.
For 50 to 55 deg. divide sq. ft. of glass and equivalent by 3.46
For 45 to 50 deg. divide sq. ft. of glass and equivalent by 4.
For 40 to 45 deg. divide sq. ft. of glass and equivalent by 4.67
For 35 to 40 deg. divide sq. ft. of glass and equivalent by 5.5

It will be noted that the temperatures given in the table are not 75 deg., 70 deg., 65 deg., etc., but 70-75 deg., 65-70 deg., 60-65 deg., etc. Greenhouses are so very sensitive to wind and so very unamenable to exact calculation that the initiated greenhouse man allows himself 5 deg. as leeway or as a factor of safety, and when he intends to heat to 60 deg. he specifies 55-60 deg.

Greenhouses do not respond exactly to figures in various ways: The same amount of glass may in two different houses enclose vastly different volumes; the air loss between the laps, though probably never calculated, may be quite different per square foot of glass in two houses of the same size, design and construction, on account of the difference in workmanship or of glass quality, or of both. The humid atmosphere of greenhouses —and for some purposes the atmosphere is much more humid than for others, as for instance, for rose growing—at some temperatures causes the laps to seal with condensation, checking, or stopping the air loss through the laps. At other temperatures these laps are sealed with ice and the inside surface of the glass is entirely frosted over so that its conductivity is changed. It may be much more difficult to heat a greenhouse at 15-20 deg. above zero, or even at 25 deg. above zero, with the wind blowing, than at zero or below, because the low temperature house may be sealed with ice, as stated. And so, the same formula will not work out exactly

for outside temperatures below zero; and in some parts where the minimum outside temperature is above zero, or where the minimum of zero is rarely reached and then for short periods only, as in some Southern states, while it is true that the same amount of heat is required to offset the low outside temperature, the duration of the cold spell is so very short that it is unnecessary to pipe the houses or to provide boilers as large as the same house or houses would require further North.

RATIO OF AIR CONTENT TO GLASS SURFACE

The ratio of air content of the greenhouses to the glass surfaces increases with the width, so the number of changes of air through laps of glass, however many they may be, are less per hour with a wide house than with a narrow one, and the experienced heating man knows this and judiciously omits a line or two of pipe in very wide houses, after having divided the glass surface by the proper divisor.

Fig. 39 shows in section two conventional, even span, adjacent greenhouses of the ridge and furrow, or saw-tooth type, converted by extending the roof lines until they bisect each other, into one even span house; and the sketch also shows at once that above the eaves line the cubic contents contained by the same amount of glass in the large house is just twice the quantity contained above the eaves lines in the two small ones, and, obviously, it requires less heat units to heat the one large house than it does the two small houses, although the glass surfaces are the same. But how much less heat? Who can say? Glass laid by eye measurement, and glass of varying quality are inconstants.

A table compiled for purposes of comparing the cubic contents and the glass surfaces in the roofs of the houses in widths of 20 to 80 ft. shows that in the 20 ft. houses:

Glass : Contents :: 1 : 2.34

whereas in 80 ft. houses, with the same roof pitch:

Glass : Contents :: 1 : 9.8

Greenhouse radiation is almost always made up of pipe surface—horizontal pipe placed on the side walls, on the sides of solid beds and under raised benches, sometimes on the columns supporting the roof.

KINDS OF PIPE

Steam mains are usually carried overhead on columns, sometimes with the return mains in trenches. The greenhouse heating engineer and contractor uses 3½-in. cast iron pipe mainly for private greenhouse heating with hot water. This pipe holds about 2 qt. per lineal foot, and the superficial surface is about 1.05 sq. ft. to the lineal foot. This pipe is very popular for heating private greenhouses with water for two reasons: (1) it holds so much water that it cools slowly and does not require close

attention through the night when a fireman or watchman is not employed; (2) because of its great durability. Cast iron pipe outlast wrought iron or wrought steel pipe in the humid atmosphere of greenhouses.

The greenhouse heating contractor divides the quantity of glass and glass equivalent in the section of the greenhouse by the proper factor from the Table 52 for the temperature desired, and accepts the result obtained as the required number of lines of 3½-in. cast iron pipe, this size providing about 1 sq. ft. of surface to the lineal foot of pipe (1.05 sq. ft.).

In most commercial greenhouses, 2-in. pipe is used for hot-water heating, and where the houses are not too long, or there are not too many of them, 2-in. pipe does not, of course, hold the same quantity of water as 3½ in., and therefore requires a little closer attention. Its cost, however, is considerably less; hence it is used in commercial ranges.

The coils are constructed, for hot-water heating, of parallel lines with the number of flows equal to the number of return lines. Two-inch pipe coils are constructed of pipes 4½ in. center to center, horizontally and vertically. It is desirable to place the bulk of the piping on the sides of the house, and the remainder of it about evenly distributed under the plant benches or on the sides of the solid beds, the main idea being to produce a proper transmission of heat across the full width of the house with due regard to the shape of the roof, its greatest cooling surface.

POSITION OF RADIATION

Greenhouses are piped in all sorts of ways to suit the great number of different ideas of greenhouse operators; to suit their different ideas on the subject of plant bench or plant bed arrangement which arrangements govern largely the location and arrangement of the piping; and to suit the special requirements of the plants or flowers to be grown in the houses. In short, it may be said that the greenhouse heating engineer does not always place the piping, the radiating surface, just where it belongs, but he does put it where he may or where the operator's plant arrangement permits.

As intimated, there are many problems of distribution of coils. When they must be large or long, and small or short coils served by the same mains, care must be taken to avoid short circuits through the short coils. Long pipe coils always present the problem of taking care of expansion.

The coils need not be graded very considerably in order to produce circulation; pitch, or grade, is required to produce high points where air may collect and be released.

A grade, or pitch, of ⅜th of an inch in 10 ft. is ample.

There is a dearth of dependable data and rules for the sizing of mains with which to connect the coils with the boiler or boilers, owing to the fact that greenhouse heating uses more pipe for radiating surface with

less head or elevation than is required or used with any other type of gravity heating. When the size of the system is so large as to call for large mains, say 7 in. pipe, or larger, it may generally be stated as a fact that the system is a little too large for gravity hot-water heating. Greenhouses should then be heated with steam, or at any rate the circulation should be accelerated by means of a centrifugal pump or hot-water circulator or accelerator, because large mains in gravity hot-water heating systems almost always present difficulties in the way of distinct self-contained circulations and counter currents.

For steam heating, 1¼-in. pipe is used almost exclusively, and the greenhouse man has found that where one line of 3½-in. pipe is required to produce a certain specified temperature with hot water as the heating medium, one line of 1¼-in. steam pipe at 0.5 lb. pressure will do the same work. This fact is inconsistent with the application of the divisors given

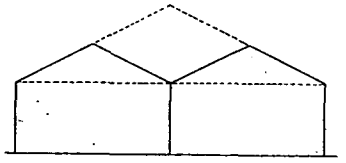


FIG. 39. SKETCH SHOWS RELATION OF CUBIC CONTENTS AND ROOF GLASS SURFACES

for quantities of radiation, but the difference is probably accounted for by the fact that 1¼-in. pipe, being of so much higher temperature, is better distributed. Much of it is distributed in single lines; most of it in flat coils, and seldom in two rows, one over the other, and even then the coils are constructed so as to provide drainage, with a pitch from the supply end to the return bends at the opposite end, and back from the return bends to the return header, so that the coils converge and are not close together. The pipe lines do not, therefore, interfere with each other in radiating their heat. Furthermore, with the proper boiler it is easily possible to increase the pressure as desired.

LARGE RANGES HAVE STEAM SYSTEMS

Hot-water heating was used almost exclusively 20 to 25 years ago. Now the use of hot-water heating is confined to private ranges and to small and medium-sized commercial ranges. It is practically never used in large commercial greenhouse ranges. Its cost would be prohibitive. Hot water is, of course, much more economical in small houses, but in

large ranges a properly designed hot-water plant and a properly designed steam system would be equally economical, but the first cost of hot water is very much above the first cost of steam. In very large ranges vacuum steam heating is frequently used. This permits the use of smaller mains, smaller return connections and has the advantage of quick circulation, and immediately responds to sudden demands.

CHAPTER V

WATER SUPPLY SYSTEMS AND PIPING

THE lack of data upon which to base water pipe sizes for plumbing fixtures, branches and mains is probably due to the great number of variables which enter into their proper determination.

Plumbing fixtures in common use, having what is known as good water flow, deliver the quantities of water per outlet as given in Table 53.

TABLE 53. COLD WATER BRANCH SUPPLY SIZES FOR FIXTURES AND MAXIMUM FLOW IN GALLONS PER MINUTE

	Number of Fixtures									
	1	2	4	8	12	16	24	32	40	
Water Closets—										
Gal. per Min.	8	16	24	48	60	80	96	128	150	Tanks
Pipe Size	½	¾	1	1¼	1½	1½	2	2	2	
Gal. per Min.	30	50	80	120	140	160	200	250	300	Flush
Pipe Size	1	1¼	1½	2	2	2	2½	2½	2½	Valves
Urinals—										
Gal. per Min.	6	12	20	32	42	56	72	90	120	Tanks
Pipe Size	½	¾	1	1¼	1¼	1½	1½	2	2	
Gal. per Min.	25	37	45	75	85	100	125	150	175	Flush
Pipe Size	1	1¼	1¼	1½	1½	2	2	2	2	Valves
Lavatories and Wash Sinks— Based upon Each Faucet										
Gal. per Min.	4	8	12	24	30	40	48	64	75	
Pipe Size	½	½	¾	1	1	1¼	1¼	1½	1½	
Bath Tubs—										
Gal. per Min.	15	30	40	80	96	112	144	192	240	
Pipe Size	¾	1	1¼	1½	2	2	2	2½	2½	
Shower Baths—										
Gal. per Min.	8	16	32	64	96	128	192	256	320	8" rain
Pipe Size	½	¾	1¼	1½	2	2	2½	2½	3	Head
Acid and Slop Sinks, Manufacturing, Kitchen and Laundry—										
Gal. per Min.	15	25	40	64	84	96	120	150	200	per bibb
Pipe Size	¾	1	1¼	1½	1½	2	2	2	2½	per bibb

Note.—The above sizes are based upon a pressure drop of 30 lb. per 100 ft.

In estimating risers and mains, the number of gallons for W. C. and urinals where flush valves are used are to be as given for tanks when the number of flush valves fed by any one main or riser is 8 or more and below this number the quantity is to be determined by adding 20 per cent to the tabular quantity for one flush valve for each succeeding flush valve, up to the quantity given in this table for 8 tanks.

The hot water faucets are to be disregarded when estimating cold water risers and mains, except for those carrying the cold water supply to hot water generators.

Water flowing in pipes is retarded by friction, the extent of which depends upon the velocity, which is the cause of unsatisfactory service when pipes are too small. The amount of head necessary to overcome this friction is known as the friction head, which is usually expressed in feet. It is also known as pressure drop, usually expressed in lbs. per sq. in. per 100 ft. of pipe. The total pressure needed to discharge a given

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quantity of water is the pressure necessary to overcome friction in the pipes (when horizontal) plus the static pressure when the discharge is higher than the supply.

Table 56, column 1, gives the vertical rise in feet to any fixture up to 150 ft. in height; column 2, gives the static head in lb. per sq. in. corresponding with the vertical rise.

The underlying principle involved in determining the proper pipe sizes for mains, risers and branches is to so regulate the size of these pipes that they will carry the maximum amount of water required of them and absorb by friction and static head, all the pressure at the source and still deliver water at the fixture in sufficient quantity but at a pressure practically equalling zero or slightly above except that due to velocity of flow through the fixture.

Table 53 gives the amount of water in gallons which should flow per minute for the number of fixtures indicated of each different type, together with the branch pipe size necessary to carry this amount of water with a pressure drop of 30 lb. per 100 ft. of run.

The volume of water required per fixture is reduced as the number of fixtures in each group is increased, to take care of the factor of probable use.

In estimating the pipe size for any part of a riser in a building of several stories, take 60 per cent of the water to be used on any floor and all floors above as determined from Table 53 and deduct 10 per cent for each floor above. This reduction in estimated amount is to take care of probable use. Thus, if 100 gallons are used on each floor of a 10-story building the size or pipe will be determined as follows:

TABLE 54. WATER RISERS FOR MANUFACTURING BUILDINGS, LOFT BUILDINGS, APARTMENT HOUSES, HOTELS

	G. P. M.	G. P. M.	PIPE SIZE WITH 10 LB. DROP
10th Floor	100 x 0.60	60% = 60	2"
10 and 9	200 x 0.60	90% = 108	2½"
10 and 9 and 8	300 x 0.60	80% = 144	2½"
10 to 7 incl.	400 x 0.60	70% = 168	3"
10 " 6 "	500 x 0.60	60% = 180	3"
10 " 5 "	600 x 0.60	50% = 180	3"
10 " 4 "	700 x 0.60	40% = 184	3"
10 " 3 "	800 x 0.60	40% = 192	3"
10 " 2 "	900 x 0.60	40% = 216	3"
10 " 1 "	1000 x 0.60	40% = 240	3"

Note.—For residences, use Table 53, and for the main supply use 25 per cent of total of gallons used by fixtures and then take pipe size from Table 55 on a basis of 10 lb. pressure drop per 100 ft. or less if water supply pressure is less than 50 lb.

The pressure drop of 30 lb. per 100 ft. of run will give satisfactory results for branches on the top floor but a higher pressure drop can be used on floors below corresponding with the pressures as given in Table 55 which show that for a building 100 ft. in height, a pressure drop of 100 lb. can be used on the fixture lowest branches and that for a building 50 ft. in height, a pressure drop of 52 lb. can be used on the lowest fixture branches; Table 53, however, can be used with safety on any of the floors but will give pipe sizes larger than necessary for the lower floors in a very tall building.

TABLE 55. PIPES MAY BE SIZED FOR GIVING ANY DESIRED PRESSURE DROP PER 100 FT. OF RUN

FRICTION PRESSURE DROP LB. PER SQ. IN. PER 100 FT. RUN	PIPE SIZES IN INCHES								
	¾	1	1¼	1½	2	2½	3	3½	4
	Gallons per Minute								
5	5.4	11	19	30	62	109	171	252	353
7	6.4	13	23	36	74	129	203	298	418
10	7.6	15	27	43	88	154	242	357	499
20	10.8	22	38	61	125	218	343	504	706
30	13.2	27	47	76	153	267	420	618	864
40	15.0	31	54	86	176	308	485	714	998
50	17.0	35	60	96	197	345	542	800	1115
75	21.0	43	74	117	242	423	665	978	1365
100	24.0	49	85	136	278	485	769	1130	1578
125	27.0	55	96	152	311	544	858	1260	1765
150	30.0	60	105	166	341	598	939	1380	1930

TABLE 56. SHOWING WATER PRESSURE REQUIRED TO DELIVER WATER TO TOP OF VERTICAL RISER WITH 15 LB. PRESSURE AT THE TOP BRANCH

VERTICAL RISE OF WATER FROM MAIN TO HIGHEST FIXTURE BRANCH	STATIC HEAD IN LB. PER SQ. IN.	WATER PRESSURE IN LBS. REQUIRED TO DELIVER WATER TO TOP OF RISER WITH 15 LB. TERMINAL PRESSURE				
		Pressure Drop per 100 Ft.				
		5 LB.	7 LB.	10 LB.	20 LB.	30 LB.
0	0	15	15	15	15	—
10	4.33	20.5	20.7	21	22	—
20	8.66	25	25.4	26	28	—
30	12.99	29.5	30.1	31	34	—
40	17.32	35	35.8	37	41	—
50	21.65	39.5	40.5	42	47	52
60	25.99	44	45.2	47	53	—
70	30.32	49.5	50.9	53	60	—
80	34.65	54	55.6	58	64	—
90	38.98	58.5	60.3	63	72	—
100	43.31	64	66	69	79	89
110	47.64	68.5	70.7	74	85	—
120	51.97	73	75.4	79	91	—
130	56.30	77.5	80.1	84	97	—
140	60.63	83	85.9	90	104	—
150	64.96	87.5	90.5	95	110	—

Note.—The water pressures given in above table are the pressures at the base of the riser, necessary to deliver water to top of riser with a terminal pressure of 15 lb., when discharging the number of gallons per minute called for in Table 55, at the pressure drop indicated.

The following examples show how to use Table 55:

Example.—What are the sizes required for mains and branches in a building 100 ft. high, supplied with a water pressure of 75 lb. per sq. in. with 100 gal. of water per minute required on each floor?

This is worked out in Table 54 and gives the pipe sizes for the main riser with a 10 lb. drop for 100 ft. of run and shows that a 3 in. main, reduced to 2 in., would be required: branches to the various groups of fixtures can be taken from Tables 55 and 56. On the top floor it will be necessary to use a 1½ in. branch to carry 60 gal. per min. with a pressure drop of 30 lb. but that at 30 ft. vertically from the supply, a 1¼ in. branch pipe will carry 60 gal. per minute, therefore 1¼ in. pipe could be selected for this branch. Assuming that the pressure drop in the main riser is 10 lb. per 100 ft. run and the pressure drop on the top floor in the branch does not exceed 15 lb. in all and the static head for building 100 ft. as given in column 2 of Table 56 is 43.31 lb. making a total of 58.31 lb.; it will be seen that 75 lb.—58.31 lb., which equals 16.59 lb., is the amount of pressure over and above that required, and that this pressure can be utilized to overcome the friction drop in the main feed line running from the source of supply to the base of the riser.

From Table 54 it is found that 240 gal. per min. will flow at the first floor, and assuming that this water supply is to be brought in a main 300 ft. long; Table 55 will show that a 3½ in. supply would be necessary.

WHEN TANK IS ON ROOF

If tank is elevated about 35 ft. above highest fixture, which would be about 25 ft. above the roof, similar computations will apply for branch connections and main risers except that the main riser will have its greatest diameter at the top. It will be seen that 35 ft. elevation will give the necessary 15 lb. pressure at the highest fixture and that the pressure drop may be made equal to the static head from the top fixtures down, or 40 lbs. per 100.

FRICTION IN ELBOWS

Friction caused by elbows should be added to straight pipe friction. Each elbow in a line will add friction equal to a length of straight pipe forty times the diameter of the pipe:

Pipe Size	¾	1	1¼	1½	2	2½	3	3½	4
Equivalent length of straight pipe in feet	2.5	3.3	4.1	5	6.7	8.3	10	11.7	13.3

The water supply formula herewith makes it possible to accurately compute the flow of water in gallons through any pipe with any friction head and also gives formula for the additional head due to water entering the main, which, if extremely accurate calculations are necessary, should be added to the head required for friction; generally, however, this can be neglected as it is comparatively small.

WATER SUPPLY FORMULA

CF = Cu. ft. per min. discharged
G = Gal. per min. discharged
H = Friction head of water in feet = pressure × 2.31; if water is raised vertically, deduct number of feet raised, from head due to pressure.
L = Length of pipe in feet—including horizontal and vertical runs.

$$CF = 0.16\sqrt{\frac{(3d)^5 \times 3\ H}{L}} \quad (1) \qquad G = 1.2\sqrt{\frac{(3d)^5 \times 3\ H}{L}} \quad (2)$$

$$H = \frac{(CF)^2 \times L}{.0768\ (3d)^5} \quad (3) \qquad H = \frac{(G)^2 \times L}{4.32\ (3d)^5} \quad (4)$$

The above formula neglects the head due to entry, which need not be computed except when L is very short. H_1 = head due to entry in feet.

$$H_1 = \left(\frac{0.83\ G}{d^2 \times 13}\right)^2 \text{ or } H_1 = \left(\frac{6.25\ CF}{d^2 \times 13}\right)^2$$

Example.—Required the discharge of a 2 in. main with pressure 30 lb. 100 ft. horizontal run and 30 ft. vertical run.

$H = 30 \times 2.31 - 30 = 39.3$. Formula (2) $G = 1.2\sqrt{\frac{(3 \times 2)^5 \times 3 \times 39.3}{100 + 30}} = 100.8$

In the above case the head due to entry would be $H_1 = \left(\frac{0.83 \times 100.8}{2 \times 2 \times 13}\right)^2 = 2.56$ ft.

Usually this can be neglected except for very close calculations.

HOT WATER SUPPLY

Tables 57, 58 and 59 give the hot water requirements for several kinds of buildings in terms of gallons per maximum hour and per day.

Pipe sizes for hot water systems may be calculated from the foregoing data on cold water systems; using the same quantities for the gallons of hot water required per min. as is given for the cold water. It may be borne in mind that a column of hot water is lighter than one of cold water amounting to about 2½ ft. per 100 ft. in the height of columns of equal weight. In case the cold water must first be fed down from roof tanks to heaters in the basement and then back up to the top floor fixtures, the extra length of run must be taken into consideration. As a check on the total quantity of hot and cold water required per day it is well to know that this generally runs from 2 to 3 times the amount of hot water required and from 80 to 100 gal. per occupant of the building.

TABLE 57. HOT WATER REQUIREMENTS FOR APARTMENT BUILDINGS

Class	Hot-Water Fixtures per Apartment						Gallons Hot Water per Apartment per Maximum Hour
	Lavatories	Bath Tubs	Showers Over Tubs	Kitchen Sinks	Laundry Trays	Separate Showers	
A	1	1	1	1	2	0	25
A	2	2	1	1	2	0	30
A	2	2	2	1	2	0	35
A	2	1	1	1	2	1	55
B	1	1	0	1	2	0	20
C	1	1	0	1	1	0	15

Note.—The quantity of hot water required per day is usually about 10 times the maximum hour requirement.

TABLE 58. HOT WATER REQUIREMENTS FOR HOTELS

Class	Gallons		Add for Kitchens per Meal Capacity		Add for Laundry		
	Hot Water per H. W. Fixture per Day	Per H. W. Fixture per Maximum Hour	Per Day	Per Maximum Hour	Per Piece per Day	Per Washer per Day	Per Washer per Maximum Hour
High-Class Transient	85	6.8	3.0	1.0	1.0	1200	250
Medium-Class Transient	70	6.5	2.5	0.80	1.0	1000	200
Apartment Hotels	50	5.0	2.0	0.60	1.0	1000	200

Note.—Instantaneous demand rate for laundry washers from 25 to 50 gallons per minute.

TABLE 59. HOT WATER REQUIREMENTS FOR OFFICE BUILDINGS

Class	Hot Water per Hot-Water Fixture	
	Per Day	Per Maximum Hour
Having Hot Water in public toilets only	50	5.0
Having Hot Water in Private Offices as well as in Public Toilets	30	3.0
For Self-Closing Hot Water Fixtures Deduct	40%	25%

As a check on the sizes of hot water mains, Table 60 will give safe sizes for gravity systems fed from roof tanks set not less than 20 ft. from the water line in tanks to the highest fixtures.

TABLE 60. SIZES OF HOT WATER MAINS

Gallons per Maximum Hour	Size of Hot Water Main, Inches
500	2
750	2½
1000	2½
1250	3
1500	3
1750	3½
2000	3½
2500	4
3000	4

CHAPTER VI

STEAM AND HOT WATER HEATING BOILERS

THE boiler is one of the most important parts of any heating system and its selection; as to type, size, rating, capacity, draft requirements, firing periods, kinds of fuel, principles of operation, efficiency and construction, should be made with great care.

TYPES OF BOILERS

Broadly speaking three types of heating boilers are commonly used.

Sectional Boilers, may be of the rectangular pattern with vertical sections, or of the round pattern with horizontal sections. They are usually constructed of cast iron; because of its great resistance to corrosion, pitting, and similar forms of deterioration under average water and atmospheric conditions. They require small amount of floor space and head room and have low water lines. Their water capacity is small and being divided into thin waterways they heat up and steam quickly.

On account of their sectional construction and the usual practice of being shipped knocked down and assembled on the job, they are easily handled through small openings at any stage of construction. Their design also facilitates the removal and replacing of damaged parts as well as an increase or decrease in capacity by the addition or removal of sections. Most sectional boilers are comparatively cheap in first cost but the labor of assembling is a factor which must be considered.

The Fire Tube Boiler, which may be of the horizontal tubular brick set pattern, the horizontal tubular fire box pattern (with or without supplementary brick setting), the vertical tubular brick set pattern or the vertical tubular fire box pattern.

Fire tube boilers are usually constructed of steel, which shows the greatest resistance to splitting, cracking or similar stress due to the expansion and contractional strains of temperature differences of too excessive pressures, or temperature. They are well adapted to oil burning on account of this resistance the wide temperature ranges encountered with this type of fuel. They have large water and steam spaces so that while they may heat up and steam slowly they retain heat and supply steam for comparatively long periods with a receding fire, thus tending to compensate for fluctuations in firing by the fly wheel effect of their water and steam capacities. Their large steam capacity also tends to prevent priming and fluctuation of the water line. They are comparatively steady under sudden and wide variations in load conditions and require little attention on this account. Steel boilers may be built for high or low pressure and are therefore, flexible in converting from one pressure to another.

Fire tube boilers may be of the direct tube, return tube or a combination of direct and return tube type and have any desired ratio between grate and heating surface. Generally this type of boiler is very efficient in operation, moderate in first cost and may be operated to at least 150 per cent of normal rating without difficulty or decreased efficiency.

The Water Tube Boiler, which may be of the horizontal brick set pattern with either horizontal or cross drums, the vertical brick set pattern, the bent or inclined tube brick set pattern, or the self contained fire box pattern with any one of the above arrangements of tubes.

Water tube boilers are usually constructed with steel or iron tubes, steel drums and either steel, cast steel or cast iron headers. On account of the smaller diameter of drums and the fact that the tubes are the only parts to come into direct contact with the hot furnace gases it is generally felt that this type of boiler is safer to operate, especially on high pressure. They heat up and steam rapidly but also lose their heat and steam pressure quickly. The water and steam spaces are moderate and their performance on rapid and wide variations of load is accordingly fair.

The principal heating surface consisting of tubes with the water inside and the heated gases outside, is easy to clean from the inside with hydraulic or pneumatic tube cleaners and from the outside with steam or air jet soot blowers although with highly scaling waters the scale formation on the inside of a small tube may be comparatively rapid.

The water line is generally high and considerable space and head room is required. On account of being constructed with drums and banks of tubes they may be shipped knocked down and be assembled on the job, thus passing through small openings at any stage of the construction. The sectional construction facilitates repairs or increase and decrease in capacity. This type of boiler is efficient in operation, comparatively high in first cost, but may be operated to 200 per cent of the usual normal rating without undue loss in efficiency. It is especially adapted to the larger plants where higher pressures are required.

SIZE, RATING AND CAPACITY OF BOILER

These three words are sometimes used indiscriminately to designate any one of the three things for which they should be used. The size of a boiler should indicate its physical dimensions, *i.e.* the size of a sectional boiler may be the inches in width or a rectangular fire box or the inches in the diameter of a round fire pot, combined with the number of sections; the size of a return tubular boiler is usually the inches in the diameter by the feet in the length of it shell combined with the number and size of tubes. The sizes of fire box boilers are usually arbitrary figures based on heating surface and grate surface. The size of a water tube boiler is generally stated in horse power, or the number of tubes wide by the number of tubes high with the size and length of tubes.

All of these are intended to designate the physical size and dimensions of the particular boiler and not its rating or capacity as it will be seen that these are quite different things. While the size or number of a boiler may give only one or more of its physical dimensions it must be the key from which all of the necessary physical dimensions may be obtained by corresponding references in tables or drawings.

The rating of a boiler is the measure of what it will do under certain conditions. The manufacturers rating is the measure which the manufacturers place upon the performance of their own boilers; this may be given for one or more well defined sorts of conditions or for what the manufacturers may choose to consider average working conditions without definition.

The ratings of low pressure boilers are usually stated in terms of the number of square feet of standard cast iron direct radiation the boiler will supply with steam or hot water, referred to conditions when the plant is heated up and operated under stable conditions with the radiation in still air at 70 deg. fahr and all proper allowances made for the added load of piping and connections. These ratings are usually for an 8 hour or other stated firing period and for hard coal or other stated fuel with allowance factors for other lengths of firing periods and for other kinds of fuel. In connections with most rating the chimney or draft requirements corresponding to the ratings are given. Most manufacturers rating tables give the square feet of grate surface and some give the square feet of heating surface in the boilers.

Unfortunately there are wide differences in the ratings of boilers by the various manufacturers due largely to the fact that there has never been a full and complete cooperation in the establishment of a standard code on which to rate. It is hoped that the proposed code which is being developed jointly by the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, the *Boiler and Radiator Manufacturers Association*, the *Heating and Piping Contractors National Association*, and others interested will supply this long felt want. In the meantime there are certain physical data about the rating of boilers which may be used to assist in the selection of proper ratings for various services.

The most important factors involved are:

1. Square feet of grate surface which determines the pounds of coal that can be burned per hour under any set of draft and firing conditions. On the basis of from 6 to 8-hour firing periods for low-pressure heating boilers using nut, egg or stove sizes of anthracite coal and with the usual draft of from ⅛ to ¾ in. water (depending on the size of boiler and coal used) the usual rate of combustion is from 5 to 20 lb. of coal per square foot of grate per hour, depending upon the size and type of boiler and ranging from the lower rate for small boilers to the higher rate for large boilers. From 25 per cent to 35 per cent more soft coal may be burned under similar conditions.

Under average working conditions from 7500 for small boilers to 8500 B.t.u. for large boilers, per pound of coal burned will be transferred to the heating medium so that the square feet of grate by the rate of combustion by the B.t.u. transferred per pound of fuel will give the normal rated output of the boiler in B.t.u. per hour. This output divided by 240 for steam and 180 for water (which corresponds to the B.t.u. transmitted per hour per square foot of steam and hot water radiation respectively under standard conditions) will give the normal rating of the boilers in terms of the radiation which it will carry as based upon the grate surface only. For other conditions as to firing periods, fuels and draft the following may be used.

Where fires are constantly attended the maximum practical rates of combustion corresponding to a draft of 1 in. of water through the fuel bed may be taken as follows and the rates of combustion for other intensities of draft to vary as the square root of the draft.

Small anthracite coal	20 lb. per sq. ft. of grate
Large sizes anthracite coal	25 " " " " "
Run of mine soft coal	25 " " " " "
Large sizes of soft coal	30 " " " " "

Practical rates of combustion run from 5 lb. per sq. ft. of grate in small heating boilers to 40 lb. per sq. ft. of grate in large power boilers depending upon the fuel and draft.

2. Square feet of heating surface which determines the capacity of the boiler for transferring heat from fuel to heating medium. This may be divided into prime heating surface (in direct contact with the fuel bed and its direct radiation) and secondary heating surfaces in contact with the heated gases, only.

In an ordinary three-pass boiler, from 60 to 80 per cent of the total heat is transferred by the surface in the first pass, which means that approximately this one-third of the surface transmits at a rate of from four to five times that of the remaining two-thirds of the surface. All or a part of the other two-thirds may be and is frequently more or less omitted as it is seen that this can be done without decreasing the capacity more than 30 per cent or the efficiency more than 20 per cent. Any omission of this surface increases stack temperatures and decreases the efficiency of the boiler.

A long-established rule for the rating of high-pressure boilers on the basis of their heating surface is to allow 10 sq. ft. of heating surface per boiler horsepower of 34.5 lb. of water evaporated from and at 212 deg. fahr. per hour. This means $\frac{33465}{10}$ B.t.u. per hour sq. ft. of heating surface. On this basis the rating of heating boilers would equal 3346.5 multiplied by the square feet of heating surface in B.t.u. per hour.

Heating boilers are seldom rated on this basis as the ratio of prime to secondary surface, the design and arrangement of surface are so different in the various types of boilers and there is no well-established practice as to stack temperatures and efficiencies upon which uniform ratings may be based. While this basis is still used for the nominal rating of high-pressure boilers it is not in effect since usual practice is to operate at from 150 to 300 per cent of this normal rating, which may be successfully done, with proper arrangement of furnace and heating surface, without serious loss in efficiency.

3. The capacity of the fire-box for fuel and the capacity of the combustion chamber for proper combustion at the full boiler rating. The capacity for fuel must be sufficient for the necessary charge to run from one firing period to another without forming too deep a bed of fuel and ash on the grate to permit the passage of sufficient air for proper combustion with the available draft and at the same time leave sufficient space for proper combustion. In the case of oil fuel the capacity of combustion chamber should be sufficient so that the flame does not impinge upon the walls or heating surface.

4. In adjusting the boiler to the load care must be exercised to see that all of the conditions to be met are taken into account and proper factors of safety are allowed for heating-up the building.

A heating boiler designed for the maximum conditions will be operating under a comparatively low load factor for the greater part of the time and may be correspondently inefficient and uneconomical, unless properly designed to meet these conditions. In the smaller plants this is hard to overcome without either having a boiler too large for economy or too small to properly heat the building up in a reasonable time. This is sometimes attempted by having the normal capacity of the boiler about 80 per cent of that required for maximum conditions. In order to make this successful the boiler plant must be adapted to operate successfully on at least 50 per cent overload for short periods.

In larger plants the boilers may be divided into two or three units, so that one unit may be operated during mild weather, one or two units during average weather and the entire plant during extreme weather which arrangement is ideal for flexibility and economy.

In office buildings, factories and other work places, it is not generally considered so necessary to have the temperature up to normal at the beginning of the working period as it is in schools, churches, theatres and other places of assemblages where the occupants are sitting still, and for this reason the relative capacity of the heating system may be less.

In school buildings and other buildings where the heating of the air for ventilation is a large part of the load, this factor may be greatly reduced by recirculating this air during the heating-up period, so that while the entire normal average load on the building may be from two to three times as much for heating the air as for supplying the direct radiation the heating-up load for the air may be reduced to from one-half to one-third of its normal value so that the total load may not be more than twice the direct radiation load. By continuous recirculation arranged to vary the amount of air taken in from the outside from 100 per cent at an outside temperature of 65 deg. to 25 per cent at an

outside temperature of 6 deg. the boiler capacity required for heating the air may be held practically constant at about 25 per cent of that required for 100 per cent of air from the outside.

The following factors of safety are recommended in the selection of boilers:

For school buildings where recirculation is not to be employed
50 per cent to 100 per cent.
For school buildings where full recirculation is to be employed
25 per cent to 50 per cent.
For buildings heated periodically 50 per cent to 100 per cent.
For other buildings 25 per cent to 50 per cent.

5. In figuring the total load on the boilers the equivalent of the piping system in square feet of radiation must be added to the actual radiation and all other heat-using elements must also be added for. In the absence of exact data from 10 per cent to 15 per cent is usually added for the average piping systems. The capacity of a boiler should state what it is capable of doing under certain conditions; the normal capacity under normal conditions and the maximum capacity under maximum conditions. The draft requirements of a boiler are for forcing the air through the grates and fuel bed and for creating the necessary velocity and overcoming friction in passing the gases through the gas passages of the boiler. Boiler ratings should give these two factors of the draft requirements under several load conditions. As a rough guide the loss in draft through the passage of the boiler from the furnace to the smoke outlet (under full load) ranges from 0.05 to 0.15 in. water depending upon the size and type of boiler.

A reliable simple formula for the chimney capacity of heating boilers is:

$$C = K A \sqrt{H}$$

where

C = pounds of coal to be burned per hour.
K = 10 for small chimneys and up to 15 for large ones.
A = cross sectional area of chimney in square feet.
H = height of chimney in feet above the grates.

IMPORTANCE OF DRAFT

The capacity a boiler is capable of developing depends more upon the amount of draft available than upon any other factor. Assuming that a chimney is smoke tight and well built according to the Ordinance for Construction of Chimneys, 1921 (recommended by the *National Board of Fire Underwriters* and approved by the Society), the intensity of the draft depends upon the height of the chimney, and the quantity or amount of draft depends principally upon the effective area of the chimney. According to their height, heating chimneys are divided into three classes, the erratic, uncertain and reliable. Chimneys less than 36 ft. high are erratic in their action. The head produced by such a low height is so small that the least unfavorable condition or interference practically puts the chimney out of commission.

Chimneys between 36 ft. and 64 ft. in height are in the doubtful zone, sometimes good and sometimes bad. The head produced by this relatively low height is frequently offset by slight unfavorable conditions that may be difficult to locate. Chimneys over 64 ft. in height are usually

reliable, because as a rule the chimney is designed by an engineer and must be well built to sustain such a heavy load and the height is such as to produce considerable head or force to offset unfavorable weather conditions, etc. Chimneys in this class produce about 0.009 in. draft per ft. of height in zero weather with 600 deg. in the stack according to the formula:

$$P = H\left(\frac{7.6}{T_o} - \frac{7.9}{T_s}\right)$$

where

P = draft pressure in inches of water.
H = height of chimney in feet.
T_o = absolute temperature of outside air.
T_s = absolute temperature of stack gases.

For low-pressure heating boilers, water heaters and warm air furnaces conservative modern practice in the matter of chimney sizes is in accordance with the accompanying schedule, Table 61:

TABLE 61. CHIMNEY SIZES

Warm Air Furnace Capacity in Leader Pipe Sq. In.	Steam Boiler Capacity Sq. Ft. of Radiation	Hot Water Heater Capacity Sq. Ft. of Radiation	Nominal Dimensions of Fire Clay Lining In.	Rectangular Flue: Actual Inside Dimensions of Fire Clay Lining In.	Rectangular Flue: Actual Area Sq. In.	Rectangular Flue: Effective Area Sq. In.	Round Flue: Inside Diameter of Lining In.	Round Flue: Effective Area Sq. In.	Round Flue: Height in Ft. from Grate
790	590	973	8½x13	7x11½	81	70			35
1000	690	1140					10	79	
	900	1490	13x13	11¼x11¼	127	99			
	900	1490	8½x18	6¾x16¼	110	100			
	1100	1820					12	113	40
	1700	2800	13x18	11¼x16¼	183	156			
	1940	3200					15	177	
	2130	3520	18x18	15¾x15¾	248	195			
	2480	4090	20x20	17¼x17¼	298	234			45
	3150	5200					18	254	50
	4300	7100					20	314	
	5000	8250	24x24	21x21	441				
	4600	7590		20x24*	480	326			55
	5570	9190		24x24	576	380			60
	5580	9200					22	380	
	6980	11500					24	452	65
	7270	12000		24x28	672	468			
	8700	14400		28x28	784	531			
	9380	15500					27	573	
	10150	16750		30x30	900	616			
	10470	17250		28x32	896	635			
	11800	19500					30	707	70
	14700	24300					33	855	
	17900	29500					36	1018	

*Dimensions below are for unlined rectangular flues.

Chimneys recommended for larger boilers 15 to 250 hp. are proportioned in accordance with the report made by a joint Committee of the *American Boiler Manufacturers Association* and *Stoker Manufacturers Association* and approved by these organizations. The sizes are given in Table 62.

TABLE 62. HEIGHT OF STACK FOR AVERAGE INSTALLATIONS (Sea Level)

Forced Draft Stokers

Per Cent Rating	100	150	200	250	300
Draft Furnace	0.15	0.15	0.15	0.15	0.15
Friction Loss (Boiler)	0.18	0.4	0.65	0.9	1.20
Friction Loss (Breeching)	0.10	0.10	0.10	0.10	0.10
Total Draft Required	0.43	0.65	0.90	1.15	1.45
Height of Stack (Ft.)	80	112	145	178	220

Diameter of Chimney in Inches for Horizontal Return Tubular Boilers				Height of Stack in Feet—For Sea Level and 60 deg. fahr. Outside Temp. Assumed Friction Loss in Stack 0.1 in. per 100 ft.			
Nominal H. P.	100% Rating	150% Rating	200% Rating	Draft at Base of Stack	100% Rating	150% Rating	200% Rating
15	13	14	17	0.12	21	22	25
20	14	16	18	0.15	26	28	30
25	16	18	20	0.20	35	37	41
30	17	19	21	0.25	43	46	51
35	18	20	22	0.30	52	56	61
40	19	21	23	0.35	60	65	71
50	20	23	25	0.40	69	74	81
60	21	24	27	0.45	78	84	91
75	23	26	29	0.50	86	93	101
90	25	28	31	0.55	95	102	111
100	26	29	33	0.60	104	112	122
115	27	31	34	0.65	112	121	132
125	28	32	35	.....	.....	.....	.....
150	30	34	38	.....	.....	.....	.....
175	32	36	40	.....	.....	.....	.....
200	33	38	43	.....	.....	.....	.....
210	34	38	44	.....	.....	.....	.....
225	35	40	45	.....	.....	.....	.....
250	36	41	47	.....	.....	.....	.....

DATA ON WHICH TABLES ARE BASED

Rating	100%	150%	200%	Stack Temp, deg. fahr.	450	500	550
Efficiency	65%	65%	63%				
CO_2	8%	9%	10%	Lbs. of Gas	85	77	73

AVERAGE FRICTION LOSS THROUGH BOILERS

Per Cent Rating	100	150	200	250	300
Loss Ins., Water	0.1 to 0.3	0.2 to 0.6	0.3 to 0.9	0.5 to 1.4	0.7 to 1.9

Friction loss through boiler varies according to construction.
For Furnace Draft.—Allow 0.15 for forced draft. *For Natural Draft* 0.35 in. or higher should be used depending upon rate of combustion and fuel used.
For Breeching Friction Loss.—Allow 0.05 in. for each right angle bend and 0.1 in. per 100 ft. of length. Cross sectional area should be 20 per cent larger than that of stack.

HEIGHT OF STACK IN FEET

For Sea Level and 60 deg. fahr. Outside Temperature and 0.1 in. Friction Loss per 100 ft.

TOTAL DRAFT REQUIRED IN. FOR FURNACE BOILER AND BREECHING	PER CENT OF BOILER RATING				
	100	150	200	250	300
0.3	56	.....	.....	.....	.....
0.4	74	69	.....	.....	.....
0.5	93	86	81	.....	.....
0.6	111	103	97	.....	.....
0.7	130	120	113	108	.....
0.8	148	138	129	123	.....
0.9	.....	155	145	139	132
1.0	.....	172	161	154	147
1.1	.....	190	177	170	162
1.2	.....	.....	194	185	176
1.3	.....	.....	209	200	191
1.4	.....	.....	226	216	206
1.5	.....	.....	.....	231	221
1.6	.....	.....	.....	.....	236
1.8	.....	.....	.....	.....	265
Assumed Flue Gas Temp.....	500	550	600	650	700

CORRECTION FOR ALTITUDE

HEIGHT ABOVE SEA LEVEL (FT.)	RATIO INCREASE IN DIAMETER	RATIO INCREASE IN HEIGHT
0	1.000	1.000
1,000	1.015	1.046
2,000	1.030	1.097
4,000	1.063	1.205
6,000	1.096	1.321
8,000	1.130	1.456
10,000	1.165	1.612

CHAPTER VII

CODE FOR TESTING LOW-PRESSURE STEAM-HEATING BOILERS

REVISION OF 1923

(Adopted by AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, Jan., 1924)

OBJECT OF THE CODE

THE object of the Code for Testing Low-Pressure Steam-Heating Boilers is to provide a standard method for conducting and reporting tests to determine the heat efficiency at various rates of steaming.

ESSENTIALS NECESSARY TO DETERMINE HEAT EFFICIENCY

The essentials necessary to determine the heat efficiency of a steam-heating boiler are:

a. The total heat input.

(The total heat input is the total heat value of the fuel charged.)

b. The total heat recovered at the boiler outlet.

(The total heat recovered at the boiler outlet is the total heat of the steam leaving the boiler less the total heat of the feed water entering the boiler.)

PREPARATIONS FOR TEST

The boiler shall be erected, covered and connected to conform to the directions and practice of the manufacturer. The piping shall be connected in such a way that the steam may be carried to a point away from the boiler and it shall be arranged so that the condensation cannot flow back to the boiler.

The moisture in the steam shall be determined by a steam separator, not less than 95 per cent efficient, placed in the steam delivery pipe as close to the boiler as possible. The piping between this separator and the boiler, also the separator itself, shall be thoroughly covered with insulating material. A pipe connected to the bottom of the steam separator shall be provided with a positive seal. The water shall be drained from the separator hourly and weighed immediately.

The steam connections between the boiler outlet and the separator shall be the same in size and arrangement as that to be used when the boiler is installed.

The water shall be fed to the boiler continuously from the feed tank through piping with all necessary valves, and all other water connections to the boiler shall be carefully blanked off. The temperature of the feed water shall be read from a thermometer inserted in a cup projecting well into the feed line near the boiler and filled with a heavy oil. All boiler water connections, including blow-off pipes, must be exposed to view, so that leakages may be observed, and either stopped or measured. The glands of the feed pump shall be carefully packed to prevent leakage.

Code prepared by Committee for Testing Low-Pressure Steam Heating Boilers: John Blizard, *Chairman*, Homer Addams, F. Paul Anderson, L. P. Breckenridge, P. J. Dougherty, L. A. Harding, F. B. Howell, and J. F. McIntire.

The boiler shall be connected with a short, direct smoke-pipe to a chimney flue of suitable size, height and construction to give proper draft.

The water spaces of the boiler shall be thoroughly boiled out with a solution of sal soda, potassium hydrate or sodium hydrate and then thoroughly rinsed with clean water.

The heating surface, firebox, ashpit, flues and chimney shall be clean and free from soot, ashes and dust at beginning of test.

APPARATUS AND INSTRUMENTS

Apparatus and instruments must be reliable and be arranged in such a way as to insure correct data.

Tanks for measuring the feed water may be calibrated with weighed quantities of water at the temperature to be used during the test, or mounted on accurate weighing scales. The water may be fed to the boiler by gravity, by air pressure or by feed pumps, from feed-water tanks supplied from the measuring tanks by gravity.

Accurate scales of suitable size shall be provided for weighing separator water, fuel and all refuse removed from the grate and ashpit.

Three draft gages shall be provided and so arranged as to determine the pressure difference at the level of inserting the pipe between the outside and the ashpit, between the outside and the firebox, and the outside and the smokehood. Draft measurements shall be made with draft gages reading to 0.01 in.

Accurately calibrated instruments shall be provided for measuring temperatures of gases, water and steam.

An Orsat apparatus shall be used for determining the flue gas composition. If recording carbon dioxide (CO_2) instruments are provided, they shall be checked every hour with the Orsat apparatus.

A Ringelmann chart shall be used for smoke observations.

Weather Bureau reports from the immediate vicinity may be used to determine the barometric pressure. When such reports are not available, a calibrated aneroid barometer or mercury column shall be used for determining the barometric pressure.

A calibrated steam gage or a mercury column shall be used for determining the steam pressure.

A log of the test shall be kept on record sheets similar to those provided by this Code.

DURATION OF TEST

The test shall continue for at least 16 hours if operated at the normal manufacturer's rating; if operated at other ratings it shall continue until as much fuel has been burned as would have been burned in a 16-hour test at normal rating.

METHOD OF STARTING AND STOPPING TEST

The New Fire Method of starting and stopping test may be used on any boiler when anthracite coal is used as fuel. All tests using other fuels shall be started and stopped by the Continuous Firing Method.

New Fire Method.—A preliminary fire shall be made and the boiler operated under test conditions for at least one hour before starting the test. The preliminary fire shall then be dumped, the ashpit thoroughly cleansed and dried wood placed on the grate and kindled. The test shall be considered started at the time of firing the charge of wood. On this charge of wood, fuel shall be placed. The wood shall be considered as having a heating value of 5000 B.t.u. per lb. The height of water line in gage glass and feed tank shall be noted and recorded at the time the preliminary fire is dumped. The water level in the boiler shall be kept at this level as nearly as possible throughout

the test and the water level in the boiler and feed tank must stand at this same height when the test closes. At the end of test the fire shall be dumped. The residual fire when dumped shall be placed in tightly covered cans, weighed and left to cool. After cooling it shall be forwarded for analysis and determination of its heat value and ash content. The total fuel fired shall be taken as the total weight of fuel exclusive of the wood used for kindling, to which shall be added the fuel equivalent of the wood and from which shall be subtracted the fuel equivalent of the residual fire. The weight of the ash content of the residual fire shall be added to the weight of ash and refuse removed from the ashpit and the sum recorded as ash and refuse removed from the ashpit.

Continuous Firing Method.—A preliminary fire shall be made and the boiler operated under test conditions for at least one firing period and not less than one hour before starting the test.

The fire shall then be burned low, thoroughly cleansed and the remaining live fuel spread evenly over the grate as the foundation for the first test fuel charge. The thickness of the fuel bed and the extent to which it has been burned through shall be quickly estimated or measured. The height of water line in gage glass and feed tank shall be noted and recorded. The test shall start at the time of making these observations. A weighed charge of fuel shall then be fired. The ashpit shall be thoroughly cleansed immediately and the test allowed to proceed.

A constant water level and rate of steaming shall be maintained throughout the test.

At the end of the test the fire should be burned low and cleansed so as to leave the same amount of live fuel on the grate as at the start. When this condition is reached and the water level in the boiler and feed tank are at the same height as at the start, record the time and this time shall be the time of stopping. The contents of the ashpit shall be removed promptly on stopping and placed in airtight cans, weighed and left to cool. The boiler shall be charged with all fuel charged during test.

METHOD OF FIRING

The method and frequency of firing shall be as agreed upon by the manufacturer and purchaser.

FUEL SAMPLING

During the progress of the test, fair samples at regular intervals shall be taken with a shovel from the fuel charge, stored in a covered vessel in a cool place, and after crushing and quartering, two one-pint glass jars or other airtight vessels shall be filled. The gross sample for slack coal and small sizes of anthracite in which the impurities do not exist in abnormal quantities or in pieces larger than ¾ in., should weigh approximately 500 lb. and not less than 1000 lb. for other solid fuels.[1]

The small samples shall be preserved for determinations of the proximate analysis, ultimate analysis and calorific value.

The refuse taken from the ashpit and grate shall be reduced by crushing and quartering to a quantity sufficient to fill two one-pint jars or other airtight vessels for determining its combustible content in the laboratory. Care must be taken to crush and quarter the coal, ash, and refuse on a clean floor; to avoid contaminating the sample a metal plate is to be preferred to a concrete floor. Care must be taken to see that the ash and refuse does not burn after removal from the grate or ashpit.

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[1] As recommended by the *American Society for Testing Materials*, D21—16, p. 756, 1921.

The Committee on Code for Testing Low-Pressure Heating Boilers of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS is prepared to interpret the meaning of any items on the Code.

It is requested that all tests be filed with the AMERCIAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.

STANDARD FORM

For Reporting Results of Low-Pressure Steam-Heating Boiler Tests

RESULTS

Of a Test on a Low-Pressure Boiler

DATE OF TEST.....
CONDUCTED AT.....
DIRECTOR OF TEST.....(signature)
MANUFACTURER OF BOILER.....
OWNER OF BOILER.....
SIZE OF BOILER.....
TYPE OF BOILER.....

GENERAL PARTICULARS OF BOILER AND FUEL

BOILER

Type.....
Made by.....
Length of Grate (or Diameter).....in.
Width of Grate.....in.
Fuel Capacity (Greatest Possible Volume).....cu. ft.
Maximum Fuel Depth (Greatest Possible Depth of Fuel).....in.
Fuel Capacity Normal.....cu. ft.
Fuel Depth Normal.....in.
Average Distance from Top of Normal Fuel Charge to Crown Sheet.....in.
Total Furnace Volume, Grate to Crown Sheet and Bridge Wall.....cu. ft.
Total Combustion Space Beyond Bridge Wall.....cu. ft.
Water Capacity (To Water Line).....lb.
Height of Water Line.....in.
Steam Connections Used {Number.....
{Size.....in.
Kind of Insulation.....
Thickness of Insulation.....in.
Detailed Description of Boiler.....

SMOKE PIPE AND CHIMNEY

Area of Smoke Pipe.....sq. in.
Length of Smoke Pipe (Boiler to Chimney).....in.
Number and Kind of Bends in Smoke Pipe.....
Chimney, Height above Grate.....ft.
Chimney, Area at Bottom.....sq. ft.
Chimney, Area at Top.....sq. ft.

FUEL

Name.....
Size.....

PROXIMATE ANALYSIS		As Fired	Moisture Free
Moisture	per cent		
Volatile Matter	per cent		
Fixed Carbon	per cent		
Ash	per cent		

ULTIMATE ANALYSIS		As Fired	Moisture Free
Carbon	per cent		
Hydrogen	per cent		
Oxygen	per cent		
Nitrogen	per cent		
Sulphur	per cent		
Ash	per cent		

These forms may be obtained on request at the office of the Secretary of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, 29 West 39th Street, New York City, at nominal cost.

HEAT VALUE (GROSS)

B.t.u. per lb. as fired.....
B.t.u. per lb. moisture free.....
B.t.u. per lb. moisture and ash free.....

CHARACTER OF FUEL

(State whether coking or free-burning, clinker troubles, etc.)

METHOD OF FIRING

PRINCIPAL RESULTS OF TEST

Heat recovered at the boiler outlet per hour.....1000 B.t.u.
Maker's rating (sq. ft. radiation × 240).....1000 B.t.u. per hr.
Percentage of maker's rating developed.....per cent
Mean interval between charging fuel.....hours
Mean interval between attention of any kind to the fire, including charging.....hours
Overall thermal efficiency.....per cent

DETAILED RESULTS OF TEST

(For full particulars of boiler and fuel see "general particulars" ante)

GENERAL INFORMATION

1. Date of Test.....
2. Number of Test.....
3. Location of Boiler.....
4. Maker of Boiler and Type.....
5. Owner of Plant.....
6. Test Conducted by.....
7. Duration of Test.....hr.
8. Manufacturer's Rating of Boiler.....sq. ft. radiation[1]
9. Grate Area[2].....sq. ft.
10. Barometric Pressure.....in. of mercury

FUEL

11. Heat value, as fired.....B.t.u. per lb.
12. Number of Times Fuel Charged during Test.....
13. Intervals between Charging, hrs. Longest.....Shortest.....Average.....
14. Intervals between Attention of any Kind to the Fire, including firing, hr. Longest.....Shortest.....Average.....
15. Average Fired per Charge[3].....lb.
16. Depth on Grate at Start of Test (After Firing).....in.
17. Depth on Grate at Finish of Test.....in.
18. Weight as Fired during Test[3].....lb.
19. Weight as Fired per Hour[3].....lb.
20. Moisture in Fuel.....per cent
21. Weight Fired per Hour less Moisture:[3]

$$\frac{100 - \text{item } 20}{100} \times \text{item } 19 \text{.....lb.}$$

ASH AND REFUSE

22. Weight of Ash and Refuse Removed from Grate.....lb.
23. Weight of Ash and Refuse Removed from Ashpit.....lb.
24. Total Weight of Ash and Refuse Removed[4] (item 22 + item 23).....lb.

[1] One sq. ft. radiation to be assumed equal to 240 B.t.u. per hr.
[2] If the grate have an unusual shape, method of computing area must be stated under "Remarks."
[3] When the New Fire Method is used the equivalent fuel charged shall be given throughout. The method of obtaining this is shown at the end of this table.
[4] To include ash content of residual fire when New Fire Method is used.

25. Total Ash and Refuse, Percentage of Fuel as Fired .....
26. Combustible in Ash and Refuse ..... per cent

TEMPERATURE

27. Steam ..... deg. fahr.
28. Feed Water ..... deg. fahr.
29. Gases Leaving Boiler ..... deg. fahr.
30. Boiler Room ..... deg. fahr.
31. Outside Air ..... deg. fahr.

DRAFT INTENSITY

32. In Smokehood ..... in. water
33. Over Fire ..... in. water
34. In Ashpit ..... in. water

OUTPUT

35. Equivalent evaporation from and at 212 deg. fahr. per hr. of test ..... lb.
36. Equivalent evaporation from and at 212 deg. fahr. per lb. of dry coal fired ..... lb.
37. Heat Recovered at the Outlet per hour (item 35 × 0.97) ..... 1000 B.t.u.

STEAM AND WATER

38. Steam pressure (gage) ..... lb. per sq. in.
39. Total Water Fed to Boiler during Test ..... lb.
40. Priming: Total Water Removed from Separator, Per Cent of Total Feed Water ..... per cent

HEAT BALANCE

	Per lb. fuel as fired	Per cent heat in fuel fired
41.[5] Heat to steam leaving outlet (and thermal efficiency boiler, furnace and grate)		
42. Heat lost by hot flue gases, exclusive of steam		
43. Heat lost by not burning carbon monoxide		
44. Heat lost by steam in flue gas		
45. Heat lost by combustible in ash and refuse		
46. Heat lost by radiation		
47. Undetermined losses and errors		
48. Total, items 41, 42, 43, 44, 45, 46, 47 and calorific value of dry fuel		100

Additional items, for use only with New Fire Method of starting

FUEL USED

49. Weight of wood for kindling ..... lb.
50. Heat value of wood ..... B.t.u. per lb.
51. Weight of residual fire ..... lb.
52. Heat value of residual fire ..... B.t.u. per lb.
53. Fuel value of wood $\left(\text{item } 49 \times \frac{\text{item } 50}{\text{item } 11}\right)$ ..... lb.
54. Total fuel fired during test (exclusive of wood) ..... lb.
55. Total equivalent fuel charged during test (item 53 + item 54) ..... lb.
56. Fuel value of residual fire $\left(\text{item } 51 \times \frac{\text{item } 52}{\text{item } 11}\right)$ ..... lb.
57. Equivalent fuel used during test (item 55 − item 56, this value to be used for item 18) ..... lb.

ASH AND REFUSE

58. Ash in residual fire (by analysis) ..... per cent
59. Total ash content of residual fire:

$\left(\text{item } 51 \times \frac{\text{item } 58}{100}\right)$ ..... lb.

[5]Item 41. Heat to "steam," includes the heat used to raise the water removed from the separator from the feed water temperature to the steam temperature.

60. Total ash and refuse removed from ashpit ..... lb.
61. Equivalent ash and refuse removed from ashpit (item 59 + item 60, this is the value to be used for item 23) ..... lb.

LOG SHEET NO. 1

GENERAL SHEET

Test of ..... boiler with ..... coal

Date ..... Test No. .....

Time | General Notes

(Here will be recorded the method and times of starting and stopping, the method of firing, the difficulties encountered with ash and clinker, the times of cleaning, slicing and raking the fire, the caking and other properties of the coal, the manipulation of the dampers, etc.)

LOG SHEET NO. 2

Date..... Test No.....

FUEL, ASH AND REFUSE

Detailed Record of Coal Fired During Test

TIME OF FIRING	QUANTITY FIRED, LB.		NET	FIRED IN INTERVAL, LB.	TOTAL FIRED, LB.
	Tare	Gross			

Detailed Record of Ash and Refuse Removed

TIME OF REMOVAL	QUANTITY REMOVED FROM GRATE			QUANTITY REMOVED FROM ASHPIT		
	Tare	Gross	Net	Tare	Gross	Net

Special observations for New Fire Method of starting:

Weight of wood used for kindling.....lb.
Weight of fire dumped at end.....lb.

LOG SHEET NO. 3

Date..... Test No.....

Observations of Feed Water, Pressures, and Temperatures

TIME	FEED WATER, LB.			SEPARATOR WATER, LB.			BOILER PRESSURE LB. PER SQ. IN.
	Gross	Tare	Net	Gross	Tare	Net	

DRAFT, IN.—WATER			BOILER ROOM TEMP. DEG. FAHR.	FEED WATER TEMP. DEG. FAHR.	FLUE GAS TEMP. DEG. FAHR.
Below Grate	Above Grate	At Smokehood			

Boiler gage correction
Thermometer corrections
Barometer: At start At finish
Correction not allowed for on sheet

LOG SHEET NO. 4

Date..... Test No.....

Detailed Record of Gas Analysis

TIME	CO_2	$CO_2 + O_2$	O_2	$CO_2 + O_2 + CO$	CO	N	REMARKS

LOG SHEET NO. 5

Date..... Test No.....

Smoke Readings

No.	TIME	RINGELMANN CHART	No.	TIME	RINGELMANN CHART	REMARKS

CHAPTER VIII

PUMPS FOR HEATING AND VENTILATING EQUIPMENT

By PERRY WEST, Member

INTRODUCTION

THE various kinds of pumps ordinarily used in connection with heating and ventilating installations may be classed under the following heads:

1. Boiler feed pumps.
2. Condensation return pumps.
3. Return line vacuum heating pumps.
4. Sump pumps.
5. Forced circulation hot-water heating pumps.
6. Circulating pumps for water brine, etc.
7. Refrigeration pumps and compressors.

In applying pumps to heating and ventilating systems the following points should be considered:

For Boiler Feed Pumps—the load factor, temperature of the intake water, static head on the pump intake, total pressure against which the pump must discharge, steam pressure available for steam driven pumps, provisions for emergency and breakdown service, method of control; as to whether pumps should be steam, electric or power driven, depending upon the relative first costs and economies taking into consideration the possibilities of the use of the exhaust from steam driven pumps and any difference in the cost of labor and attention required.

For Condensation Return and Vacuum Pumps—method and efficiency of return trapping, degree of tightness of the system, temperature of the condensate at the pump, probable cooling effect of the return piping, lifts (if any) required in the system, length of run of piping from farthest radiator to the pump, the total pressure against which the pump must discharge the total load to be carried, the load factor, the vacuum (if any) to be carried, as to whether the pump is to be automatically controlled from the water-line in a condensate receiver from the vacuum, or from both, the static heads on the suction and discharge, provisions for emergency and breakdown service and as to whether the pump is to be steam, electric or power driven, etc., as above.

For all other Pumps—the service to be performed, loads and load factors, emergency and breakdown service, methods of driving and methods of control.

Standards for Condensation to be Handled—The quantities of condensate

to be handled from direct radiation, direct-indirect radiation and indirect or fan blast radiation may be estimated as follows:

For direct radiation $W = 0.3\ R$
For direct-indirect radiation $W = 0.6\ R$
For indirect radiation $W = \frac{Q \times 60 \times T}{55.6 \times H}$.

where

W = lbs. of condensate per hour, R = sq. ft. of radiation, Q = cu. ft. of air per min., T = temperature rise of air in deg. fahr. and H = the latent heat of steam in the system in B.t.u. per pound.

The normal capacity of pumps to be based on condensate at a temperature of not over 180 deg. fahr. For temperature of condensate above 180 deg. fahr. capacity should be increased above that estimated for 180 deg. fahr. condensate as per the following Table 63.

TABLE 63. TEMPERATURE OF CONDENSATE AT PUMP SUCTION

Deg. fahr.	Factor
190	1.15
200	1.56
204	2.00

To use Table 63, multiply the quantity of condensate to be handled by the factor corresponding to the temperature of the condensate at the pump suction and select a pump suitable for the quantity thus found.

The above increase in pump capacity may be reduced by providing a static head above the pump suction and when this static head is made equivalent to 15 ft. minus the absolute boiling pressure of the condensate (measured in feet of water) no increase is necessary.

Allow sufficient head in addition to the total head necessary to overcome static head, velocity head, pipe friction and boiler pressure, wherever condensate is to be returned direct to a boiler from the pump.

BOILER FEED PUMPS

Types.—Boiler Feed Pumps may be of the following types:

1. Direct acting steam driven reciprocating pumps.
2. Power driven reciprocating pumps.
3. Centrifugal pumps.
4. Screw pumps.

Capacities.—The capacity of a boiler feed pump should be based on 34.5 lb. of water per hour per maximum boiler horsepower served, with a slippage allowance of 10 per cent in the water cylinders and a factor of safety allowance of 2 for intermittently operating pumps and a factor of safety allowance of 1½ for continuous operating pumps, to provide for unusual demands when the water in boilers becomes low or excessive loads are carried.

Piston Speeds in Feet per Minute.—For reciprocating boiler feed pump

not to exceed 10 times the square root of the number of inches in the length of stroke of the water pistons.

Direct acting reciprocating steam driven or power driven boiler feed pumps are generally found to be more efficient for smaller installations especially with widely fluctuating loads as the efficiencies of centrifugal

TABLE 64. DIRECT ACTING STEAM DRIVEN DUPLEX RECIPROCATING BOILER FEED PUMPS

Dia. of Steam Cyl. in Inches	Dia. of Water Cyl. in Inches	Length of Stroke in Inches	No. of Strokes per Min.	Discharge in Gallons		Equivalent Dia. of Single Cyl. Pump	Boiler H. P. Served Without Factor of Safety	Size Pipe, Inches			
				Per Stroke	Per Min.			Steam	Exhaust	Suction	Discharge
3	2	3	70	0.04	5.6	2⅞	80	½	¾	1¼	1
4½	2¾	4	60	0.10	12.0	4	180	½	¾	1½	1¼
5¼	3½	5	50	0.20	20.0	5	300	¾	1¼	2	1½
6	4	6	50	0.33	33.0	5⅝	480	1	1½	2½	2
7½	4½	6	50	0.42	42.0	6⅜	600	1½	2	3	2½
7½	5	10	40	0.85	68.0	7	1000	1½	2	3	2½
10	6	10	40	1.22	97.6	8½	1400	2	2½	4	3
12	7	12	35	2.00	140.0	9⅞	2000	2½	3	5	4

TABLE 65. HORIZONTAL DUPLEX PISTON PACKED POWER DRIVEN BOILER FEED PUMPS FOR 100 LB. WORKING PRESSURE

Size of Pump Cylinders in Inches		No. of Revolutions per Min.	Displacement Gallons		Boiler H. P. Served Without Factor of Safety	H. P. Required to Drive Pump	Pipe Sizes Inches	
Dia.	Stroke		Per Rev.	Per Min.			Suction	Discharge
2½	4	30	0.34	10.2	148	1.5	1½	1¼
3	4	30	0.49	14.7	213	4.0	2	1½
3½	5	30	0.83	24.9	361	3.5	2½	2
4	6	25	1.30	32.5	471	4.0	3	2½
8	10	20	8.69	173.8	2520	18.0	5	4

TABLE 66. RECIPROCATING SINGLE ACTING POWER DRIVEN TRIPLEX BOILER FEED PUMPS FOR 150 LB. WORKING PRESSURE

Size of Pump Cylinders in Inches		No. of Revolutions per Min.	Displacement Gallons		Boiler H. P. Served Without Factor of Safety	H. P. Required to Drive Pump	Pipe Sizes Inches	
Dia.	Stroke		Per Rev.	Per Min.			Suction	Discharge
1½	2	50	0.045	2.25	33	0.40	¾	¾
1¾	2½	50	0.078	3.90	57	0.65	1	1
2	3	40	0.122	4.88	70	0.80	1¼	1
2½	4	30	0.255	7.65	110	1.15	1½	1¼
3	4	30	0.367	11.01	160	1.40	1½	1¼
4	4	30	0.652	19.56	280	4.60	2	1½
4	6	25	0.978	24.45	355	3.10	2½	2
5	8	20	2.041	40.82	592	5.00	3	2½
6	8	20	2.938	58.76	852	6.00	3½	3
8	10	20	6.520	130.40	1891	14.00	4	3

boiler feed pumps drop off very rapidly for the smaller sizes of pumps and for low load conditions. For this reason centrifugal pumps are not

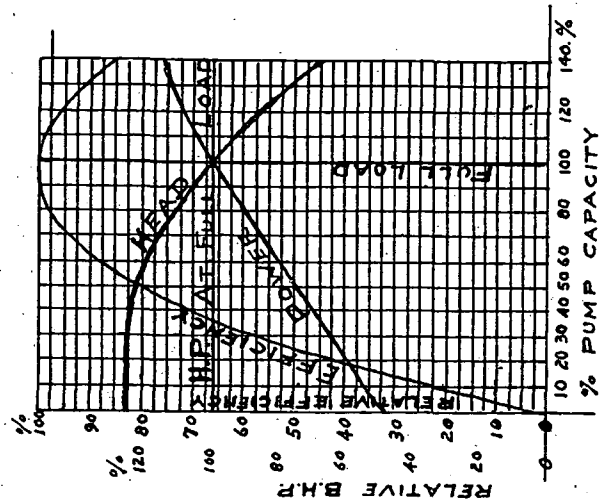


FIG. 41. FOR SELECTION OF SIZE AND STAGE OF CENTRIFUGAL BOILER FEED PUMPS

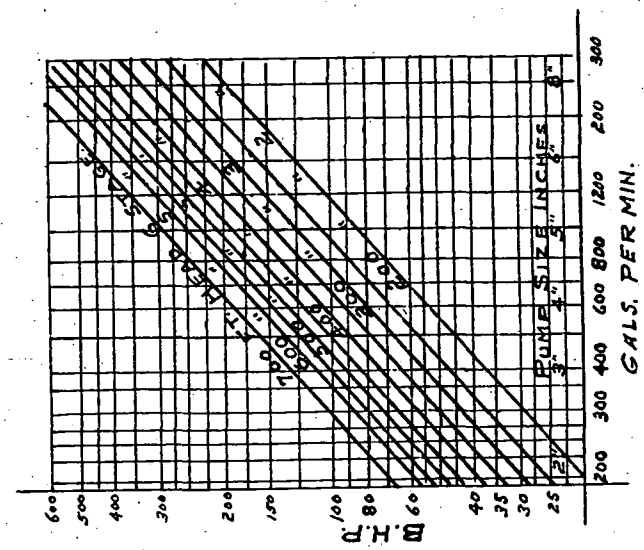


FIG. 40. TYPICAL CHARACTERISTICS OF CENTRIFUGAL BOILER FEED PUMPS

usually employed for installations of less than 1000 boiler horsepower. Screw pumps may be used with good economy for small capacities.

TABLE 67. SCREW PUMPS

Since the capacity and pressure at which Screw Pumps will operate is almost infinite, we can only give some idea of their capacity. Efficiencies range from 60 per cent to 70 per cent.

SIZE	G. P. M.	MAX. REV.	SUCTION INCHES	DISCHARGE INCHES
2	2– 15	1600	2	1½
2½	10– 20	1600	2	1½
3	20– 50	1600	2½	2½
3¼	40– 60	1600	3	2½
3½	55– 100	1500	4	3
4	85– 200	1400	4	4
5	175– 275	1200	5	4
5¼	200– 325	1200	5	4
6	275– 475	1200	6	6
7	300– 600	1000	8	6
8	450– 750	875	8	8
9	700–1000	720	10	10
10	800–1400	700	12	12
12	1200–2100	600	14	14
16	1750–4200	425	16	15

TABLE 68. SIZES, REVOLUTIONS PER MIN. HEADS PUMPED AGAINST, POWER REQUIRED AND BOILER HORSE POWER FOR SEVERAL COMMERCIAL SIZES OF CENTRIFUGAL BOILER FEED PUMPS

SIZE OF PUMP INCHES	H. P.	PIPE SIZES INCHES		CAPACITY GALLONS PER MIN.	BOILER H. P. SERVED WITHOUT FACTOR OF SAFETY
		Suction	Discharge		
Two Stage for 100 lb. Working Pressure					
2	.....	2½	2	100	1450
2½	.....	3	2½	150	2175
3	.....	4	3	225	3262
4	.....	5	4	400	5800
5	.....	6	5	620	8990
6	.....	8	6	900	13,000
8	.....	10	8	1600	23,000
Three Stage for 150 lb. Working Pressure					
2	.....	2½	2	100	1450
2½	.....	3	2½	150	2175
3	.....	4	3	225	3262
4	.....	5	4	400	5800
5	.....	6	5	620	8990
6	.....	8	6	900	13,000
8	.....	10	8	1600	23,000
Four Stage for 250 lb. Working Pressure					
2	.....	2½	2	100	1450
2½	.....	3	2½	150	2175
3	.....	4	3	225	3262
4	.....	5	4	400	5800
5	.....	6	5	620	8990
6	.....	8	6	900	13,000
8	.....	10	8	1600	23,000

CONDENSATION RETURN PUMPS

Condensation return pumps may be of the following types:

a. Automatic pumps and receivers
b. Continuous operation non-automatic return pumps

Automatic Pumps and Receivers
And Continuous Operating Non-automatic Return Pumps

Volumetric Capacities of Receivers.—To be not less than 3 times the maximum minute volumetric flow of condensation to be handled, measured between the high and low water lines in the receiver.

Piston Speeds in Feet per Minute.—Not more than 10 times the square root of the number of inches in the length of stroke.

The ratio between the pump displacement and the maximum volumetric rate of the flow of condensate to be handled shall be not less than 3.0 for automatic pumps and receivers and 2.0 for non-automatic return pumps.

Normal Capacities for Centrifugal Pumps.—Not less than 2 times the maximum rate of flow of the condensation to be handled.

TABLE 69. DUPLEX PISTON TYPE RETURN PUMPS WITH RECEIVERS STANDARD PRESSURE

SIZE OF PUMP	RECEIVER CAPACITY GALLONS	SQ. FT. DIRECT RADIATION	LB. CONDENSATE PER HOUR	MINIMUM STEAM PRESSURE
3 × 2 × 3½	12	6000	2000	50
4½ × 2¾ × 4	20	10,500	3500	40
5¼ × 3½ × 5	40	19,500	6500	35
6 × 4 × 6	60	30,000	11,000	35
7¼ × 5 × 6	100	45,000	15,000	30
Low Pressure				
4½ × 2 × 4	12	6000	2000	25
5¼ × 2½ × 5	20	10,000	3500	20
6 × 2½ × 6	40	120,000	4000	15
6 × 3 × 6	40	180,000	6000	20
6 × 3½ × 6	60	290,000	9000	25

TABLE 70. CENTRIFUGAL RETURN PUMPS WITH RECEIVERS

SIZE OF PUMP DISCHARGE INCHES	RECEIVER CAPACITY GALLONS	SQ. FT. DIRECT RADIATION	LBS. CONDENSATE PER HOUR	H. P. TO DRIVE	TOTAL HEAD FT.
1	40	12,000	4000	1	25
1½	60	25,500	8500	1½	50
2	100	42,000	14,000	2	50

TABLE 71. CHARACTERISTICS OF CENTRIFUGAL PUMPS AND RECEIVERS DELIVERING AGAINST 15 LB.

SIZE	SQ. FT. EQUIVALENT DIRECT RADIATION	GAL. PER MIN.	R. P. M.	ACTUAL H. P.	H. P. MOTOR SUPPLIED	FLOOR SPACE	SHIPPING WEIGHT
101	8000	11	1725	0.4	¾	5′ 3″x3′ 8″	700
102	16,000	22	1725	0.6	¾	5′ 3″x3′ 8″	700
103	26,000	35	1725	0.8	1	6′ 5″x3′ 8″	750
104	40,000	60	1140	1.0	1½	7′ 6″x4′ 2″	1050
105	65,000	90	1140	1.4	2	7′ 6″x4′ 2″	1100

RETURN LINE VACUUM HEATING PUMPS

These may be of the following types:

a. Direct acting reciprocating steam driven return line vacuum pumps
b. Reciprocating power driven return line vacuum pumps
c. Motor driven return line vacuum pumps

High pressure traps should never discharge directly into a vacuum return. An excessive amount of vapor will form due to re-evaporation of a considerable part of the hot condensation. This may cause a very material reduction in the vacuum maintained by the pump. Fig. 42 shows a method of disposing of the greater part of the vapor of re-evaporation and at the same time lowering the temperature of the condensate.

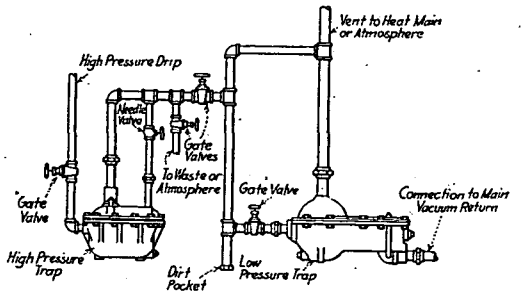


FIG. 42. METHOD OF DISCHARGING HIGH-PRESSURE APPARATUS INTO LOW-PRESSURE HEATING MAINS AND VACUUM RETURN MAINS THROUGH A LOW-PRESSURE TRAP

DISPOSAL OF VACUUM PUMP DISCHARGE

The discharge from reciprocating vacuum pumps of either the steam or power driven type is a mixture of water and air. Means must be provided for releasing the entrained air. This requires water surface area in either a tank having a large horizontal cross section or a stand pipe of enough sectional area to permit a low velocity of downward water flow while the entrained air is escaping to the surface against the water current. For removal of air allow one square foot of horizontal cross-section for each 2100 lb. of water per hour. A stand pipe with diameter equal to that of the pump cylinder is usually sufficient.

Wherever a suitable location may be obtained the freely vented air

separating tank is generally used. The tank must be located high enough so that the pressure produced by the water column in the discharge pipe will be sufficient to overcome that in the low-pressure boiler feed water heater or other point of disposal. Fig. 43 shows the proper arrangement of vacuum pump, air separating tank and feed water heater.

The air escapes through a vent in the top of the tank and the water flows by gravity to the feed water heater through the loop seal attached to the discharge outlet in the tank. If the rate of flow of returns to the tank exceeds the rate of discharge from the tank the excess overflow through an opening on the end near the top.

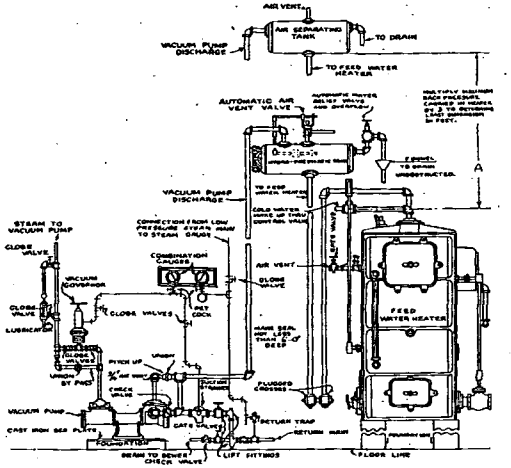


FIG. 43. METHOD OF CONNECTING VACUUM PUMP, FEED WATER HEATER AND SINGLE CONTROL HYDRO-PNEUMATIC TANK OR AIR SEPARATING TANK

Where an open tank cannot be located at a height sufficient to provide gravity head to discharge the tank contents against the maximum pressure in the heater or boiler, the hydro-pneumatic tank is used. A float controlled valve is placed on the air outlet of the separating tank and so arranged that when the water of condensation has not sufficient head to flow by gravity to the point of use, the air will be confined in the upper part of the tank. As the pump continues to deliver water and air to the tank the pressure within the tank increases until sufficient to discharge the water, thus lowering the water-line and eventually permitting escape of the surplus air through the float controlled air valve. The confined air pressure in the tank plus the gravity head in the tank discharge pipe must be sufficient to cause flow to the place of disposition. This confined air pressure plus the column of mixed air and water in the pump discharge to the tank is the total head against which the pump must act. Fig. 43 shows a hydro-pneumatic tank, Figs. 44, 45 and 46 show vacuum pump connections for several different conditions of service.

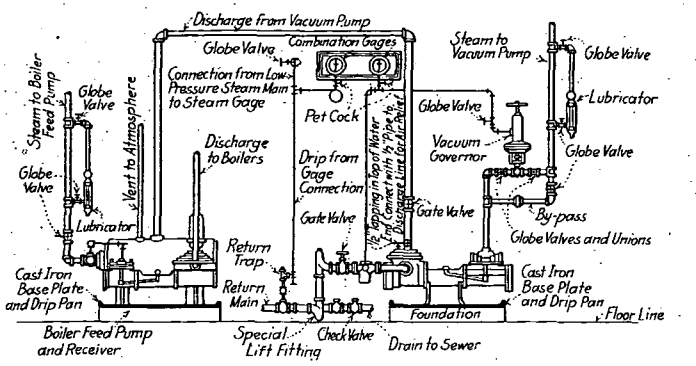


FIG. 44. METHOD OF CONNECTING VACUUM PUMP AND AUTOMATIC BOILER-FEED PUMP AND RECEIVER

Table 72 gives the sizes of plain or hydro-pneumatic tanks for air separating purposes and also those for storage of returns. In the latter case the tanks are based upon storing the quantities of water which will be discharged during five minutes at the basis of hourly rates given in the first column.

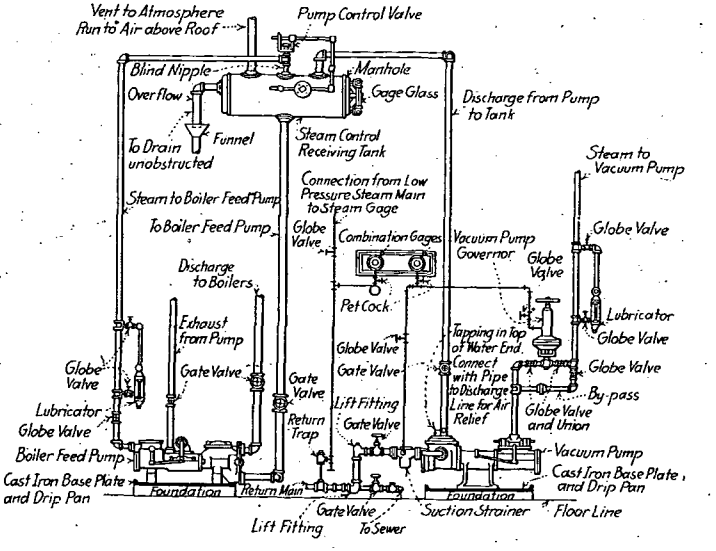


FIG. 45. METHOD OF CONNECTING VACUUM PUMP, BOILER-FEED PUMP AND STEAM-CONTROL RECEIVING TANK.

TABLE 72. SIZE OF PLAIN AND HYDRO-PNEUMATIC TANKS

COMPENSATION LB. PER HR.	SIZES OF PLAIN AND HYDRO-PNEUMATIC TANKS			
	FOR AIR SEPARATOR ONLY		FOR AIR SEPARATOR AND WATER STORAGE	
	Diameter In.	Length In.	Diameter In.	Length In.
4000	12	24	24	36
6000	12	36	24	48
8000	18	30	24	72
10,000	18	48	30	48
16,000	24	48	30	60
24,000	30	48	36	60
	24	72	36	72
34,000	36	60	36	96
	36	72	42	72
45,000	42	60	42	96
	36	96	....	....
60,000	42	72	48	72
	42	96	48	96

LIFT FITTINGS

Lift fittings are special devices used in pairs at points in a vacuum heating system where condensation is to be lifted to a higher level. The condensation is lifted in "slugs" on the air lift principles: the slugs being obtained by the use of a comparatively small diameter vertical return with its lower end submerged in the well below the level of the horizontal return which it drains. The lower lift fitting allows the condensation to accumulate in the well below the inlet connection until it seals the vertical passage, thus causing a slight reduction of the vacuum on the inlet side and forcing the water from the well through the vertical lift pipe to the higher level. The upper lift fitting allows the condensation to flow into the horizontal return without falling back into the lifting line.

Lifts of 6 ft. or over should be made in steps rather than all in one rise. Steps should be used instead of "Drag" lifts through long upwardly inclined pipes. In any case the pipes between the lifts must grade downward toward the pump.

When these fittings are required, the usual places to install them, is with a suction strainer at the pump, and when step-ups occur, in the return line.

STEAM DRIVEN RECIPROCATING RETURN LINE VACUUM PUMPS

Volumetric displacement of the water cylinders 8 to 10 times the volumetric rate of flow of the condensate to be handled.

Piston Speeds.—Not more than 20 times the square root of the number of inches in the length of stroke.

Steam driven pumps can be economically used with steam pressures of 15 lb. or over and where the exhaust steam can be completely utilized.

Where the supply of exhaust steam from engines or other sources is continuously in excess of that necessary to supply the heating system the electric driven pump is generally the most efficient and is also preferable when the steam pressure is too low to operate a steam driven pump.

TABLE 73. DIRECT DOUBLE ACTING STEAM DRIVEN RECIPROCATING VACUUM PUMPS

DIAMETER IN INCHES WATER CYLINDER	CONDENSATION LB. PER HR. FOR PUMPS WITH STROKE EQUAL TO BORE	DIRECT CAST IRON RADIATION SERVED	PIPE SIZES		DISCHARGE IN.	PUMPS HAVING UNEQUAL STROKE AND BORE	
			Steam In.	Suction In.		Stroke ÷ Bore	Capacity Factor
3	510	1700	½	1¼	¾	2.50	1.58
4	1047	3490	½	1½	1	2.25	1.48
5	1830	6100	½	2	1¼	2.00	1.38
6	2890	9633	½	2½	1½	1.90	1.34
7	4250	14,166	¾	2½–3½	1½–2	1.80	1.31
8	5920	19,733	¾	3–3½	2	1.75	1.29
9	7980	26,600	¾	3½–4	2	1.70	1.27
10	10,350	34,500	1	4–4½	2½	1.67	1.25
12	16,300	54,333	1	4½–5	2½	1.60	1.23
14	24,000	80,000	1¼	5–6	3	1.50	1.10
16	33,500	111,666	1¼	6–7	3½	1.40	1.15
18	45,000	150,000	1½	7	4	1.33	1.13
20	58,500	195,000	1½	7–8	4½	1.30	1.12
22	74,300	247,666	2	8	4½	1.25	1.10
24	92,300	317,666	2	8–10	5	1.20	1.08
26	112,800	376,000	2½	10	6	1.10	1.04
28	135,800	452,666	2½	12	6	1.00	1.00
30	161,300	537,666	2½	12	6	0.90	0.96
32	189,600	632,000	3	14	7	0.80	0.91
34	221,000	736,333	3	14	7	0.75	0.89
36	254,000	846,666	3	14	8	0.70	0.87
						0.67	0.85
						0.60	0.82
						0.50	0.78

The capacities given in Table 73 are for pumps having water cylinder with the length of stroke equal to the diameter of the water piston.

The capacities for pumps of a greater or less length of stroke may be found by use of the last two columns in this table as follows:

Divide the stroke by the piston diameter and find the corresponding ratio in the column headed stroke/bore. The capacity factor opposite this in the last column is then multiplied by the capacity given in the table to give the capacity of the pump in question.

Proportioning of Steam End of Reciprocating Vacuum Pumps

In proportioning the steam cylinder of the pump the following formula will give results which are safe to use.

$$A_s \times \frac{P_b}{3} = A_w \times \left(\frac{V}{2} + P_d\right)$$

From which we have

$$A_s = \frac{A_w \times \left(\frac{V}{2} + P_d\right) \times 3}{P_b}$$

in which

A_s = Area of steam piston in square inches.
A_w = Area of water piston in square inches.
P_b = Boiler pressure in pounds per square inch.
P_d = Discharge pressure in pounds per square inch.
V = Vacuum at pump expressed in inches of mercury.
$\frac{V}{2}$ = Approximate vacuum in pounds per square inch (2 in. mercury = approximately 1 lb. per sq .in.)

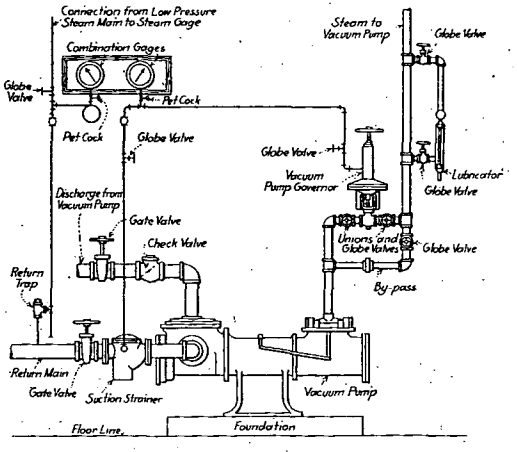


FIG. 46. METHOD OF MAKING CONNECTION TO STEAM-OPERATED VACUUM PUMP

In no case should the head against the discharge of reciprocating pumps exceed 15 lb. unless the pump stroke exceeds the bore and thus reduces the bad effect of clearance.

Where the pressure on the heater, boiler, etc., varies materially from time to time but in general is near the minimum, a substantial saving in energy may be obtained by using a hydro-pneumatic tank instead of a plain tank set at a higher elevation to overcome the peak pressure in the boiler or heater. The use of a plain tank keeps the pump operating against the maximum head, where the hydro-pneumatic tank set lower operates as a plain tank whenever the gravity head in the tank is sufficient to cause flow from its elevation, and employs the combination of air pressure and gravity head, with air vent closed, only at times of peak load. Only then is the air pressure load added to the pump discharge.

Where the head on the delivery side of steam driven pumps exceeds 15 lb. it is good practice to deliver the condensation to a vented receiver located close to the level of the vacuum pump outlet. This receiver should be connected to a separate steam or power driven water pump capable of delivering against the maximum head and controlled by a throttle valve, actuated by the water line in the receiving tank.

MOTOR DRIVEN RETURN LINE VACUUM PUMPS

Reciprocating Vacuum Pumps.—The displacement and piston speeds should be the same as for the water end of reciprocating steam driven return line vacuum heating pumps.

The type of drive between motor and pump may be chain, gear or belt.

Other than Reciprocating Pumps.—May be of the centrifugal or rotary type with receivers and generally of one of the following arrangements.

a. One pumping unit and motor for handling both air and condensate

b. One pumping unit and motor for handling air and a separate pumping unit and motor for handling condensate.

c. One pumping unit and motor for handling condensate with an air ejector operated by a recirculated portion of the condensate for handling the air

d. One pumping unit for handling condensate and another for handling the air, both operated by one motor.

The receiving tank capacity should be stated in gallons, and in case of automatically controlled units should be the capacity of the tank in gallons between the high and low water levels in this tank, as determined by the water-line control.

The receiving tank may be placed either on the suction side or on the discharge side of the pump. When placed on the suction side of the pump the capacity of the tank may be used to retain the condensation and to take care of the fluctuations between the rate of condensate returned and the rate of the pump delivery.

The suggested receiving tank capacities (as previously defined) for continuously operated and for automatically controlled units should be as follows:

TABLE 74. RECEIVER TANK CAPACITIES

SQ. FT. EQUIVALENT DIRECT CAST IRON RADIATION SURFACE	TOTAL RECEIVER TANK CAPACITY IN GALLONS	RECEIVER TANK CAPACITY BETWEEN HIGH AND LOW WATER LIMITS WHERE AUTOMATIC WATER LINE CONTROL IS USED.
8,000	28	20
16,000	33	24
26,000	40	29
40,000	49	35
65,000	63	47
100,000	80	63

The air capacities recommended, referred to cubic feet of air per 1000 sq. ft. of equivalent cast iron direct radiation, may be assumed on a decreasing ratio as the system increases in capacity of equivalent square feet of radiation, in accordance with the following Table 75. It should be noted that while water capacities of pumps to be added for fan blast

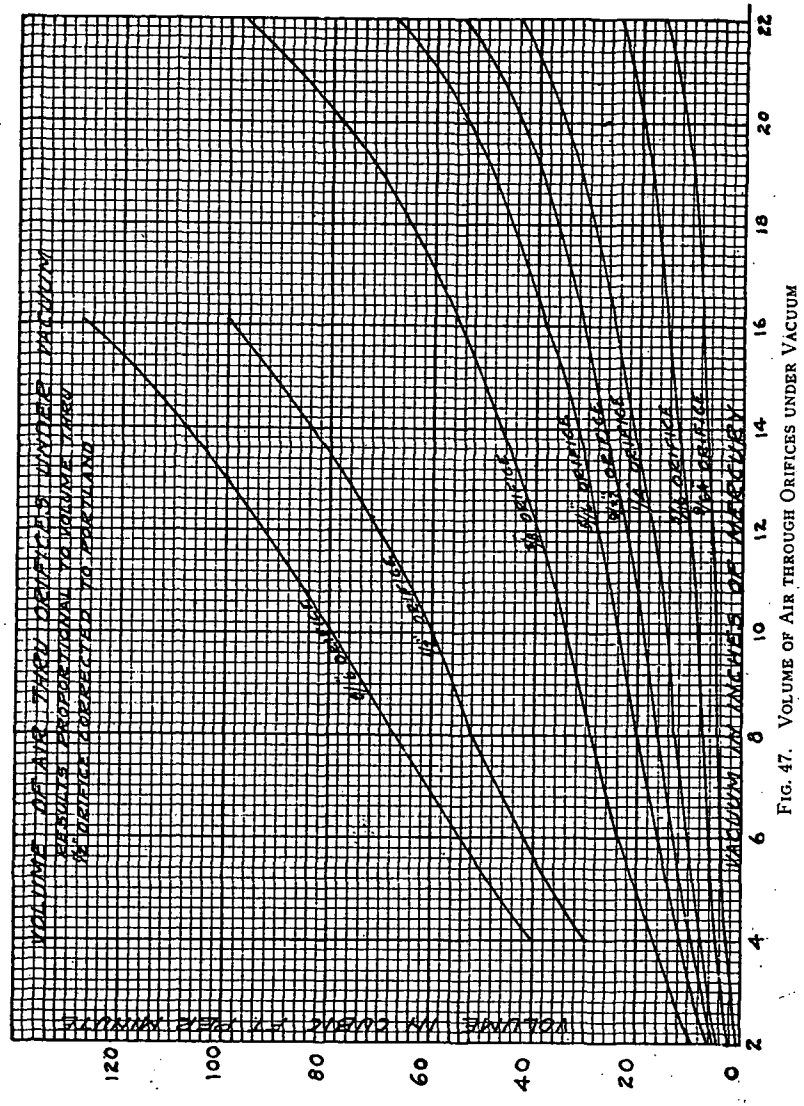


FIG. 47. VOLUME OF AIR THROUGH ORIFICES UNDER VACUUM

heaters are to be based upon their equivalent in direct radiation the air capacities for this class of radiation may be the same as for direct radiation.

TABLE 75. AIR CAPACITIES

SQ. FT. DIRECT EQUIVALENT RADIATION SURFACE	DIAMETER ORIFICE VAC. 10"	AIR CAPACITY CU. FT. PER MIN.
8,000	$\frac{9}{64}$"	5
16,000	$\frac{3}{16}$"	9
26,000	$\frac{1}{4}$"	15
40,000	$\frac{9}{32}$"	19
65,000	$\frac{3}{8}$"	34
100,000	$\frac{1}{2}$"	60
150,000	$\frac{9}{16}$"	80
250,000	Three $\frac{1}{2}$"	180

The air capacity of the pump should be measured at a point in the main vacuum return line just ahead of the vacuum strainer when the pump is operating under the vacuum specified at the pump suction and when handling the quantity of condensate specified at a temperature not exceeding 180 deg. fahr.

Air test may be made with water at lower temperatures. This determination should be made by means of a standard test orifice located in an inlet connection to the pump suction and consisting of a plate $\frac{1}{8}$ of an inch thick with a reamed hole having sharp edges and of a diameter corresponding to the capacity of the pump.

The accompanying Fig. 47 may be used to give the quantity of air handled, corresponding to several sizes of orifices and different degrees of vacuum met with in practice.

The water capacity of the pump when operating against 8 in. of mercury vacuum should be not less than three-tenths (0.3) of a pound of water per hour per square foot of equivalent cast iron direct radiation based upon condensation at a temperature of not over 180 deg. fahr. when the pump is delivering water against a specified gage pressure at the water discharge of the pump. For pumps handling both air and water the above water capacity must be delivered, when the pump is maintaining a vacuum of 8 in. of mercury and handling air through a standard orifice corresponding to the air capacity of the pump as herein specified.

Commercial pumps are built for 10, 20, 30 and 40 lb. gage pressure at the water discharge of the pump.

TABLE 76. SIZES, SPEEDS, HORSE POWERS AND CAPACITIES HYTOR ELECTRIC MOTOR DRIVEN CONDENSATION RETURN PUMPS

Rating in Sq. Ft.	0 to 2000		2000–4000		4000–8000		8000–16000	
Discharge Pressure, Lb.	10	20	10	20	10	20	10	20
Gallons per Min.	3	3	6	6	10	10	20	20
H. P. Motor	$\frac{3}{8}$	$\frac{3}{4}$	$\frac{3}{8}$	$\frac{3}{4}$	$\frac{3}{8}$	$\frac{3}{4}$	$\frac{3}{8}$	$\frac{3}{4}$
R. P. M. 60 Cycle and D. C.	1700	1700	1700	1700	1700	1700	1700	1700
R. P. M. 25 Cycle	1440	1440	1440	1440	1440	1440	1440	1440
Shipping Weight	330	350	350	370	420	440	535	565

No additional allowance need be made for covered mains or risers, but exposed mains or risers used as heating surfaces should be included in calculating the equivalent square feet of direct radiation.

PUMP SPECIFICATIONS

Reciprocating and power driven pumps should be specified as to make, size, water and steam working pressures, piston speed, temperature of water to be handled, electric motor characteristics and the trade standard, required in accordance with the manufacturers adoptions copy of which is appended to this section of the code for reference.

TABLE 77. MOTOR DRIVEN CONDENSATION PUMP CAPACITIES FOR DELIVERING AGAINST VARIOUS PRESSURES

RADIATION IN SQ. FT. OF DIRECT RADIATION	MINIMUM GALLONS PER MIN.	MAXIMUM BOILER PRESSURE LB.	MOTOR H. P.	SUGGESTED SIZE OF PIPING INCHES	RADIATION IN SQ. FT. OF DIRECT RADIATION	MINIMUM GALLONS PER MIN.	MAXIMUM BOILER PRESSURE LB.	MOTOR H. P.	SUGGESTED SIZE OF PIPING INCHES
4000	6–8	10	¼	1	15,000	25–30	10	¾	2
4000	6–8	15–40	½	1	15,000	25–30	15	1	2
4000	6–8	50–60	¾	1	15,000	25–30	20–30	1½	2
					15,000	25–30	40	2	2
					15,000	25–30	50–60	3	2
6000	9–12	10	¼	1¼	20,000	30–40	10	¾	2
6000	9–12	15–40	¾	1¼	20,000	30–40	15	1	2
6000	9–12	50–60	1	1¼	20,000	30–40	20	2	2
					20,000	30–40	30–40	3	2
					20,000	30–40	50–60	5	2
8000	12–16	10	½	1¼	25,000	40–50	10	1	2½
8000	12–16	15	¾	1¼	25,000	40–50	15	1½	2½
8000	12–16	20	1	1¼	25,000	40–50	20	2	2½
8000	12–16	30–60	1½	1¼	25,000	40–50	30–40	3	2½
					25,000	40–50	50–60	5	2½
10,000	15–20	10	½	1½	30,000	50–60	10	1	2½
10,000	15–20	15	¾	1½	30,000	50–60	15	1½	2½
10,000	15–20	20–30	1	1½	30,000	50–60	20	2	2½
10,000	15–20	30–40	1½	1½	30,000	50–60	30–60	5	2½
10,000	15–20	50–60	2	1½					

The kind of drive should be specified for power driven pumps.

Centrifugal and Rotary pumps should be specified as to make, type, capacity temperature of water to be handled, speed and motor characteristics including:

1. Name of motor manufacturer
2. Manufacturers rated Horse Power
3. The maximum temperature rise for any part of the motor above the temperature of the surrounding air
4. Full Speed in R. P. M.
5. Current characteristics
6. Whether the motor is open, semi-enclosed or fully enclosed

The following should also be included in the specifications, total head to be pumped against including suction lift friction head, velocity head

TABLE 78. ONE PUMP ONE MOTOR RETURN LINE SYSTEM

SIZE	SQ. FT. DIRECT EQUIVALENT RADIATION SURFACE	DIAMETER ORIFICE VACUUM 10 IN.	AIR CAPACITY CU. FT. PER MIN.	WATER CAPACITY GALS. PER MIN. 10 LB. PRESSURE 180° F.	ACTUAL H. P.	R. P. M.	H. P. OF MOTOR
A	8000	9–64	6	11	0.9	1800	1
B	16,000	3–16	11	22	1.4	1800	1½
C	26,000	1–4	19	35	2.0	1800	2
D	40,000	9–32	25	60	2.8	1200	3
E	65,000	3–8	42	90	3.9	1200	5
F	100,000	1–2	75	140	9.0	1200	10
G	150,000	9–16	90	200	10.0	900	10
H	250,000	Three 1–2	180	400	10.0	720	20

TABLE 79. TWO PUMP ONE MOTOR RETURN LINE SYSTEM VACUUM PUMPS

CAPACITY SQ. FT. OF DIRECT RADIATION	CAPACITY G. P. M.	PRESSURE AT PUMP	MOTOR H. P.
6000	9	10	¾
6000	9	15	1
8000	12	10	1
8000	12	15	1½
12,000	18	10	1
12,000	18	15	1½
18,000	27	10	1½
18,000	27	15	2
30,000	45	10	2
30,000	45	15	3

TABLE 80. TWO PUMP TWO MOTOR RETURN LINE SYSTEM VACUUM PUMP

CAPACITY SQ. FT. OF DIRECT RADIATION	CAPACITY G. P. M.	PRESSURE AT PUMP	MOTOR H. P.	
			Air	Water
6000	9	10	½	¾
6000	9	15	½	¾
8000	12	10	½	¾
8000	12	15	½	1
12,000	18	10	¾	¾
12,000	18	15	¾	1
18,000	27	10	¾	1
18,000	27	15	¾	2
25,000	38	10	1	1½
25,000	38	15	1	2
30,000	45	10	1	1½
30,000	45	15	1	2

and head against which the pump must discharge. The vacuum under which return pumps are required to operate and as to whether two or more units are to operate in parallel or separately.

INSTALLATION DATA

All pumps should be set on substantial foundations and be provided with heavy cast iron sub-bases, securely anchored to foundation and provided with drip ring with drain properly connected to sump or sewer.

The exhaust from steam driven pumps supplying steam for heating purposes should be taken through an efficient oil separator before entering any part of the heating system or other apparatus.

A full set of the manufacturers working drawings should be used in connection with each installation.

Motors should be not less than ⅓ greater in horsepower than that actually required to drive the pump under full load conditions.

CHAPTER IX

WARM-AIR FURNACE HEATING*

IN this chapter of THE GUIDE consideration will be given to the design of gravity circulating warm-air heating systems. For fan circulating systems see the Chapter XX on Design and Construction of Air Ducts. Complete engineering data, including the procedure to be followed in designing a typical system, are presented in the first part of the chapter, while the last part of the chapter presents a Standard Code Regulating the Installation of Warm-Air Heating Furnaces in Residences, approved by the *National Warm Air Heating and Ventilating Association*, AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, *National Association Sheet Metal Contractors*, *Western Warm Air Furnace and Supply Association*, and the *Midland Club*, as a workable Code for furnacemen.

DEFINITIONS

In general, warm-air furnace heating plants consist of a fuel burning furnace or heater enclosed in a casing of sheet metal or brick, which is placed in the basement of the building. The heated air, taken from the top or sides near the top of the furnace casing, is distributed to the various rooms of the building through sheet metal warm-air pipes. The warm-air pipes in the basement are known as leaders, and the vertical warm-air pipes which are run in the inside partitions of the building are called stacks. The heated air is finally discharged into the rooms through registers which are set in register boxes placed either in the floor or in the side wall, usually at or near the baseboard.

The air supply to the furnace may be taken (1) entirely from inside the building through one or more recirculating ducts, or the air supply may be taken (2) entirely from outside the building, in which case no air is recirculated. Sometimes a combination of the inside and outside air supply system is employed.

Furnace heating plants may be (1) of the gravity circulating type in which the motive head producing flow depends upon the difference in weight between the heated air leaving the casing and the cooler air entering the bottom of the casing, or (2) of the fan circulating type in which a fan may supply all or part of the motive head producing flow. In most house installations, the former type of system is in general use.

*Material for this section was prepared especially for THE GUIDE by Arthur C. Willard, Professor of Heating and Ventilation and Head of the Department of Mechanical Engineering, University of Illinois, Urbana, Illinois.

All figures and much of the engineering data which follow are from Bulletin No. 141, "Warm Air Furnaces and Heating Systems," Part II, by Professors A. C. Willard, A. P. Kratz and V. S. Day, Engineering Experiment Station, University of Illinois.

DESIGNING A FURNACE HEATING SYSTEM

The design of a furnace heating system involves the determination of the following items:

a. Heat loss in B.t.u. from each room in the building.

b. Area and diameter in inches of warm-air pipes in basement known as leaders.

c. Area and dimensions in inches of vertical pipes known as wall stacks.

d. Free and gross area and dimensions in inches of warm-air registers.

e. Area and dimensions of (1) recirculating or (2) outside air supply ducts in inches. There may be one or more of each.

f. Free and gross area and dimensions in inches of recirculating registers.

g. Size of furnace necessary to supply the warm air required to overcome the heat loss from the building. This "size" should include square inches of leader pipe area which furnace must supply. It is also desirable to call for a minimum bottom fire-pot diameter in inches, which is the nominal grate diameter.

h. Area and dimensions in inches of chimney lining and smoke pipe. If an unlined chimney is to be used, that fact should be made clear.

HEAT LOSSES FROM BUILDING

The heat which will be required for each room in the building depends on (1) the heat transmission losses through walls and glass as well as through floors and ceilings when the latter two are next to unheated spaces, and (2) the infiltration of cold air through the cracks around outside windows and doors. Calculations for the heat required in B.t.u. per hour should be made as indicated in Chapter I Heat Losses from Buildings.

LEADER SIZES

In a gravity circulating warm-air furnace system the size of the leader to a given room depends on the temperature of the warm-air entering the room at the register. A reasonable air temperature at the registers must, therefore, be agreed upon before the system can be designed. The *National Warm Air Heating and Ventilating Association* has approved an air temperature of 175 deg. fahr. at the registers as satisfactory. At this temperature, the heat carrying capacity (heat available above 70 deg. fahr.) per sq. in. of leader pipe per hour for first, second or third floors is shown by Fig. 48 at 175 deg. fahr. to be 105, 170 and 208 B.t.u. respectively. For average calculations, the values 110, 166 and 200 will simplify the work and may be satisfactorily substituted for these heat carrying capacities. If H represents the total heat to be supplied any room, the resulting equations are:

$$\text{Leader areas for first floor, square inches} = \frac{H}{110} = \text{approximately } 0.009H \qquad (1)$$

$$\text{Leader areas for second floor, square inches} = \frac{H}{166} = \text{approximately } 0.006H \qquad (2)$$

$$\text{Leader areas for third floor, square inches} = \frac{H}{200} = \text{approximately } 0.005H \qquad (3)$$

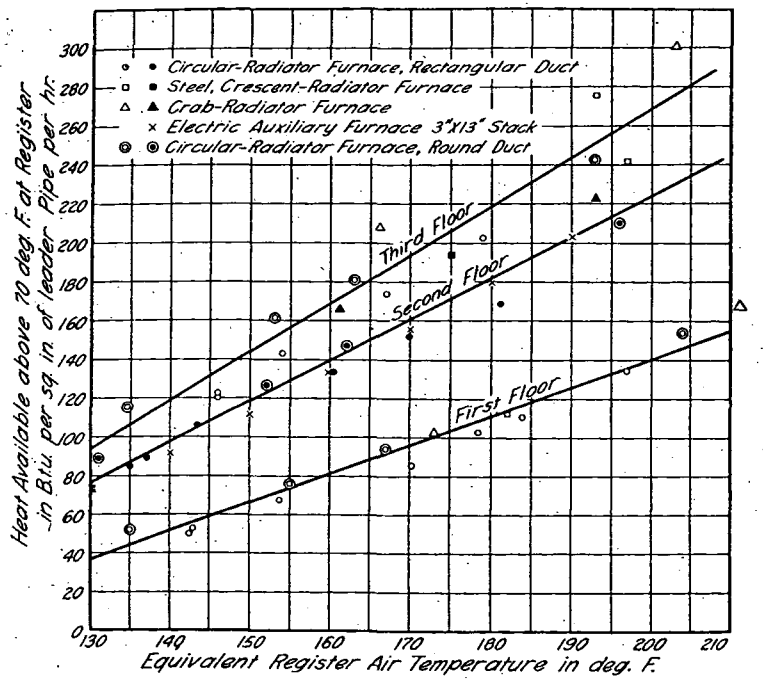


FIG. 48. VALUE OF SQUARE INCH OF LEADER PIPE AREA FOR FIRST, SECOND, AND THIRD FLOORS

In designing for a lower warm-air register temperature, say 160 deg. fahr., the factors 110, 166 and 200 become 80, 140 and 166 (Fig. 48 at 160 deg. fahr.), and the resulting equations are:

$$\text{Leader areas for first floor, square inches} = \frac{H}{80} = \text{approximately } 0.012H \qquad (4)$$

$$\text{Leader areas for second floor, square inches} = \frac{H}{140} = \text{approximately } 0.007H \qquad (5)$$

$$\text{Leader areas for third floor, square inches} = \frac{H}{166} = \text{approximately } 0.006H \qquad (6)$$

These equations are applicable to straight leaders from 6 to 8 ft. in length. Longer leaders must be very thoroughly covered or else the vertical stacks must be increased in area as discussed under wall stacks. If some provision is not made for these longer leaders, the air temperature may be much lower than anticipated and the room will not be properly heated.

While Fig. 48 takes care of the drop of temperature in straight leaders up to 8 ft. in length connected to stacks having about 75 per cent the

area of the leader, the designer must make allowances for all other conditions. The temperature drop in leaders of various lengths at three different register temperatures is shown in Fig. 49.

Leader sizes should in general be not less than obtained by equations (1) to (3) nor should leaders less than 8 in. in diameter be used. It is not considered good commercial practice to specify diameters except

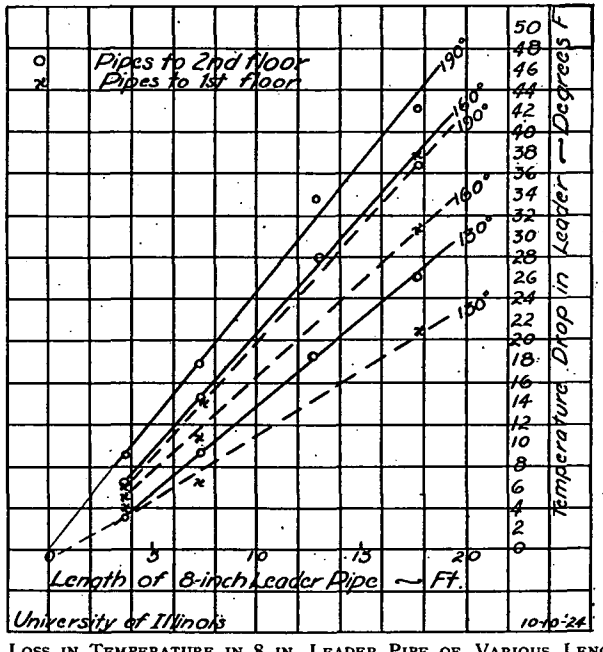


FIG. 49. LOSS IN TEMPERATURE IN 8 IN. LEADER PIPE OF VARIOUS LENGTHS AT DIFFERENT REGISTER TEMPERATURES

Note.—Pipe bare, bright tin except asbestos strips for joints.

in whole inches, although there is no real reason for not using half inches if necessary. The tops of leaders should be at the same elevation as they leave the furnace bonnet, and from this point there should be a uniform up-grade of 1 in. per foot of run in all cases. Leaders over 12 ft. in length are to be avoided or receive very special attention.

WALL STACKS

The wall stack for an upper floor should be made not less than 70 per cent of the area of the leader which has been selected from Fig. 48. So long as the leader is short and straight as was the case for Fig. 48, such a practice is probably justified since the loss (Fig. 50) in capacity occasioned by the smaller stack is not very serious for ratios above 70 per cent. For leaders over 8 ft. in length or for leaders which are not

straight, the ratio of stack area to leader area should be greater than 70 per cent in order to offset the greater temperature losses (Fig. 49) in the longer leader. In gravity circulating systems, this stack to leader

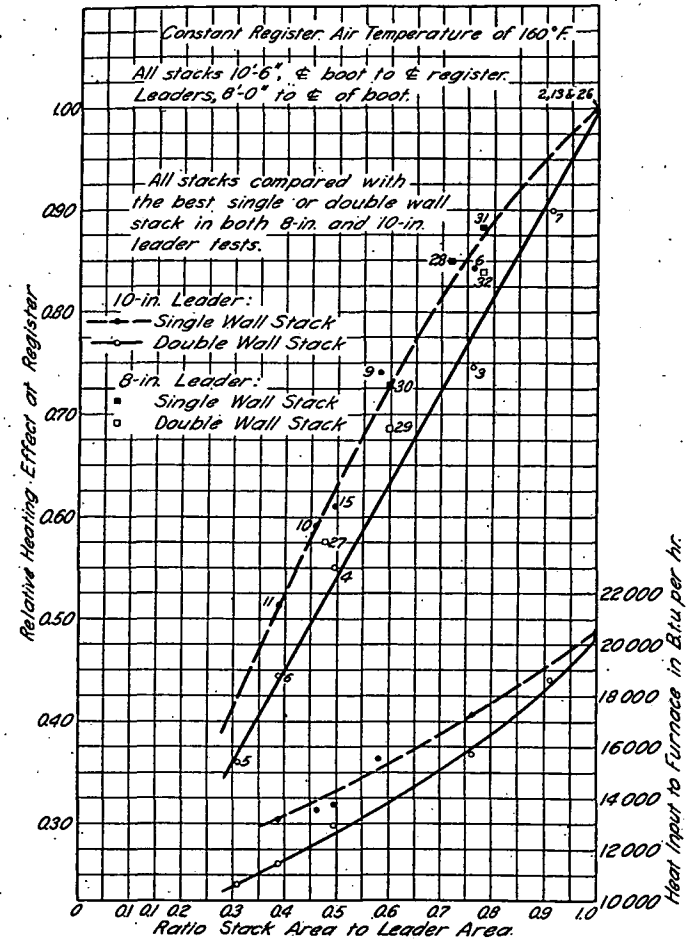


FIG. 50. RELATIVE HEATING EFFECT OF STACKS AT CONSTANT REGISTER AIR TEMPERATURE

area ratio is a very important consideration. Specific data for a great variety of cases are presented in Figs. 51 and 52 and the designer should check his stack to leader combinations with the nearest comparable case as shown in these figures. Any second floor stack supplying heat

to a room whose heat loss is 9000 B.t.u. or above. (See Figs. 51 and 52 which show that high temperatures are necessary if rooms of more than 9000 B.t.u. requirement are heated by stacks in 4 in. studding), should be run within 6 in. studded walls or should have multiple stacks. Stack

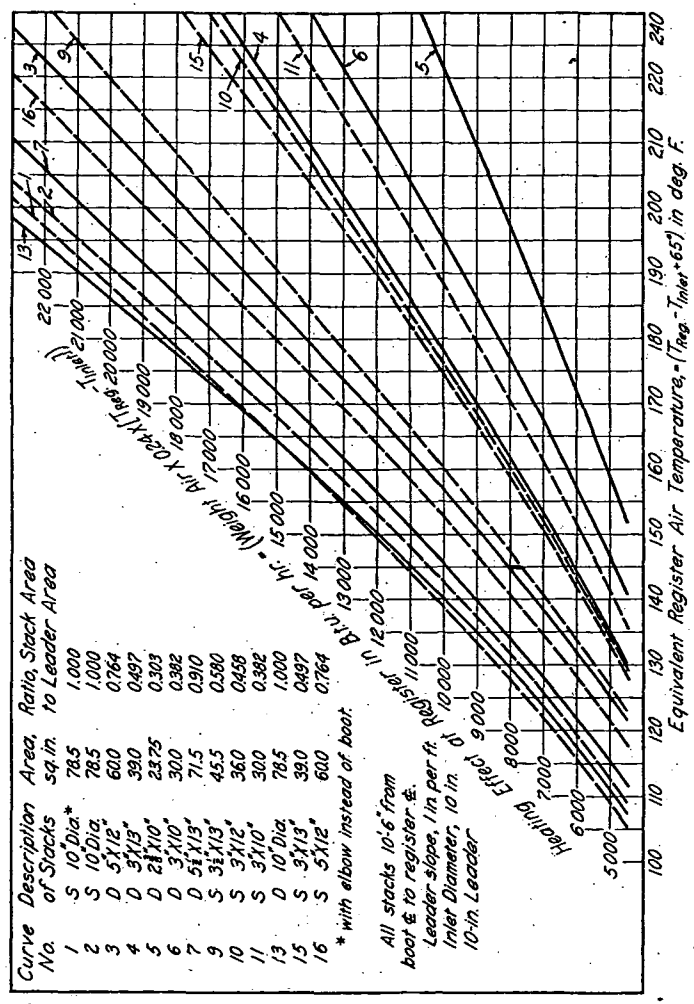


FIG. 51. HEATING EFFECT AT REGISTERS FOR VARIOUS STACKS WITH 10-INCH LEADER

sections, wherever possible, should be changed from the thin rectangular to the more nearly square shape. Stack heads should have upper end curved to provide easy flow of warm air to the room. Splitters in the upper end of the duct increase the air discharge.

WARM-AIR REGISTERS

The registers used for discharging warm-air into the rooms should have free or net area not less than the area of the leader in the same run of piping. The free area should be at least 70 per cent of the gross area

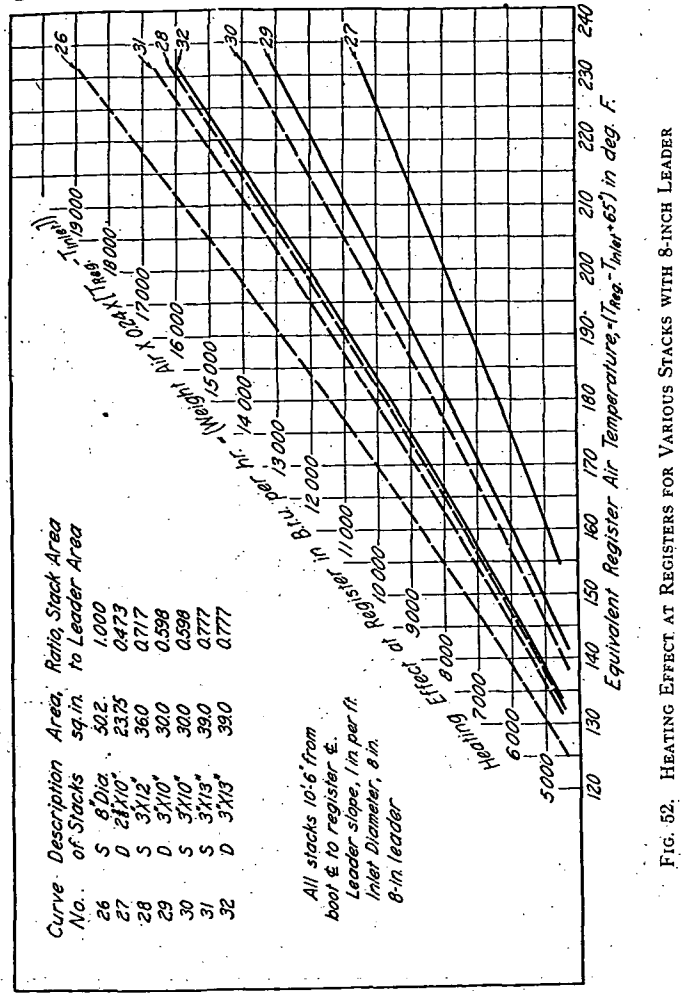


FIG. 52. HEATING EFFECT AT REGISTERS FOR VARIOUS STACKS WITH 8-INCH LEADER

of the register. No upper floor register should be wider horizontally than the wall stack, and it should be placed either in the baseboard or side wall, and not in the floor, First floor registers may be of the base-

board or floor type with the former location preferred. No first floor register should require a register box more than 14 in. wide, although it may be longer than 14 in.

AIR SUPPLY DUCTS

Ducts for recirculating air from the house or for bringing in outside air should be as short and direct as possible. The areas of such ducts should never be less than the combined areas of all warm-air leaders and ducts of the recirculating type may be made even larger than the total leader area. The importance of running the air supply ducts as direct

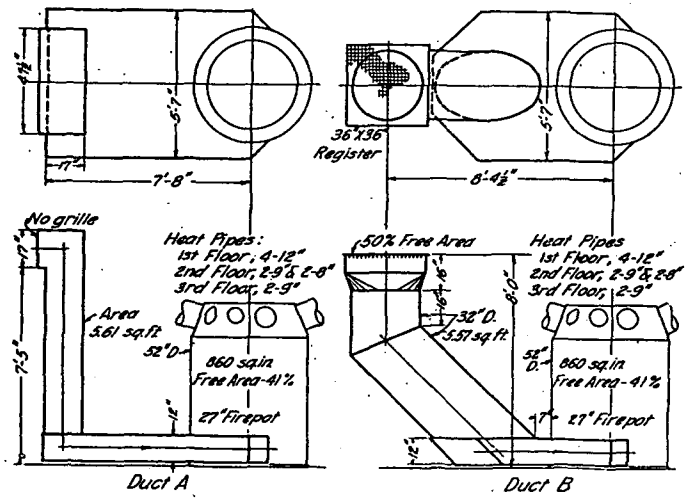


FIG. 53. TWO TYPES OF RECIRCULATING DUCT TESTED

as possible without sharp elbows is shown by the comparative performance on the same plant of two ducts (Fig. 53), as presented in Table 81.

In both cases a very wide low shoe was used for connecting the ducts to the back of the furnace casing. The top of this shoe should never enter the casing above the level of the grate in the furnace, and to accomplish this the shoe must be wide. The superior performance of

TABLE 81. HEAT AVAILABLE AT REGISTERS FOR TWO TYPES OF RECIRCULATING DUCTS

REGISTER AIR TEMPERATURE DEG. FAHR.	HEAT AVAILABLE AT REGISTERS ABOVE 70 DEG. FAHR. B.T.U. PER HR.		PER CENT INCREASE FOR ROUND DUCT
	Rectangular Duct	Round Duct	
130 (Low)	47,000	54,000	15.0
160 (Moderate)	81,000	94,000	16.0
190 (High)	120,000	138,000	15.0

the round duct using two 45 deg. instead of two 90 deg. elbows is very apparent. Values given in Fig. 48 are based on such a duct. Outside duct connections, if used, should be made to a window frame the full area of duct and such window should be in a wall exposed to prevailing winter winds. The inside type of recirculating duct or ducts is always preferred for residence installations.

RECIRCULATING REGISTERS

The register through which the air in the building is returned to the furnace should always be placed in a central position in the first floor, usually in the main hall if one exists. Air from the upper floors must have free access to this register through the stairway of the building. Sometimes more than one return air register is found desirable, and such multiple returns are often justified. The recirculating registers should have a free area at least equal to the duct to which they connect, and their free area should never be less than 50 per cent of their gross area.

FURNACE

The size of furnace should, of course, be such as will provide the necessary air heating capacity, usually expressed in square inches of leader pipe area, and at the same time provide a grate of the proper area to burn the necessary fuel at a reasonable chimney draft. The total leader pipe area required is easily obtained by finding the sum of the leader pipe areas as already designated.

The grate area will depend on several factors of which four are very important. First of all, the air temperature at the register for which the plant has been designed must be determined. Usually, this temperature is taken as 175 deg. fahr. Second in importance is the combustion rate, *which must always correspond with the register air temperature*, as is shown by reference to a set of typical furnace performance curves (Fig. 54) for a cast-iron circular radiator furnace with a 23-in. diameter grate and 50-in. diameter casing. The conditions shown on these curves which seem to approximate nearest to the 175 deg. register warm-air temperature are—combustion rate 7 lb., warm-air register temperature 173 deg., efficiency of the furnace 58.5 per cent. The third factor is efficiency, which, in turn, is a function of the combustion rate varying with it as shown by the efficiency curve of Fig. 54. The fourth factor is the heat value per pound of fuel burned, which was 12,790 B.t.u., but is not shown on the curves since it was constant for all combustion rates.

From the relation existing between these factors it is found (Fig. 54) that the capacity of the furnace under test is 147,750 B.t.u. per hour for the total grate, which gives the capacity at the furnace bonnet per square foot of grate as 51,300 B.t.u. and per square inch of grate as 356 B.t.u. per hour.

Suppose it is desired to select a furnace to deliver air to the rooms at a register temperature approximating 160 deg. rather than 175 deg. Referring to the curves, the relation is—combustion rate 5.5 lb., register warm air temperature 160 deg. and efficiency of the furnace 62 per cent.

Under this condition the capacity of the furnace at the furnace bonnet per square foot of grate area is 43,300 B.t.u. per hour, and per square inch of grate it is 300 B.t.u. per hour. From these performance values, the grate area for any plant requirement will be, (allowing 20 per cent heat loss between furnace and registers):

$$\text{Grate area (175 deg. register temperature), square inches } \frac{1.2\ H}{356} = 0.0034H^* \quad (7)$$

$$\text{Grate Area (160 deg.), square inches } = \frac{1.2\ H}{300} = 0.0040H^* \quad (8)$$

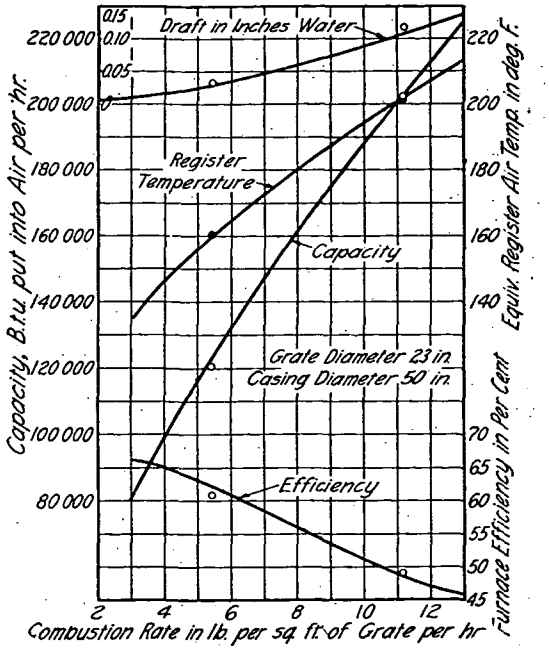


FIG. 54. TYPICAL PERFORMANCE CURVES FOR A WARM AIR FURNACE AND INSTALLATION IN A THREE-STORY TEN LEADER PLANT, OPERATING ON RECIRCULATED AIR

As a check upon the method of selection by performance curves, the method of selecting the furnace which has been in general use is as follows:

*Let H = B.t.u. heat loss from the entire house per hour = summation of all room losses $H_1 + H_2$ + etc. + the B.t.u. necessary to heat the fresh air if any, at intake. This fresh air loss in B.t.u. will be approximately 1.27 times the cubic feet of air admitted through the intake per hour on a zero day. For systems which recirculate all the air this value will be zero. For systems which have a fresh air intake, controlled by damper, this value might well be approximated, since this loss will probably be reduced to a minimum on a zero day. Assume for such cases, that the building loss is increased by 25 per cent, and that there is the usual 20 per cent loss between furnace and registers.

Let E = efficiency of the furnace
f = fuel value of the coal in B.t.u. per pound
p = pounds of coal burned per square foot of grate surface per hour and the formula then becomes

$$\text{Grate area, square inches } = \frac{1.2 \times 144\ H}{E\ f\ p} \text{ if all inside air} \quad (9)$$

For coal having a heat value of 12,000 B.t.u., a furnace having 60 per cent efficiency and 6 lb. of coal burned per sq. ft. of grate per hour, this becomes:

$$\text{Grate area, square inches } = \frac{1.2 \times 144\ H}{0.60 \times 12{,}000 \times 6} \text{ for all inside air} \quad (10)$$

The air temperature at the registers corresponding to the conditions covered by equation (10) would be approximately 160 deg. fahr. and for 175 deg. fahr. and 12,000 B.t.u. the combustion rate should be at least 7.5 lb. with an efficiency of about 57 per cent, using curves of Fig. 54 as a guide.

CHIMNEYS

The construction, location, height and area of the chimney to which the warm-air furnace is connected affect the operation of the entire heating system. Most residence chimneys are built of brick and may be either lined or unlined, but in either case the *walls must be air tight* and there should be *only one smoke opening* into the chimney. Cleanout, if provided, must be *absolutely air tight* when closed.

The walls of brick chimneys shall be not less than 3¾ in. thick (width of a standard size brick) and shall be lined with fire-clay flue lining. Fire-clay flue linings shall be manufactured from suitable refractory clay, either natural or compounded, and shall be adapted to withstand high temperatures and the action of flue gases. They shall be of standard commercial thickness but not less than ¾ in. All fire-clay flue linings shall meet the standard specification of the *Eastern Clay Products Association*. The flue sections shall be set in special mortar, and shall have the joints struck smooth on the inside. The masonry shall be built around each section of lining as it is placed, and all spaces between masonry and linings shall be completely filled with mortar. No broken flue lining shall be used. Flue linings shall start at least 4 in. below the bottom of smoke-pipe intakes of flues, and shall be continuous the entire heights of the flues and project at least 4 in. above chimney top to allow for a 2 in. projection of lining. The wash or splay shall be formed of a rich cement mortar. To improve the draft the wash surface should be concave wherever practical.

Flue lining may be omitted in brick chimneys, provided the walls of the chimneys are not less than 8 in. thick, and that the inner course shall be a refractory clay brick. All brick work shall be laid in spread mortar, with all joints push-filled. Exposed joints both inside and outside shall be struck smooth. No plaster lining shall be permitted.

Chimneys shall extend at least 3 ft. above flat roofs and 2 ft. above the ridges of peak roofs when such flat roofs or peaks are within 30 ft.

of the chimney. The chimney shall be high enough so that the wind from any direction shall not strike the top of the chimney from an angle above the horizontal. The chimney shall be properly capped with stone, terra cotta, concrete, cast-iron, or other approved material; but no such cap or coping shall decrease the flue area.

The size or area of flue lining or of brick flue depends on height of chimney and capacity of heating system. For chimneys not less than 35 ft. in height above grate line, the net internal dimensions of lining should be at least 7 x 11½ in. for a total leader pipe area up to 790 sq. in. Above 790 and up to 1000 sq. in. of leader pipe area the lining should be at least 11¼ x 11¼ in. inside. In case of brick flues not less than 35 ft. in height with no linings, the internal dimensions should be

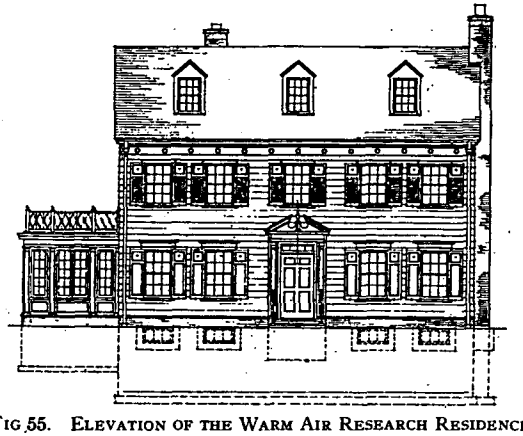


FIG. 55. ELEVATION OF THE WARM AIR RESEARCH RESIDENCE

at least 8 x 12 in. up to 790 sq. in. of leader area, and at least 12 x 12 in. for leader capacities up to 1000 sq. in. Chimneys under 35 ft. in height are often unsatisfactory in operation and hence should be avoided.

TYPICAL EXAMPLE

The application of the preceding data to an actual example may be of assistance to the designer. Figs. 55, 56, 57, 58 and 59,* represent the plans of the Warm Air Research Residence of the *National Warm Air Heating and Ventilating Association* recently erected at the University of Illinois.

Assuming all air recirculated, the minimum furnace for the plant will be:

Grate Area = 0.0034 × 132,370 = 450 sq. in. = 24 in. diam. at 175 deg. register temperature. (7).

Grate Area = 0.0040 × 132,370 = 530 sq. in. = 26 in. diam. at 160 deg. register temperature. (8) (10)

*Plans used with permission and bath room on third floor not heated at present.

If provision shall be made for certain outside air circulation, then increase the building heat loss by, say 25 per cent and obtain by equation (7) a 27-in. grate and by equations (8) and (10) a 29-in. grate.

SUMMARY OF DATA APPLIED TO WARM AIR RESEARCH RESIDENCE

Rooms	From Chapter I on Heat Losses from Buildings B.t.u. Heat Losses *H*	Leader Area Sq. In.	Stack Area Sq. In. 0.7 × *LA*	Leader Diameter Inches	Stack Size Net	Register Size Gross
First Floor		= 0.009*H*				
Living	17250	155	....	14	.....	14 × 18
Dining	6810	61	....	9	.....	8 × 12
Breakfast	2300	21	....	8	.....	8 × 10
Kitchen	9210	83	....	11 or 12	.....	12 × 14
Sun	25710	230	....	Two 12	.....	Two 12 × 14
Hall and stair	12570	113	....	12	.....	12 × 14
Second Floor		= 0.006*H*				
Owners	15030	90	63	11 or 12	5 × 12	12 × 14
S. W. Bed	9800	59	41	9	3½ × 12	8 × 12
Bath	2450	15	10	8	3 × 10	8 × 10
N. Bed	14800	89	62	11 or 12	5 × 12	12 × 14
Third Floor		= 0.005*H*				
E. Bed	8220	41	29	8	3 × 10	8 × 10
W. Bed	8220	41	29	8	3 × 10	8 × 10

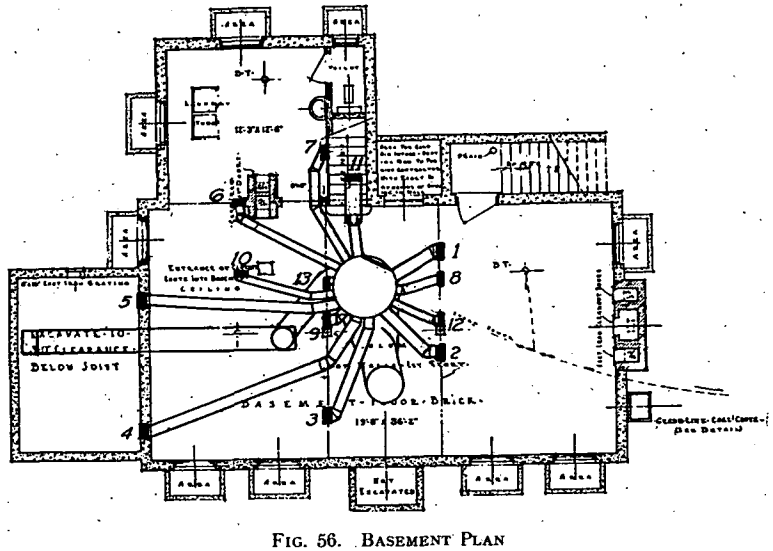


FIG. 56. BASEMENT PLAN

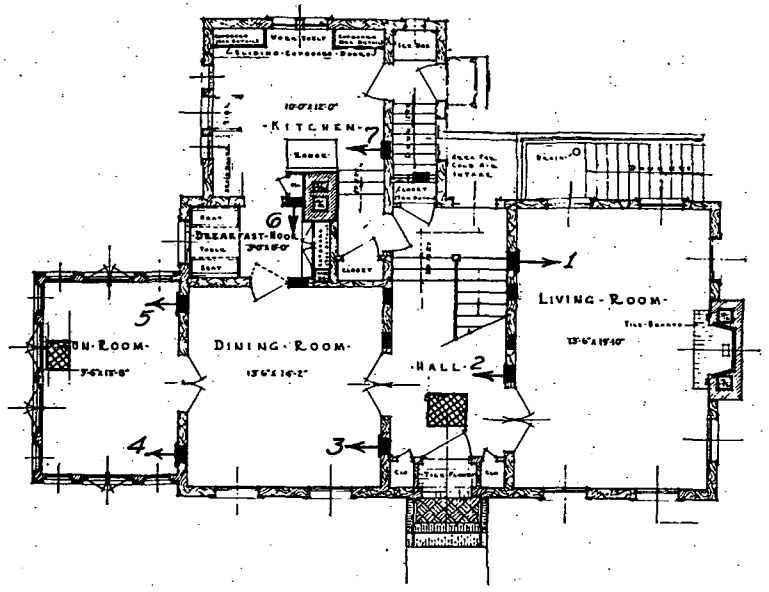


FIG. 57. FIRST FLOOR PLAN

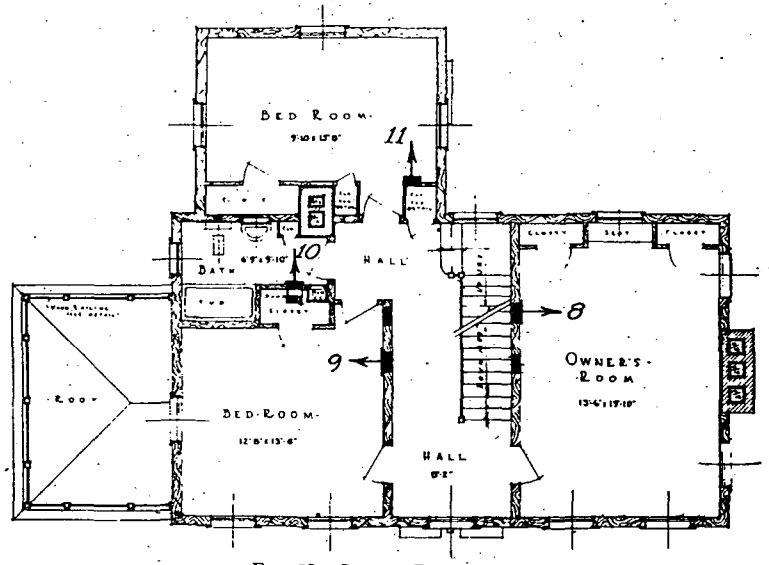


FIG. 58. SECOND FLOOR PLAN

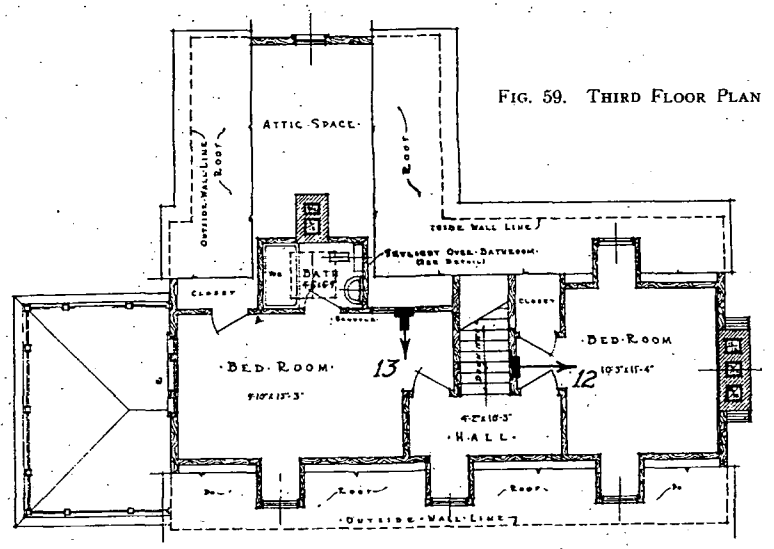


FIG. 59. THIRD FLOOR PLAN

STANDARD CODE REGULATING THE INSTALLATION OF WARM AIR FURNACES IN RESIDENCES*

THIRD EDITION
June 1, 1924

*This Code is approved and issued by authority of the *National Warm Air Heating & Ventilating Association*, THE AMERICAN SOCIETY OF HEATING & VENTILATING ENGINEERS, *National Association Sheet Metal Contractors*, *Western Warm Air Furnace and Supply Association* and *The Midland Club*.

ARTICLE 1.—Meaning of the Term "Warm Air Furnace Heating Plant"

Warm air furnace heating plants, to which this code refers, shall consist of one or more warm air furnaces, enclosed within casings, together with necessary appurtenances thereto, consisting of warm air pipes and fittings, cold air or recirculating pipes, boxes and fittings, smoke pipes and fittings, registers, borders and face plates, the same being intended for heating buildings in which they may be installed.

ARTICLE 2.—Provisions to be made in Building under Construction for Reception of Warm Air Furnace Heating Plants

Section 1. a The following provisions shall be made by the owner or building contractor, in any building wherein a warm air heating plant is to be installed.

b Where warm air register boxes, heads, pipes, or stacks are to be installed, joists shall be set not less than sixteen inches (16″) on centers and shall be butted and not lapped. Studding shall set directly over and under joists, leaving a space of not less than fourteen inches (14″) between studs and joists. Wherever joists are cut, headers must be put in to support joists.

c All first story single or sub-floors shall be continuous. In all houses having studded exterior walls, these floors shall be extended to the outside sheathing and all spaces between studding shall be closed at the attic line.

Note 1.—It is strongly recommended that the attic be tightly floored to reduce heat losses.

d All partition walls (or sections of these walls) in which heat stacks to second floor rooms are to be installed, shall be built of six-inch (6″) studding to second story floor joists.

Chimneys

Section 2. *a* The owner shall provide a chimney for the furnace constructed in a manner to comply with the following specifications.

b The chimney must be absolutely smoke tight throughout its entire length, and must extend at least three feet (3′) above a flat roof or two feet above the ridges of peak roofs.

c If built of a single thickness of brick or of cement blocks, it shall be lined throughout its entire length with fire-clay flue lining, having not less than three-fourths inch (¾″) thickness. Flue lining to be laid in mortar and made air tight.

d The furnace flue must have no other opening for attaching any fireplace, furnace, stove, range, water heater, gas or ventilating connection.

e If necessary to offset the flue, it must be done in such a manner as not to reduce the cross sectional area nor create a ledge or obstruction, where loose material may lodge.

f Its narrowest internal dimension shall not be less than eight (8″) inches and no flue smaller than 8″ x 8″ rectangular or eight (8″) inch diameter round will be considered suitable when hard coal is to be burned, or 8″ x 12″ rectangular or ten (10″) inch round for soft coal or wood.

g It is strongly recommended that nothing less than 8″ x 12″ internal dimensions be used in any case.

Note 2.—It is recommended that the height above the furnace grate be not less than twenty-six (26′) feet.

Note 3.—It is strongly recommended that all new chimneys be built in strict accordance with the ordinance recommended by the National Board of Fire Underwriters.

ARTICLE 3.—Method for Determining Size of Warm Air Pipes, Wall Stacks and Furnaces for Use in a Residence

Method of Determining Size of Basement Warm Air Pipes

(Read Explanatory Notes 4 to 11

Section 1. First Floor Rooms.

Divide square feet of glass by 12,
Divide square feet of net outside wall by 60,
Divide cubic contents by 800,
Add together the above and multiply by 9.
The result is the area of the basement pipe.

$$\left\{\begin{array}{l}\text{The sum of:}\\ \text{Glass (sq. ft.) } (\textit{Note 4}) \div 12\\ \text{Net Wall (sq. ft.) } (\textit{Note 5}) \div 60\\ \text{Cubic Contents} \div 800\end{array}\right\} \times 9 = \text{Area of Basement Pipe } (\textit{Note 10})$$

Section 2. Second Floor Rooms.

Divide square feet of glass by 12,
Divide square feet of net outside wall by 60,
Divide cubic contents by 800,
Add together the above and multiply by 6.
The result is the area of the basement pipe.

$$\left\{\begin{array}{l}\text{The sum of:}\\ \text{Glass (sq. ft.) } (\textit{Note 4}) \div 12\\ \text{Net Wall (sq. ft.) } (\textit{Note 5}) \div 60\\ \text{Cubic Contents} \div 800\end{array}\right\} \times 6 = \text{Area of Basement Pipe } (\textit{Note 10})$$

Section 3. Third Floor Rooms.

Divide square feet of glass by 12,
Divide square feet of net outside wall by 60,
Divide cubic contents by 800,
Add together the above and multiply by 5.
The result is the area of the basement pipe.

$$\left\{\begin{array}{l}\text{The sum of:}\\ \text{Glass (sq. ft.) } (\textit{Note 4}) \div 12\\ \text{Net Wall (sq. ft.) } (\textit{Note 5}) \div 60\\ \text{Cubic Contents} \div 800\end{array}\right\} \times 5 = \text{Area of Basement Pipe } (\textit{Note 10})$$

Method of Determining Size of Wall Stacks

Section 4. First Floor Rooms.
Same as Section 1.

Section 5. Second Floor Rooms.
Deduct 30 per cent from basement pipe area determined in Section 2.

Section 6. Third Floor Rooms.
Deduct 30 per cent from basement pipe area determined in Section 3.

Explanatory Notes

Note 4.—In obtaining glass surface use full casement opening. An outside door is figured as glass.

Note 5.—To obtain net outside wall multiply height by width and deduct the glass in all windows and outside doors.

Note 6.—For rooms having unusual exposure, ordinarily north, northeast and northwest, add 15 per cent to pipe area. For east and west exposure, add 10 per cent.

Note 7.—For cold ceilings, add one-half net area of ceiling to net exposed wall (cold ceilings are those next to unfloored attics.)

Note 8.—Use no warm air pipe less than 8 inches in diameter. If a basement warm air pipe figures greater area than any standard commercial size then the next larger size shall be used.

Note 9.—It is understood in using the above values for determining basement warm air pipe areas, that these pipes should be run comparatively straight and that they should not be over 10 to 12 feet in length. Sharp turns and long pipes should have extra capacity.

Note 10.—These formulae are for 70 deg. inside temperature with zero temperature outside. For a temperature of 10 deg. below zero, add 10 per cent to the capacity of each pipe.

Note 11.—The value of 800 (used in cubic contents) is for an estimated air change of one room volume per hour. If it is desired to provide for 1½ room volume use the figure 600. If for 2-room volumes use the figure 400. "The factors 9, 6 and 5 in sections 1, 2 and 3 are calculated for a register air temperature of 175 deg."

Transition Fittings and Stacks

Section 7. Transition from warm air pipes to stacks shall be made with a well-designed elbow or boot and no stack shall be less than 70 per cent of the warm air pipe area.

Method of Determining Size of Registers

Section 8. All registers shall have a free area at least equal to the calculated area of the basement pipe.

Method of Determining Size of Furnace

Section 9. Add together the actual warm air pipe areas in square inches as obtained in Sections 1, 2 and 3, and select a furnace having a free area not less than the sum of all the warm air pipe areas.

ARTICLE 4.—Installation—Location of Furnace

Section 1. The location of the furnace shall equalize the length of warm air runs as far as possible, yet give necessary preference to pipes supplying living rooms, dining rooms and main halls.

Foundation

Section 2. Furnace foundation of brick, cement, or other incombustible material must be provided. Said foundation to extend at least fifteen (15″) inches at rear and sides of furnace casing and at least thirty-six (36″) inches in front of furnace casing. Foundation to be level.

Setting or Assembling of Furnace

Section 3. *a* The base ring of the furnace shall be cemented to the foundation, making an air tight joint. The furnace parts shall be assembled plumb and level, and in a workmanlike manner.

b All sections and joints shall be properly fitted. Joints requiring cement shall be well filled and all bolts shall be drawn up tightly.

Casings

Section 4. *a* Warm air furnaces shall be enclosed in metal casings or walls of brick, tile or concrete.

b Portable. Sheet metal casings including casing tops shall be made of galvanized sheets, not lighter than 26 U. S. Standard Gauge. They shall fit the castings and casing rings closely, so as to be dust tight, and shall be securely fastened to the front. The casing shall be lined from the upper casing ring down to a line on a level with the grate.

c When side collars are used the casing top must be of sufficient height so that the largest warm air pipe can be taken from side without ovaling. In no case shall a distance less than eight (8″) inches be maintained between the top of any furnace and the top of casing or bonnet.

d Any furnace, the casing top of which shall come within sixteen (16″) inches of a combustible floor, ceiling or joist, shall be protected by a metal shield, extending not less than eighteen (18″) inches beyond the casing of said furnace. This shield shall be suspended at least two inches below wood work, allowing free air space between shield and woodwork. No furnace casing or top, coming nearer than six (6″) inches of ceiling or joists shall be allowed in any case.

e Openings for side casing collars shall be cut into the casing top, so that the tops of all openings are on a level. Casing collars shall be fitted into place with a proper flange, or bead on the outside and drawn up on the inside, making a dust-tight joint. All collars shall be of same size as the warm air pipes to which they are to be connected.

f Brick set, cement or hollow tile casings shall be constructed as follows: Walls shall be not less than eight (8″) inches in thickness, and shall be constructed air tight. Rectangular casing shall be, with least inside dimensions, the same as that of the portable casing of a corresponding size of furnace. Walls shall be carried to the same height as the portable walls, allowing not less than eight (8″) inches between the top of the furnace and the bottom of the top cover. After placing the collars for the warm air pipes, continue the masonry up even with the top of the collars, lay spacing rods of bar iron on edge or angle irons across the furnace top, cover these with sheet iron, cover the sheet iron with masonry and run the side walls four (4″) inches above the masonry bed. A galvanized iron casing bonnet may be used on brick set furnaces.

Provisions shall be made in the walls for a manhole to give ingress to heater.

Warm Air Pipes in Basement

Section 5. *a.* All warm air pipes shall be made of bright tin not lighter than IC, or galvanized iron. Side seams shall be locked seams. All joints shall be either double seamed or lapped not less than one and one-quarter (1¼″) inches and such joints shall be beaded and soldered or riveted. All pipes shall be properly secured to ceiling or joist. No solder or riveted joint is required where round pipe slips over the casing collar. Any pipe twelve (12″) inches or greater in diameter shall not be made of material lighter than IX tin or No. 26 U. S. Standard Gauge galvanized iron.

Note 12.—It is recommended that all warm air pipes in the basement shall have an upward pitch of not less than one (1″) inch per running foot.

b. No warm air pipe shall run within one (1″) inch of any woodwork unless such woodwork is covered with asbestos paper and the paper covered with tin or iron.

c. All warm air pipes in the basement shall be provided with dampers not more than two feet from the casing.

d. Where warm air pipes pass through a masonry wall, a metal thimble shall be provided, having a diameter at least 1 in. greater than the pipe, and pipe supported in such a manner that the air space is uniform on all sides.

Wall Stacks

Section 6. *a.* Single Stacks. All single wall stacks or wall pipes, heads, boots, ells, tees, angles and other connections shall be made of bright tin or galvanized iron and shall be covered with not less than one thickness of 12 lbs. per one hundred (100) sq. ft. of asbestos paper. All studding and other woodwork facing said pipe shall be lined with metal and metal lath used in place of wood lath. An air space of not less than three-eights (⅜″) of an inch shall be allowed on the two sides nearest the vertical studs. All such pipes shall be braced in a proper manner so as not to obstruct the flow of air but to retain the full capacity throughout. All joints shall be locked and held in place by means of lugs, or straps. No joint shall depend wholly upon solder to make it tight.

b. Double Stacks. All double wall stacks or wall pipes, heads, boots, ells, tees, angles and other connections shall be made of bright tin, not lighter than IC or galvanized iron and shall be made double, from and including the boot or foot piece in basement to the top of each and every stack and register head on all floors. There shall be continuous uniform air space of not less than five-sixteenths (5/16″) of an inch, which must be maintained between the outer and inner walls of all such pipes and fittings of all kinds, styles and descriptions; such pipes, heads, boots and other fittings to be of the styles, or equal to those accepted by the *National Board of Fire Underwriters.*

All pipes and fittings either single or double must be secured firmly in place by lugs or straps attached to the outer walls of stacks and fittings, and no nails shall be driven through these stacks or fittings at any point. No wall pipes or fittings shall be used which depend wholly on soldered joints. The various members shall be so made that all joints are locked and soldered and the several members shall be attached to each other with slip joints, which are, for the purpose intended, air tight.

Registers

Section 7. *a.* When baseboard or wall registers are used, they shall be properly and permanently attached to the stack head in such a manner that will prevent any leakage of air between the head and the register.

b. Floor registers shall be provided either with register borders, or double register boxes of tin or galvanized iron with an air space of not less than five-sixteenths (5/16″) of an inch between inner and outer boxes.

c. Registers for warm air and warm air pipes shall not be located in outside walls. The warm air registers in the various rooms shall be located in or near the inside walls in all cases.

Air Supply to Furnace

Section 8. *a.* The air supply to furnace for warm air heating plants may be taken from outside or from within the building or may be taken partially from outside and partially from within. In no case, however, shall air be supplied to any furnace from any basement or furnace room.

b. The cold air intake or return where air is taken from within the building shall have a net area throughout its entire length of not less than the combined net area of all warm air pipes leading from the furnace. This may be maintained in one or more ducts.

c. When the cold air supply is taken wholly from the outside of the building the supply duct at its most contracted area must equal or exceed eighty (80%) per cent of the combined area of all warm air pipes leading from the furnace.

d. Cold air ducts shall be constructed of metal, tile or other incombustible material having smooth inner surface and shall maintain a constant net area throughout their entire length and shall be made air tight. Where a boot or shoe is connected to the casing at the base, the opening shall not extend higher than a line on the level of the grate of the furnace. The width of the shoe shall be of proper measurement to make the area at least equal to that of the round or square pipe to which it is connected.

e. Wherever the space between joists is used to convey cold air overhead, the joists and all wooden surfaces between such joists shall be lined with metal and a sheet metal pan constructed to extend not less than six (6″) inches below said joists. The connection from this pan to the boot or shoe shall be made of galvanized iron not lighter than No. 26 U. S. Standard Gauge, and shall have a transition collar, the top area of which shall be at least 10 per cent greater than the area of the connecting pipe.

f. The cold air face or faces shall be made of wood, or metal. When set in floors the top of same shall be flush with floor. Where cold air face is placed in a seat or side wall (whether furnished by owner, general contractor or furnace contractor) the open work of face must extend to within at least one (1″) inch of the floor line.

The free area of cold air faces shall be at least 10 per cent in excess of the free area of the duct or ducts to which they are connected.

Note 13.—The effective area of a vertical cold air face lies within twelve (12″) inches of the floor line, hence, the capacity of any vertical cold air face shall be determined by multiplying the base line in inches by not to exceed twelve (12″) inches in height and deducting for the grills or cross bars.

Smoke Pipes

Section 9. a. The smoke pipe shall be as short and direct as consistent with the location of the furnace. It shall be made of either black or galvanized iron not lighter than No. 24 U. S. Standard Gauge, and of the full size of the collar on the furnace throughout its entire length. It must have no other opening for attaching any fire place, stove, range, water heater, gas or ventilating connection. It shall be lock-seamed or riveted; all joints shall lap not less than one and one-half (1½″) inches and it shall be rigidly secured. Cast iron smoke pipe may be used.

b. Where the smoke pipe enters the flue, a thimble shall be cemented into the flue and the connections thereto made air tight. Should any smoke pipe come within eighteen (18″) inches of any combustible material, such combustible material must be covered with asbestos paper and a metal shield so fastened that a two-inch air space exists between this shield and the combustible material. This shield shall be no less in size than twice the diameter of the smoke pipe and of sufficient length to cover the wood at all points.

c. No smoke pipe shall project through any external wall or window.

Pipeless or One Pipe Furnaces

Section 10. a. When but one duplex grating is used for both warm air and cold air in a so-called pipeless furnace, the area of the cold air intake shall be at least equal to the area of the warm air outlet of the grating. Article 4, Section 4, relative to casing shall not govern when this type of furnace is installed, but the following specification shall be followed: The inner and outer casing of this type of furnace may be made of either black or galvanized iron not lighter than No. 26 U. S. Standard Gauge. A uniform air space shall be maintained at all points between the inner and outer casing. In no case shall the top of the furnace be allowed closer than twelve (12″) inches to any ceiling or joists above the furnace.

b. Where joists are cut to accommodate this furnace, headers shall be put in and braced so as not to weaken the structure of the floor above the furnace.

c. Article 3 for determining area of warm air pipe shall not govern in figuring a pipeless furnace.

d. Where one warm air register face is used and separate face or faces for cold air supply are used, then Article 4, Sections 5 and 8 shall apply.

CHAPTER X

OIL FUEL FOR INDUSTRIAL AND DOMESTIC HEATING

By BYRON K. EATON, Member

INDUSTRIAL OIL BURNING

THE general use of coal in the United States and the decline of the use of wood as fuel began about 100 years ago, and like the inhabitants of the country was confined to the Atlantic seacoast. The bituminous coals first used were imported from England and afterward they came from Virginia mines and other fields as population spread. Anthracite coal was first sent down the Delaware River and afterward came by the canal routes that served during the early part of the century. From Philadelphia this coal was at first distributed on the Atlantic Coast by means of sailing vessels and with the advent of the railroads, the bulk of this distribution was affected by rail transportation.

One hundred years after these events, a new form of fuel, bids for a place in the world of combustion. This fuel is liquid in form, being petroleum in its constituent parts. There is claimed for liquid fuel, the advantages of space for storage, simplicity in location of storage adjacent to boilers and means of transportation from the remote points of storage to boiler, reduction in labor and handling of fuel, the elimination of ash removal, ease of control of furnace temperatures, and the elimination of the expense of banked fires. Each case, however, where the liquid fuel is contemplated will have, of necessity, to stand on its merit. The heating engineer must figure out the operating cost both with coal and with oil, and the user will have to evaluate the extra convenience, after which a decision can be made as to what type of fuel should be used.

Crude oil has either a paraffin or asphalt base, or a blending of the two. Fuel oil, is heavy, dark in color and has a greater viscosity, higher calorific value and higher flash point than the crude oil from which it is made. It results from the distillation of crude oil during which processes naptha, benzine, gasoline, kerosene and other distillates are removed. The character of the fuel oil varies in accordance with the extent to which the crude oil has been refined.

In the selection of burner equipment and in the determination of storage facilities, it is well to decide what grade of oil is to be used, its Baumè gravity, viscosity, flash point, and cold test, or temperature at which it will cease to be fluid.

The following table gives data from standard authorities on various oils. The flash point varies considerably in the oils from different fields, hence the figures given are subject to variation:

TABLE 82. DATA ON FUEL OILS

OIL	BAUME GRAVITY DEG. FAHR.	FLASH POINT DEG. FAHR.	POUNDS PER GALLON	B.T.U. PER GALLON	B.T.U. PER LB.
Kerosene	42	140	6.80	135,524	19,900
Distillate	38	160	6.96	137,402	19,700
Light Gas Oil	36	190	7.03	138,421	19,700
Dark Gas Oil	32	200	7.21	140,811	19,600
Light Fuel Oil	24	150–200	7.58	145,612	19,000
Heavy Fuel Oil	18	180–280	7.89	149,484	18,900

Note. While the use of an oil may be contemplated, having a cold test sufficient to meet the lowest temperatures experienced, *if there is any possibility of higher cold test oils being used, heating coils should* be installed in the storage tank.

A fuel oil burner installation comprises oil storage, and pumping equipment, an atomizing assembly and a correctly designed fire-box within the boiler for complete combustion and for proper diversion of the fire and gases. There are certain essential accessories, such as pipe-lines, oil pre-heaters, regulating valves, meters, strainers, pressure gages, relief valves and the proper adaptation of them all to the particular needs of each specific case.

Adequate oil storage should be planned. Where trackage is available, carload deliveries should be provided for. Local ordinances and the requirements of the *National Board of Fire Underwriters* and the local bureau having jurisdiction should be studied and strictly adhered to, especially in the matter of locating and burying outdoor tanks and in the brick-housing and sand-fill usually required for large interior tanks that are not buried.

Where the storage tank is buried outside the building, the oil suction, oil return and the steam flow and return lines should all be run in one large split tile, carefully cemented. The steam line should then drop into the oil storage tank, either spirally around the suction line, thence returning back through the tile, to discharge into the heating system trap, or the coil can extend to and be laid along the bottom of the tank, with the return similarly returning to the steam system. Great care should be exercised in the construction of steam lines inside of oil tanks, so that there will be absolutely no possibility of a leakage from the oil into the steam coils when coils are under a vacuum or of the steam leaking into the oil.

Every tank should be provided with a man-hole and with the following tappings:

4 in. fill
3 in. suction
1½ in. return
1½ in. vent
1½ in. steam flow
1½ in. steam return

All these tappings should be in the top of the tank. The suction pipe should not extend closer than six inches to the bottom of the tank. These tappings can be varied in size to suit local ordinances or conditions.

There are three general types of tanks—vertical steel, horizontal steel or concrete. Up to 10,000 gal. the horizontal steel tank is commonly used; the vertical steel tank is used for larger capacities; although the concrete tank is gaining very much in popularity, because of its durability, economical installation cost and the readiness with which concrete may be shaped to fit any space available for storage.

Since the minimum car of oil is 8,000 gal., it is well not to plan any tankage of less than 10,000 gal. capacity, where carload deliveries are possible. Where oil companies maintain reserves of oil, smaller storage can be provided for than in districts where all the oil has to be brought in by car. In this case, there should be enough storage for a reasonable period. One ton of coal is equivalent to approximately 170 gal. of fuel oil.

Standard construction for underground horizontal steel tanks provides 3/16 in. steel for up to 4,000 gal., ¼ in. from 4,000 to 10,500, 5/16 in. from 10,500 to 20,000 gal. Vertical above ground tanks should be built in accordance with the Underwriter's tables for diameter and height.

While oil consumption can be fairly accurately checked by gaging the tank, the oil meter is the most logical method of quickly determining fuel costs and in estimating the relation between fuel consumption and work performed.

It is not the purpose of this article to discuss the relative merits of various types of burners. The respective claims of burner manufacturers can be carefully weighed and a decision made as to which is best adapted to the work in question. Mechanical simplicity and the assurance of correct principles of atomization should be of foremost consideration in judging burners.

The decision as to the burner will govern the type of oil pump utilized to draw the oil from the storage tank and introduce it into the burners. The various burner campanies have provided what they consider the most suitable pumping devices for their equipment.

One of the most important phases of oil burner installations, is the design of the combustion chamber of the boiler or furnace. While the consumption of coal is limited in a boiler, by the square feet of grate and the draft available where handfiring is utilized, with oil burning equipment, the only limit to the oil consumption, is in the cubical contents of the combustion chamber or fire-pot. Practically any of the boilers that are in use today are adaptable to oil burning equipment but there should be a rearrangement of the combustion chamber. The grates may be removed, and the burner dropped below their level thus enlarging the combustion space.

The introduction of secondary, heated air is quite important to best combustion results and it is, therefore, customary for brick walls to be built on either side of the fire-box of the boiler to support 2½ × 2½ × ⅜ in. tee-irons laid crosswise, upon which a checker hearth of firebrick is laid. The spaces in this hearth should vary, dependent upon the individual draft and conditions of the heating plant. Air is drawn in

through the ash door of the boiler, and its damper can be adjusted to suit conditions. The air is heated as it rises through the openings between the intensely heated fire-brick. The heated air then mingles with the straight-shot flame, projecting into the boiler, thus giving that additional air required for completion of combustion.

A wide, long, high combustion chamber is ideal, within certain limits. It is only necessary to extend checker or protecting walls where there are water-drop legs projecting downward from the crown-sheet. All such water surfaces must be protected from any direct contact with the fire. It is well to brick up the sides of boilers, of fire-box or sectional type, to a point 8 or 9 in. higher than the center-line of the burners. Impingement walls should be so built as to properly deflect the gases of combustion.

The brick used should be of the very highest heat-resisting type and each brick should be dipped in a thin batter of heat-resisting cement and water and laid up tightly to the next brick. This will give a very excellent wall which will require a minimum of attention. Oil burner manufacturers have plans for the bricking of the various types of boilers, which plans are usually submitted after the contract has been approved.

There are a number of oil heaters on the market, which are meritorious. If low pressure steam boilers are being equipped with oil burners, ordinary coil waterheaters may be connected below the water-line of the boiler. Sufficient heater capacity should be installed to bring the temperature of the oil up to within 25 or 30 deg. of its flash-point. This pre-heating of the oil not only decreases the viscosity but takes a certain combustion burden from the fire in the boilers and also tends to carry in suspension basic deposits which might otherwise be left in the burners. In high pressure work, coil heaters can be connected into the exhaust or live steam lines depending upon the type of heater selected.

Naturally, the heavier the oil, the greater will be the tendency towards sediment deposit consequently strainers must be provided. Unless the oil is exceedingly heavy, a single strainer in the suction line just before it enters the pumping equipment, will be sufficient. This strainer can be so built as to be easily accessible for cleaning. In some instances, duplex strainers are used, in which case, the mere throwing of a lever, will change the flow of oil from one strainer to another, so that cleaning can be accomplished without interfering with the supply of oil.

The question of the elevation of the pump is of some importance, as some communities prohibit the installation of oil pumping equipment at a point lower than the top of the oil storage tank. As the result, it is frequently necessary to build platforms in the boiler-room on which to mount the pumping equipment, so that there will be no danger of siphoning. If this is not done anti-siphoning devices should be used.

While fuel oil burners are not automatic in character, yet a great many burner companies provide automatic regulators to maintain a fire between "high-low" limits, so as to maintain uniform pressures.

The foregoing discussion refers continually to boilers, it must not be lost sight of that oil fuel is adaptable to scores of industrial purposes. Bake ovens, melting pots, annealing furnaces, dryers and countless other heat demanding units are continually and adequately operated with this modern fuel.

DOMESTIC OIL BURNERS

The problem of applying oil fuel to residential heating is essentially different from that pertaining to industrial installations. While in an industrial installation the size of the plant usually warrants the necessary investment for installing auxiliary equipment for preheating and atomizing the heavy fuel oils such investment is seldom warranted in the small plant required in a residence. Further, the hazard associated with preheating and the complication incident with atomization is an added factor weighing against the use of heavy oils for this purpose. These facts results in the use of lighter or higher Baumè gravity oils for domestic purposes. These oils which include gas oil, distillate, and kerosene are liquids of low viscosity even at zero temperature.

The problem of oil storage is relatively simple, since all the fuel may be stored in tanks buried outside. One-thousand gallon tanks of 3/16 in. steel seem to be most popular although the two and three thousand gallon sizes are coming into considerable favor. In estimating the size of storage tank it is well to remember that 170 gal. of oil is approximately equivalent to 1 ton of coal.

Inquiry should be made as to the available truck capacities before selecting tank sizes, as the tank should be large enough to accommodate an entire truck-load of oil, while still containing a "working balance."

Local ordinances should be strictly adhered to. Some cities require that a buried tank shall be at least 2 ft. beneath the surface of the ground and at least five feet from a building wall. Others provide that a line drawn at 45 degrees from the junction of the basement floor and the building wall, shall not touch the tank.

The tappings, 2½ in. fill, 1 in. vent and 1 in. oil suction, should all be in the top of the tank. Manholes, oil return lines and steam coils are unnecessary in tanks for the kind of oil suitable for residential work.

In the low-priced burners utilizing basement auxiliary tanks, such tanks should be at least 10 ft. from the nearest fire; they should be replenished by hand pumps connected to the main oil tank buried outside. Where no outside storage is provided, these auxiliary tanks should be filled and vented outside, and should also be provided with a tight-fitting, float gage, so that if the tanks are over-filled, there can be no spilling of oil in the basement.

The thermostatic equipment should consist of a room thermostat, centrally located in a position, representative of the general home temperature, remote from any source of heat or cold, and a boiler control to prevent the temperature of the water or the steam pressure from exceeding a predetermined point.

While oil burners are most successfully operating in hundreds of different makes and styles of boilers and furnaces yet in planning new heating systems the adaptability of boilers to oil burning should be given serious consideration. Generally speaking, boilers with a preponderance of indirect or flue surfaces, are best suited to oil burning, because an oil fire develops a considerably hotter flame than does coal. This means higher combustion gas temperatures, and naturally demands more heat absorbing, water-backed flue surfaces.

Where round domestic boilers are contemplated, those with a maximum number of horizontal water sections above the fire-box are to be preferred.

In selecting burner sizes the total load imposed upon the boiler and thence upon the burner should be carefully determined. This load should be determined in accordance with the method for determining the load on any boiler as outlined in preceding chapters.

The same allowance for hot water heaters should be made as for ordinary boiler practice and the same precaution should be followed in insulating the boiler and piping.

Draft is a matter of importance, since the quantity of air introduced by the very essential motor driven burner fan, must have adequate opportunity to pass freely into the stack. The standard practice of assigning an individual flue to the heating boiler should be strictly adhered to.

Oil burners with their frequent periods of idleness, and the consequent elimination of needless fuel consumption, do not always impart sufficient heat to ordinary water coils in the fire-pot of heating boilers.

Where vapor or steam is used, any of the boiler water-heating units that connect into the boiler below the water-line, thus heating the storage tank, should be used. In hot water heating plants, larger coils are necessary.

In studying the burner equipment itself, attention should be given to the stability of the burner manufacturer and that of his local distributor. The reputation of the burner in past performance is of equal importance. The simplicity and quality of the mechanical construction should be studied and the element of noise, must be given attention.

A burner listed as standard by the Underwriters' Laboratories, may be considered as having been built-up standards.

CHAPTER XI

GAS HEATING

By W. E. STARK, Non-Member

THE increase in the use of gas for space heating has been a great stimulus to the development of highly efficient gas burning appliances. Gas-burning heating installations as the sole source of heat for residences, factories, and public buildings (formerly limited to those localities where there was an abundant supply of cheap gas) are taking a more prominent place in coal-burning regions.

Gas-burning heating appliances present an opportunity for the realization of nearly ideal efficiencies in combustion and heat transmission. Full advantage must, however, be taken of the inherent efficiency of such appliances and every effort made to retain this efficiency, for it is only on this basis that gas can compete with coal.

TYPES OF GAS HEATING APPLIANCES

Gas-burning heating appliances may be classified as those for heating individual rooms; and central heating plants, heating an entire residence or other building. Each classification may be subdivided as follows:

1. Room Heaters
   - *a* Reflector Heaters (luminous flame)
   - *b* Radiant Heaters (blue flame)
   - *c* Gas Logs (blue flame)
   - *d* Tubular and Cylindrical Radiators
     - (a) Floor Furnaces
   - *e* Gas Fired Steam Radiators
     - (a) Bungalow type hot water systems

2. Central Heating plants
   - *a* Warm Air Furances
   - *b* Steam Heating plants
   - *c* Water Heating plants

COMBUSTION OF GAS

In the above classification it will be seen that some heaters are designated as *luminous flame* or *blue flame*. This distinction comes from the type of burner used. Gas burners are of two general types: Luminous flame burners, and the more widely used Bunsen or blue flame type. Each type of flame has its own field of usefulness; and if combustion is complete, and the flame properly applied, each will deliver the same amount of heat from a given quantity of gas. Gas requires for complete combustion air in the proportion of about 1 cu. ft. for each 110 B.t.u. of gross heat value. The two flames differ in the manner in which this air is supplied for combustion. If gas is forced directly into the atmosphere through a small hole, the air required for combustion is drawn into the

jet and the gas burns with a large yellow flame. As the holes in such burners must be small, appliances using them cannot burn gas in large quantities. A gas flame must not be permitted to touch any cold solid surface as this will result in arrested or incomplete combustion, the deposit of soot and the formation of carbon monoxide.

Blue flame or Bunsen type burners are provided with an external mixer in which a portion of the air (about 2 cu. ft. per cubic foot of gas) is mixed with the gas previous to ignition. This is called primary air. The flame issuing from the port of the burner has two distinct parts: a pale blue inner cone and a darker cone surrounding it. The heat of the flame issuing from the burner port draws currents of air past the flame and into it in sufficient quantity to cause complete combustion. This is known as secondary air. The flame should sit squarely on the port and should not have a yellow tip. A yellow tip indicates insufficient primary air, and is corrected by opening the adjustable air shutter.

It should be noted here that the proportions of the orifice at the entrance to the burner tube, and the proportions of the burner ports must suit the heat content of the gas being burned. A burner proportioned for natural gas is not suitable for water gas or coal gas, which are much bulkier in relation to their heat contents.

Table 83 shows the heat values of a cubic foot of gas and air mixture, the gas being mixed with the amount of air theoretically required to burn it. In practice excess air must be admitted to the fire in order to insure complete combustion.

TABLE 83. VOLUME OF AIR REQUIRED FOR COMBUSTION OF DIFFERENT GASES*

GAS	B.T.U. PER CUBIC FOOT	CU. FT. AIR TO BURN CU. FT. GAS	B.T.U. PER CU. FT. OF MIXTURE
Natural Gas	1084	10.27	96.2
Coal Gas—Rich	580	5.21	93.4
Coal Gas—Lean	510	4.43	93.9
Carburetted Water Gas	575	5.02	95.5

*Thomas King. *American Gas Journal*, October 22, 1921.

HEAT VALUE AND EFFICIENCY

A gas may be said to have two heat values; a gross or *higher* heat value and a net or *lower* heat value. The lower heat value is obtained by subtracting from the higher heat value the latent heat of vaporization of the water formed by the combustion of the gas, amounting to about 10 per cent of the higher heat value. Since it is very rarely that the heat of vaporization can be recovered and usefully applied, the efficiency of a gas burning appliance should be based on the higher heat value. When comparing guarantees of efficiency, care should be taken to understand whether the guarantee is based on the higher or lower heat value.

For example.—Take an hypothetical gas having a gross heat value of 550 B.t.u. per cu. ft. and a net heat value of 500 B.t.u. per cu. ft., burned in a steam boiler giving an evaporation of 465 lb. of water (from and at 212 deg.) per 1000 cu. ft. of gas burned:

$$\text{Efficiency} = \frac{\text{B.t.u. in steam}}{\text{B.t.u. in gas}} \times 100 = \frac{465 \times 970.4}{\text{cu. ft.} \times \text{heat value}} \times 100$$

$$\text{With Gross Value Efficiency} = \frac{451{,}235}{550{,}000} \times 100 = 82.04 \text{ per cent}$$

$$\text{With Net Value Efficiency} = \frac{451{,}235}{500{,}000} \times 100 = 90.25 \text{ per cent}$$

It will be noted from the example cited that when the efficiency is based on the net or lower heat value, the appliance apparently absorbs 8.21 per cent more of the heat supplied to it than when the efficiency is based on the gross heat value. This is a false conclusion as it is not possible to recover the heat represented by this difference in percentage unless the products of combustion are cooled below 212 deg.

The following Table 84 shows the maximum possible efficiencies obtainable when burning a typical manufactured gas with various stack temperatures. These are based on the gross heat value and do not include any

TABLE 84. PRODUCTS OF COMBUSTION AND EFFICIENCIES WITH TYPICAL MANUFACTURED GAS

Stack Temperature (deg. fahr.)	220	235	250	265	280
Heat in Dry Flue Gas above 60° (%)	3.25	3.57	3.90	4.14	4.28
Heat in Water Vapor above 60° (%)	9.95	10.03	10.10	10.16	10.22
Heat absorbed by Boiler or Efficiency (%)	86.80	86.40	86.00	85.70	85.50
	100.00	100.00	100.00	100.00	100.00

Flue Gas Analysis

CO_2 8.04% O_2 5.86% N_2 86.10%

correction for radiation from the boiler covering. Radiation would reduce these efficiencies from 2 to 10 per cent depending on the insulating properties of the covering. The gas is assumed to be burned with 35 per cent excess air and has the following composition:

CO	8.6 per cent	
H_2	52.5 " "	
CH_4	31.6 " "	
C_2H_4	1.1 " "	Heat value per cubic foot at 60 deg. fahr.
C_6H_6	1.1 " "	and 30 in. hg., 580 B.t.u.
O_2	0.1 " "	Specific gravity 0.418 (air = 1)
CO_2	1.5 " "	Air Temperature 60 deg. fahr.
N_2	3.5 " "	Atmospheric moisture neglected.
	100.0	

TYPES OF GAS HEATERS

Luminous Flame Reflector Heaters diffuse a large part of their heat by virtue of the radiating power of the bright yellow flame. They are usually backed by a polished copper sheet which reflects radiant heat into the room. The flame must never be so long that it strikes any part of the heater.

Radiant Heaters have a blue flame which heats refractory "radiants" or "glowers" to incandescence. Radiant heaters are quite sensitive to

changes in gas pressure. The radiants should not glow more than two thirds of their height if operation is to be safe from carbon monoxide gas and in no case should flame issue from tops of the radiants. These heaters operate best if the gas pressure at the orifice is left constant, regulation being secured by an adjustment at the orifice and not by a cock in the gas line.

Gas Logs have a very poor efficiency if they are placed in a vented fire place, as the radiating power of a blue flame is low and most of the heat goes up the flue.

Tubular and Cylindrical Radiators give off their heat by radiation from black sheet iron covers, similar to old style coal stoves. They are also made in the shape of a steam radiator, either cast iron or pressed steel being used.

Floor Furnaces heat by convection, being placed directly beneath floors and heating the room above by the currents of air set up through the heater. They discharge products of combustion into the heated room.

Gas-Fired Steam Radiators permit local heating with close automatic control, without the extremely intense heat that is present when the gas gives up its heat directly to the radiating surface.

VENTING

It is always safest to vent individual room heaters to an unobstructed chimney. Then no danger can arise from the flame flashing back into the mixer due to low pressure, or from a sudden increase of pressure above that for which the appliance is adjusted. If the gas pressure is certain and constant and if the burner adjustment is correct such appliances are often vented into ventilated rooms and are considered reasonably safe. In no case, however, should unvented heaters be used in sleeping rooms.

CENTRAL HEATING PLANTS

Individual room heaters are suitable only for taking the chill off in mild weather; or, in the case of a house heated with a coal boiler or furnace, for warming up a room quickly, while the more sluggish coal burning appliance is getting under way. Central heating with gas offers the opportunity to secure uniform temperature throughout the house and instant response to the wishes of the owner, without a multiplicity of controls and vents.

Gas can be burned efficiently in hot air furnaces designed for the purpose. The principal requirements in the design of such furnaces are: a path for the hot gas that can be traversed with very little draft loss, thus permitting maintenance of sufficient draft with a low flue gas temperature; and sufficient surface to insure the transmission of most of the heat by direct contact with the hot gases, as a gas flame gives off very little radiant heat.

The heating surface can be placed very close to the burner as combustion is complete within a short distance from the burner. The use of gas in a coal furnace is unsatisfactory at best.

INSULATION AND CONTROLS IMPORTANT

Gas-fired boilers, designed for gas, give very high efficiencies, 80 per cent (based on gross heat value) being readily obtainable. A properly designed boiler should operate noiselessly at full rating and with a flue gas temperature not over 50 deg. higher than steam. Gas boilers can be applied to any type of steam or hot water heating system and will give satisfactory service when properly proportioned to the load. To obtain fully the benefits to be realized from the inherent efficiency of the gas boiler, certain precautions should be observed. Chief among these precautions are insulation and controls.

A boiler should be thoroughly insulated by a non-conducting fireproof material. A gas pressure regulator should be provided and adjusted to hold at the burners the expected minimum service pressure and the burners adjusted to operate at this pressure. A gas valve, operated either by steam pressure or by a thermostat placed in the house, or by both, should be installed. Another requisite for steam jobs is a low water cut-off that will cut-off the gas supply in case the water in the boiler becomes dangerously low. Flues should be provided with some sort of a draft check. This serves the double purpose of keeping the chimney draft low so that the heat lost to the stack will not be excessive and of preventing the pilot flame from being blown out due to back drafts. The pilot flame should be certain in operation and so placed that it will not be blown out by the slight "pop" that often occurs when the main burners go out.

On account of their small heat storage capacity, gas boilers are particularly adaptable to those steam heating systems operating at extremely low pressures; the so-called "vapor" type. The small heat storage capacity and ability for quick steaming insure instant response to the sensitive steam pressure regulators.

RATINGS

Gas appliance manufacturers have followed the custom established by coal appliance manufacturers in rating their product in terms of cubic feet of warm air and square feet of steam or water radiation. The capacity of a gas furnace or boiler is subject to smaller fluctuations than a boiler employing solid fuel and the element of length of firing period does not enter into consideration. Gas appliance manufacturers rate their boilers in terms comparable with the usual 8-hour rating of coal boilers. In other words, where a 2400 sq. ft. coal boiler would be chosen, a 2400 sq. ft. gas boiler would generally be appropriate.

It is common practice for gas boiler manufacturers also to rate their boilers in terms of *Available B.t.u. per hour*. To use this rating the calculated heat loss from the building is increased by the usual percentage allowed for piping losses and the appropriate boiler chosen.

A gas furnace or boiler will show essentially the same capacity of efficiency with any gas fuel, provided steps are taken to furnish burner

equipment and air regulation appropriate to the fuel burned. Most manufactured gases, although of lower heating value than natural gases, if burned in sufficient volume will produce equivalent results. The heating value of a mixture of gas and air (air just sufficient to burn the gas completely) is almost the same for any typical commercial gas, as is shown in Table 83.

FUEL REQUIREMENTS FOR GAS HEATING

It is a fact, based upon observation, that the user of a gas-fired central heating appliance uses more heat during the course of a year than he does when depending upon solid fuel. The extreme ease of starting and operating a gas burning appliance leads to the pilot light being lighted on the first cool day of the season. Thereafter, the system generally operates entirely under thermostatic control and is left in operation on many days when very little heat is required to keep the inside temperature at 70 to 72 deg.; days when it would be impracticable to keep a coal fire going. On many cold days, the gas unit is kept operating continuously at maximum capacity so that the premises are never permitted to cool below the temperature ordinarily maintained.

Table 85 gives an approximate idea of the fuel requirements in various climates.

TABLE 85. FUEL REQUIREMENTS FOR RESIDENTIAL BUILDINGS FOR DIFFERENT OUTSIDE TEMPERATURES

*Gas of 500 B.t.u. (Gross) per cu. ft.**

TYPE OF SYSTEM	CU. FT. PER SQUARE FOOT OF RADIATION AVERAGE OUTSIDE TEMPERATURE, OCTOBER 1 TO MAY 1						
	25°	30°	35°	40°	45°	50°	55°
Water	850	775	700	625	550	475	400
Vapor	1080	985	890	795	700	605	510
Steam	1380	1260	1140	1020	900	780	650

The figures are based on maintaining a temperature of 70 deg. fahr. over practically the entire house, or 15-hr. per day.

*(Requirements for gases of other heating values vary inversely as the heating value; e.g., for natural gas of 1000 B.t.u., consumption per sq. ft. is one-half that shown in table.)

The requirements of individual installations may vary considerably from an average of several. Generally stores, offices, factories, and other commercial buildings require less heat per season than do residential buildings provided with an equal amount of radiation.

WASTE FROM USING GAS IN COAL-BURNING APPARATUS

In coal furnaces or boilers, the path traveled by the hot gases is relatively short and the surface with which they come in contact is relatively small as compared to gas heating apparatus. A large proportion of the heat in the coal is given off by the incandescent fuel bed as radiant heat. As a gas flame radiates very little heat, the hot products of combustion must come in direct contact with the heating surfaces. For this reason the use of gas in coal-burning appliances is always wasteful and about three times as much gas will be required than if it were burned in a properly designed appliance. The gas-burning appliances have a longer fire travel and more heating surface than those burning coal and can therefore absorb more heat from the hot products of combustion in a given time.

Coal-burning boilers are constructed with large passages for the flue gas so that the draft loss through them can be kept as small as possible, thus permitting most of the chimney draft to be exerted in drawing the air through the fuel bed. When gas is burned under a boiler with such liberal passages, the draft becomes too great and the stack losses become excessive. A boiler designed for gas can have restricted passages for the products of combustion, permitting them to come into very intimate contact with the heating surfaces. The experiences of the gas companies in several large cities with conversions have been such as to discourage their use.

Warm air furnaces, designed for use with manufactured or natural gas, are available in sizes ranging from 5000 to 20,000 cu. ft. rated capacity. House-heating boilers, of the cast iron sectional type, designed especially for gas fuel, are available in single units ranging from 200 to 7500 sq. ft. of equivalent direct radiation.

CROSS-CONNECTING COAL AND GAS BOILERS

Quite frequently, when a customer has already a coal boiler in his home, it is desirable to leave the coal boiler in place, and to cross-connect the gas boiler with it. For small gas companies or any others where there is any possible chance of a shortage or failure of gas, it would seem to be good practice to encourage cross-connecting as the customer would realize very little for a second-hand coal boiler, and it is worth more to him as a safeguard against failure of his gas system than he would realize by selling it. It also produces a more secure feeling in the customer's mind when putting in gas-fired house-heating equipment, if he knows that he can burn coal at any time he has occasion to. There is almost no difference in the cost of an installation, whether it is cross-connected or displaced. Cross-connection also gives the customer a means of disposing of papers, crating and other waste material.

In hot water heating systems, it is necessary to valve off the return pipes on the coal boiler, which prevents circulation through the latter when the gas boiler is in use. Since the gas boiler holds comparatively little water and is almost always insulated, no valves are needed on the return pipes to the gas boiler. Hence, by opening the valves on the coal boiler, it may be operated independently or in conjunction with the gas boiler.

For steam or vapor installation, it is necessary to valve off all of the returns and flows on each boiler unless the gas boiler is set so that the

water-line in both boilers is at the same level, in which case it is necessary to valve off only the coal boiler to prevent the heating of the water in the coal boiler when it is not in use.

The gas boiler should be set as close to the coal boiler as practicable, and the flows and returns should cut into the flows and returns of the coal boiler as near to the latter as possible.

CHAPTER XII

AUTOMATIC HEAT CONTROL

By SAMUEL R. LEWIS, Member

TEMPERATURE regulation is a vital function in the human body. We all carry about with us remarkably effective automatic heat control equipment. In the best functioning of many social and commercial services, automatic temperature regulation is proved to be necessary, not only to comfort and health, but also to the prevention of waste and to the perfection of manufacturing processes.

Temperature control is usually achieved by preventing overheating. It follows that *automatic heat control* is a better term than automatic temperature regulation, and it is obvious that automatic heat control in itself must always effect an economy.

All heating apparatuses must be sufficient in capacity to render acceptable service under the most arduous conditions. The most arduous conditions, especially as to extreme cold outside, are in effect only a small part of the heating season. It may surprise many people to realize that in Chicago, for instance, the most extreme cold prevails only on about six days per year. Hence there is ample ability and strong probability for overheating during the major part of each heating season unless automatic control of the heating apparatus is provided.

Ventilating systems without automatic heat control give trouble from drafts.

Rooms heated by radiators can be cooled more quickly by opening windows than by shutting radiator valves, so that it is found that great heat waste occurs through open windows and open radiator valves, unless automatic heat control is furnished.

Gas and oil heaters and similar devices using quickly responsive fuels become prohibitively expensive for fuel unless automatic heat control is used.

Service hot-water heaters must have automatic control, not only for economy and satisfaction, but also to prevent scalding the bodies of users.

Thermostats are very simple mechanisms. Almost every physical thing expands or changes under the influence of heat and so can be made into a more or less effective thermostat. Liquids can be compounded which will become gases at any reasonable temperature desired. Metals having different rates of expansion can be harnessed together so as to give a greatly increased thermostatic movement. Common air is an excellent thermostatic medium, and is used extensively.

There are two general divisions into which devices for automatic heat control may be grouped, as follows:

1. The simpler class includes the type in which the thermostats and the valves and dampers which they operate are self-contained without any outside power, gaining

sufficient energy from the thermostat itself. This class of apparatus is especially adpated to single installations, as for service hot-water heaters, residence heating, and the like. It is suggested that this kind of thermostat be called the unit type. In present commercial practice most unit type thermostats use the expansive power of a liquid or gas, contained in a hermetically sealed receptacle.

2. The other and more elaborate class of thermostat, Fig. 60, includes the type of thermostat which controls air or liquid or electricity already under pressure, and which by controlling this outside power, operates the dampers or valves against springs or weights and similar opposition which will reverse conditions when the outside power is shut-off. There is practically no limit to the power which can be applied in this manner.

It is suggested that this kind of thermostat be called the pilot type. In present commercial practice, pilot type thermostats are used for large buildings, where many thermostats are required, usually with air at about 15 lb. pressure, from an electric or steam compressor.

Compressed air is a very reliable agent, capable of great flexibility and elaboration of control, and is of considerable corollary use for remote

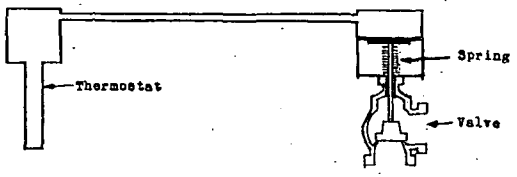


FIG. 60. EXAMPLE OF UNIT TYPE THERMOSTAT

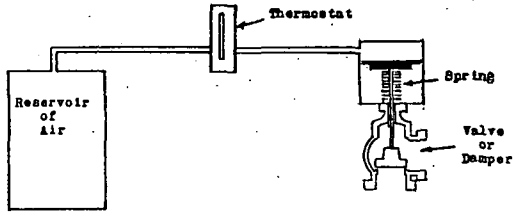


FIG. 61. EXAMPLE OF THERMOSTAT USING OUTSIDE POWER

Note.—When thermostat opens, air passes from reservoir and closes valve. When thermostat closes, air between thermostat and valve is released and spring opens valve.

operation manually of distant dampers and valves. Pilot type thermostats are used to operate electric switches, the current then passing to electric motors or to magnets which move the dampers and valves. Electricity is so flexible and adaptable that very complicated and elaborate interlocked functions are possible.

Pilot type thermostats are also used to operate valves on pipes from water supply mains, thus using hydraulic power for moving valves and dampers. Owing to silting up of pipes which have sluggish currents and to corrosion, this method is not always to be advised.

APPLICATIONS OF AUTOMATIC HEAT CONTROL

New uses and styles are developed daily. Some of the applications will be listed which are believed to be approved methods of installation.

Tempering Heaters

The tempering heaters, particularly if they are of copper with extended surfaces, and there is a two-pipe vacuum system of steam circulation having a vacuum pump, should be a separate outer layer of radiation capable of heating the air from the coldest temperature likely to be encountered to a temperature above freezing. This outer layer should be controlled by an outside thermostat set to shut off steam when the outside temperature reaches around 34 deg., and to keep steam turned on when the outside temperature is cooler than 34 deg. There should be an additional layer of tempering heater, controlled by an additional thermostat in the duct beyond the fan, where mixing of the strata of air has been accomplished by the fan. This thermostat should be set to control the temperature at the desired degree for cooling the building, such as will give an average temperature at the delivery opening of say 65 deg., or if this causes drafts, at a slightly higher temperature.

If there is no vacuum system of steam circulation, it is decidedly likely that any attempt to control the temperature by opening and closing steam and return valves will result unfavorably, due to freezing of the radiation and sudden temperature fluctuations in the rooms, as tempering heaters are immediately responsive and flash hot or freeze solid with great rapidity. Where no vacuum system is available it will be wiser to control the tempering heaters by means of dampers, preferably of the interlocked double type operating in a slow or intermediate manner and reducing positively the air volume through the heaters as they increase the air volume through the by-pass around the heaters. Under this condition no diaphragm valves will be placed on the tempering heater supply and return connections.

Air Washers

The air washer should invariably be placed between an outer tempering heater capable of warming the air above a freezing temperature, preferably controlled by an outside thermostat, and an inner tempering heater capable of warming the conditioned air to the desired delivery temperature and controlled by a thermostat in the duct beyond the fan. It is never permissible to use a by-pass damper around a tempering heater in front of an air washer.

Control of humidity is possible by adjustment of the temperature of the air as it meets the water, and in greater refinement, by control with an additional thermostat, of the water temperature, cooler for lower relative humidity, possibly from a refrigerated supply; and warmer for a higher relative humidity, possibly from a heated supply.

Room Temperatures

The room temperatures are controlled by individual thermostats, operating valves on the radiators and mixing dampers in the flues, as may be necessary. If a vacuum system of steam circulation is installed,

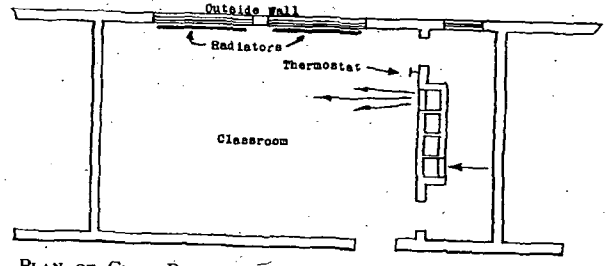


FIG. 62. PLAN OF CLASS-ROOM IN AN ELEMENTARY SCHOOL, SHOWING LOCATION OF THERMOSTAT

the room thermostats should be intermediate or slow moving, while if steam circulation is by single pipe or any kind of gravity system, the radiator valves should be operated quickly from full open to full closed. It is important that the mixing dampers in any case shall be moved slowly and held in intermediate positions.

If there is any room which has a separate supply fan and heating equipment, such as an auditorium or gymnasium heated by warm air and without radiation, as is often convenient and desirable, it is advisable to provide against cold drafts by a variation in the above arrangement, as follows:

Suppose that there is a fan drawing through a heater composed of five layers, and delivering air directly to an auditorium, or to a picture theatre. The thermostat in the room ordinarily will strive to keep the room cool. If there are many occupants and many artificial lights, the problem will be to keep cool rather than warm, and the room thermostat, in a temperature above that at which it is set to operate, will ordinarily shut-off all heat, while the fan will deliver unheated air. In a room at 80 deg. the admission of air colder than about 70 deg. (depending on the point of entry) will cause discomfort from drafts.

The prevention of this unfortunate situation is achieved by installing two thermostats, one in the room and one in the air duct, the room thermostat serving merely to admit air to the duct thermostat. When the room is cool, both thermostats will be closed and warm air will enter. When the room temperature gets to the critical point of the room thermostat, the room thermostat opens, passing air to the duct thermostat. The duct thermostat may be set to permit this air to pass on by and to function

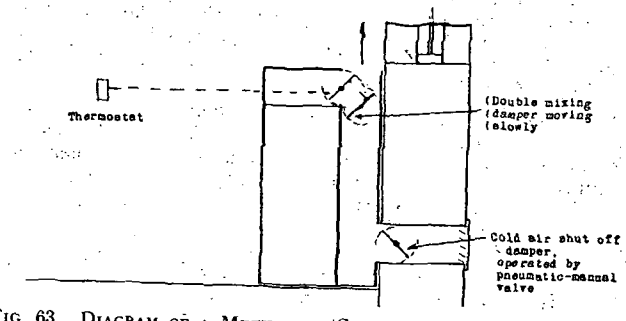


FIG. 63. DIAGRAM OF A METHOD OF CONTROL FOR A UNIT VENTILATOR

at the heater to reduce the temperature, but will be set so that when the duct temperature lowers to the critical point of the duct thermostat, the latter takes control and prevents the entering air from getting so cool as to cause drafts.

Unit Ventilating Systems

These individual fan-radiator units are usually equipped with highly efficient radiators in one section, having one supply and one return valve, and depend on nicely adjusted dampers for mixing the heated air with unheated air to gain a desirable admission temperature. It is usually not wise to operate the steam supply valves with thermostats, since freezing may occur, and it is usually not practicable to install in these units separate tempering heaters with separate automatic control. The approved procedure is to use an intermediate or slow acting room thermostat for operating the mixing dampers in the unit. This thermostat may also operate the radiator valves if a vacuum system of steam circulation is provided. If the steam circulation is single pipe, or any kind of gravity type, the direct radiators should have positive thermostats.

The fresh air intakes to the units should be closed when the building is unoccupied, and the human operator cannot be trusted, especially in an installation comprising many units, to do this by manual means at each unit. An excellent recourse is to handle these cold air intake dampers by a compressed air line running from the control point, say in the boiler room, which by manual opening of a valve permits air to pass to all of the units and to open all of the inlet dampers, the arrangement being such that the dampers will always be held shut by springs or weights when no air is permitted to pass or when the air compressor is shut down.

***Direct-Indirect* Radiators**

Direct-indirect radiators are usually housed in, having cold air inlets at their bases, and give rather a make-shift type of ventilation. It is not practicable usually to install mixing dampers, such as are used with fan-units, in these, and since the heating surface is in a single radiator calculated for the coldest air inlet temperature, regulation is difficult. The best results are obtained, where the use of direct-indirect radiators is necessary, by installing slow acting thermostats on special brackets directly above the radiators where the thermostat will be exposed to the air currents from the outside, and arranging for these to receive air only through additional thermostats placed in the room and controlling the direct radiators. There should be a vacuum system of steam circulation, and the thermostats should be of slow or intermediate acting type, operating on the supply valves to the radiators.

Hot-Water Radiators

Hot-water radiators lend themselves to automatic heat control, especially where the circulation of water is of the forced type, but as the radiators heat and cool rather slowly, there will be some temperature fluctuation or range at the thermostat, especially when the radiator surface is excessive in amount. It is wise to use supply valves which will close tightly and to place lock-shield valves on the return ends of

radiators, to facilitate repairs, and the lock-shield valves may prove invaluable in equalizing with great nicety the circulation.

In residence heating with hot-water it often suffices to install a general thermostat in some representative room, which controls the draft, as with coal, or which controls the fire, as with gas or oil, but there should always be furnished in addition a thermostat in the water or circulating medium which will reinforce the general thermostat and which will prevent boiling over in case the latter should be subjected to unfair exposure such as an open window.

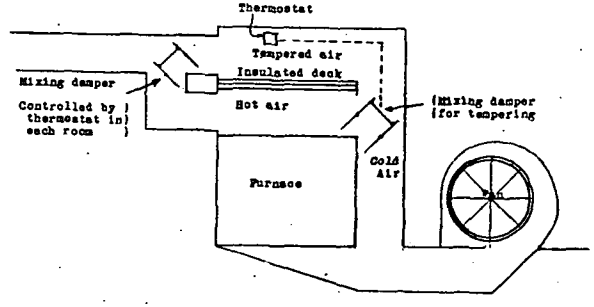


FIG. 64. AN ARRANGEMENT FOR TEMPERED AIR WITH WARM AIR FURNACES

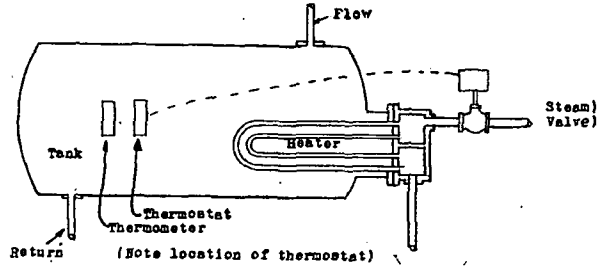


FIG. 65. STEAM HEATED SERVICE WATER HEATER

Warm-Air Heating

With warm-air heating from furnaces, with fans, as in public buildings, it is always necessary to provide a supply of tempered air for cooling after the rooms become warm. A duct thermostat and dampers easily and positively will accomplish this, either by mixing some cold air with heated air from the furnaces in an intermediate chamber, or by injecting some hot air from the furnaces into the cold air at the fan inlet, recirculating a measured and controlled part of the air around the furnaces. The room temperatures are controlled by intermediate thermostats and double mixing dampers the same as for a steam system.

Warm-air heating for residences may be controlled by a general thermostat in a representative room, and again, as with hot water, an additional thermostat at the furnace in the warm air chamber is desirable to reinforce the general thermostat.

Service Hot-Water Heating

It is safe to say that no service hot-water heater should ever be installed without automatic heat control. A unit type thermostat is most desirable, since it will function whether or not the general mechanical apparatus is in service, and will control steam and return valves or draft dampers, oil or gas fires, or electric heaters.

In hotels, hospitals and similar institutions, there should always be at least two independent water heaters, one having very hot water for

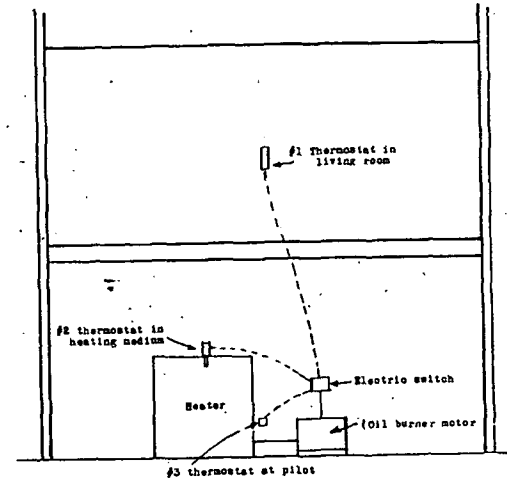


FIG. 66. TYPICAL ARRANGEMENT FOR OIL BURNER

kitchen uses, the other having water of medium temperature for bath and lavatory purposes, both controlled automatically. Thermostatic anti-scalding devices are available for showers and the like, but these will not prevent the great heat waste due to maintenance of scalding temperatures for bath water. No kitchen administration is satisfied without very hot water, but this demand is intermittent and small in volume as compared with usual bath and lavatory demands.

Oil Burner Control

No oil burning apparatus, unless provided with automatic heat control, can compete in operating cost with coal. An approved method for residence heating with oil is to install the following combination:

1. A general thermostat in a representative room, controlling the electric supply to the burner motor.

2. An additional thermostat in the boiler or furnace which will take control should No. 1 thermostat fail to prevent improper or unsafe temperature being maintained inside the heater.

3. An additional thermostat at the gas pilot which, unless kept warm by the pilot flame, will bring about the opening of the main switch to the burner motor, thus insuring that no fuel shall be injected unless a flame is in being surely to ignite it.

There are many other combinations for giving assured protection with oil burners other than thermostatic devices, such as pressure and weight-actuated mechanisms, but it is doubtful whether they are as reliable as the thermostatically controlled schemes.

Where electric ignition for the intermittent oil spray is used, it is safer to provide for a continuously operating spark, and to have a thermostat in the heater which will cut out the main switch if the temperature ever gets lower than the critical point which indicates failure to ignite the spray.

Gas Burner Control

The same high intensity as with oil fuel makes it necessary to depend on thermostats to prevent waste, and the intermittent operation and necessity for a pilot flame makes it wise to install for gas the same combination of three thermostats as for oil burners, one on the general service, one in the heater and one on the pilot flame.

DOUBLE THERMOSTATIC CONTROL

Nearly all buildings equipped with a large number of thermostats and using compressed air for power, are occupied only part of each 24 hours, and can without any prejudice be kept at a lower temperature during unoccupied periods, as over night or over a holiday. The conventional thermostats as ordinarily applied militate against this arbitrary reduction, and each instrument would have to be adjusted each time for the lower degree, and then each would have to be restored following the unoccupied period. Equipment is available which provides two temperature adjustments to each instrument, such that if the general air pressure leading from the central compressor to the thermostat is suddenly changed, the service is switched automatically from one control to the other, and if the pressure again shall be suddenly changed, the service will be switched back. Thus at 6 o'clock P. M., say, the engineer of an office building releases the air pressure for an instant and all of the thermostats are switched from the 68 deg. control to the 45 deg. control. Either control, of course, is set for any temperature desired. At say 7 o'clock the following morning, a repetition of the drop in air pressure will restore to service the 68 deg. temperature.

In a school building the compressed air supply mains may be grouped so that parts of the building used for night school only remain on the 68 deg. service, while others can be thrown over to the alternate service and kept much cooler until again required for occupancy.

A familiar scheme similar to the foregoing, with a cooler temperature automatically maintained during the night and increased early in the morning is in use, with the switch operated by a clock, for residence work.

Central Station Heating

Central plants should always be governed by thermostats as a measure of economy, and many public service companies require the installation of automatic heat control for this reason. Where economy is of greater consideration than comfort, it often suffices to install one unit type thermostat in a representative room, this controlling a main valve at the entrance to the building.

Where steam at appreciable pressure is furnished from a central station, a combination of pressure reducing valve and cut-off valve, controlled by a thermostat in a representative room, gives excellent results, as it automatically varies the steam pressure in the radiating surface within a considerable range, giving excellent regulation as well as economy.

Automobile Engine Control

The importance of thermostatic regulation of the cylinder temperature of internal combustion engines has long been recognized, but until comparatively recent developments in the production of thermostats, has been ignored in practice.

Now the majority of automobiles are provided with thermostats in the cooling medium controlling the volume of air passing the radiator by means of shutters. Several widely advertised and highly developed makes have thermostatic control of valves in the circulating medium.

AUTOMATIC HEAT CONTROL IN INDUSTRY

Automatic control of heat in manufacturing processes is believed to be still in its infancy. The promotion and development of automatic heat control was hard pioneering for many years. The reward for this pioneering seems to be in process of realization in the fabulous uses of thermostats in industry.

Without automatic heat control in innumerable manufacturing processes, what now are sure and perfect reactions would be only occasional successes, and the cost of production would be much higher.

In beet sugar making there are at least eleven processes where exact thermostatic control is imperative. In tanning leather there are at least fourteen such stages.

Without exact temperature and humidity control, no fine printing is possible, and no good weaving or dyeing is assured.

In the preparation of most food products automatic heat control is vital.

Thermostats prevent scorching in clothes dryers. They reduce evaporation and are a safety device for oil storage tanks.

They are essential to control gelatine temperature in making photographic films. They are used to control paraffin vats in making waxed paper, milk containers, etc.

They control baking ovens, no matter how the ovens are heated. A thermostat is a necessary equipment with each automatic refrigerating machine.

CHAPTER XIII

INSULATION

By L. B. McMILLAN, Member

THE determination as to whether or not pipes and other heated surfaces should be insulated is based on the magnitude of the losses from such surfaces if they were allowed to remain bare. Fig. 67 shows the rate of bare surface losses under still air conditions in B.t.u. per square foot per degree temperature difference per hour (Curve 1, TRANS. A. S. H. & V. E., Vol. 26, p. 368) and the total losses in pounds

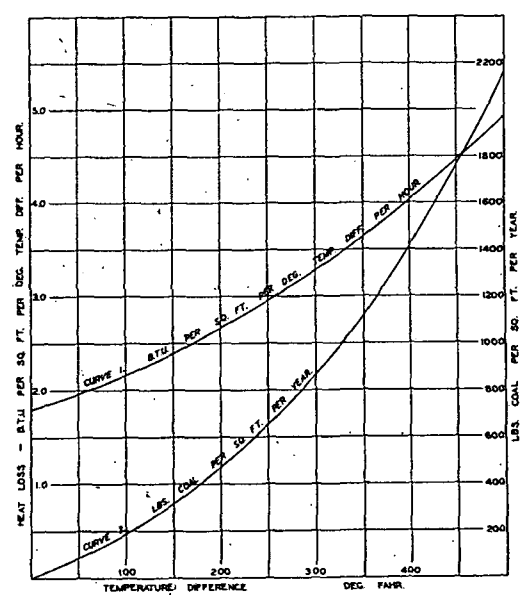


FIG. 67. HEAT LOSSES FROM BARE SURFACES

of coal per year (Curve 2). The latter is based on 10,000 B.t.u. available per pound of coal and 8760 hours per year. Where surfaces are not heated for entire year, losses for actual period of operation may readily be obtained by multiplying values taken from Curve 2 by the appropriate proportion. This also applies to the losses in dollars per year shown in Fig. 68.

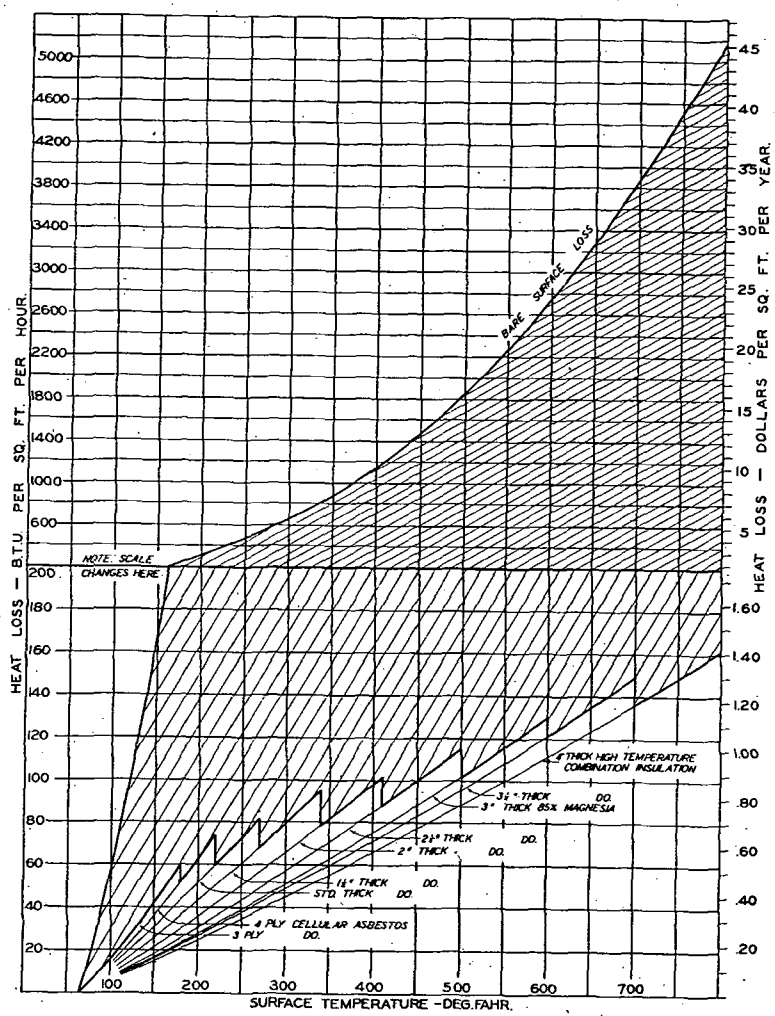


FIG. 68. LOSSES FROM APPROPRIATELY INSULATED SURFACES AS COMPARED WITH LOSSES FROM BARE SURFACES

Note.—The scale showing Dollars loss per sq. ft. per year is based on a unit cost of $1.00 per 1,000,000 B.t.u. *The actual cost is usually less than this* where heat is derived directly from burning coal or oil, but may be greater where illuminating gas or electricity is the source of heat. However, the use of $1.00 as the unit greatly simplifies the use of the chart in connection with any cost per 1,000,000 available B.t.u. All that is necessary is to multiply the values from the chart by the *ratio of the actual cost to $1.00*. For example, if the cost of heat is $.50 per 1,000,000 B.t.u., multiply values from the chart in dollars by 0.5, etc.

HEAT LOSSES FROM INSULATED SURFACES

Fig. 68 shows the losses from appropriately insulated surfaces compared with losses from bare surfaces. It will be noted that it was necessary to plot the upper part of the bare surface curve to a greatly reduced scale in order to show it on the same sheet with the curves for losses through insulation. Therefore, for a true measure of the relative losses from bare and insulated surfaces, compare the numerical value of the ordinates of the curves rather than the apparent spaces between the curves on the chart.

The chart, Fig. 68, is based on still air conditions, room temperature of 70 deg. fahr., and 5 in. pipe size. The effect of pipe size on losses through insulations of various thicknesses is shown in Fig. 69. (TRANS. A. S. H. & V. E., Vol. 26, p. 375).

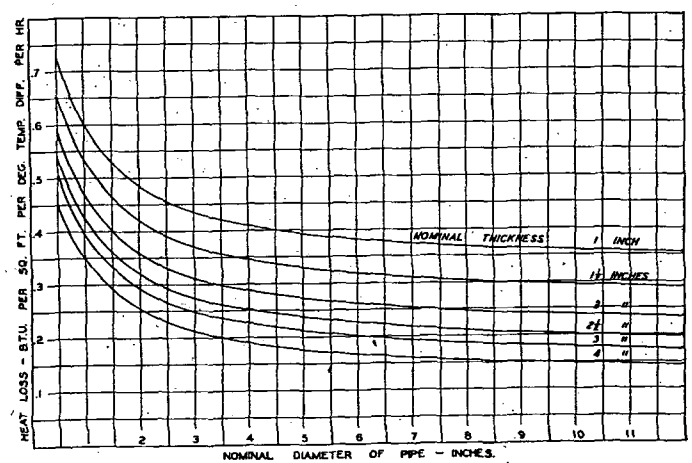


FIG. 69. VARIATION WITH PIPE SIZE OF RATE OF HEAT TRANSMISSION THROUGH A GIVEN THICKNESS OF INSULATION

For equations by means of which heat losses may be calculated for any thickness of insulation on any pipe size see TRANS. A. S. H. & V. E., Vol. 26, p. 360. Refer also to Manufacturers' Data for heat losses and efficiencies of different insulations on various sizes of pipes.

RADIATING SURFACE OF PIPES

In order to determine heat losses per linear foot of pipe from known losses per square foot, it is necessary to know the number of square feet area per linear foot of pipe. Table 86 gives these areas for various standard pipe sizes.

CONDUCTIVITIES OF INSULATING MATERIALS

The conductivities, in B.t.u. per square foot per hour per inch thick per degree fahr. temperature difference, of various insulating materials are given in Table 87. It should be emphasized that in this table all variables due to differences in thickness, different pipe sizes, and different air conditions, are eliminated.

TABLE 86. RADIATING SURFACE PER LINEAR FOOT OF PIPE

Pipe Size In.	Surface Sq. Ft.	Pipe Size In.	Surface Sq. Ft.	Pipe Size In.	Surface Sq. Ft.
½	0.22	2	0.622	5	1.456
¾	0.275	2½	0.753	6	1.734
1	0.344	3	0.917	8	2.257
1¼	0.435	3½	1.047	10	2.817
1½	0.498	4	1.178	12	3.338

TABLE 87. CONDUCTIVITIES OF VARIOUS INSULATING MATERIALS

	Conductivity	Temp. Diff. at which Conductivity was Determined Deg. Fahr.	Authority	Year
Asbestos-Sponge Felted	0.468	300	*Trans. A. S. M. E.*, Vol. 37, p. 968	1915
Wool Felt	0.521	300	"	1915
85% Magnesia	0.54	300	*Trans. A. S. M. E.*, Vol. 40, p. 667	1918
Carocel	0.54	300	*Trans. A. S. M. E.*, Vol. 37, p. 968	1915
Nonpareil H. P.	0.543	300	"	1915
Plastic, 85% Magnesia	0.587	300	"	1915
Asbestocel	0.596	300	"	1915
Expanded Asbestos	0.598	300	"	1915
Indented	0.656	300	"	1915
Molded Asbestos	0.778	300	"	1915
Air Cell	0.802	300	"	1915
Vitribestos	1.087	300	"	1915
Asbestos Fire Belt	1.093	300	"	1915
Corkboard	0.304	36	TRANS. A. S. H. & V. E., Vol. 26, p. 406	1920
Hair Felt	0.246	36	"	1920

TABLE 88. PROPER THICKNESS OF INSULATIONS FOR MAXIMUM NET SAVING

Steam Pressures (Lb. Gage)	Steam Temperatures (Deg. Fahr.)	Thickness of Insulation		
		Pipe larger than 4 in.	Pipes 2 in. to 4 in.	Pipes ½ in. to 1½ in.
0 to 25	212 to 267	1 in.	1 in.	1 in.
25 to 100	267 to 338	1½ in.	1 in.	1 in.
100 to 200	338 to 388	2 in.	1½ in.	1 in.
Higher Pressure or Superheat	388 to 500	2½ in.	2 in.	1½ in.
Higher Pressure or Superheat	500 to 600	3 in.	2½ in.	2 in.

ECONOMICAL THICKNESS OF INSULATION

Table 88 (TRANS. A. S. H. & V. E., Vol. 26, p. 377) shows the thicknesses of insulation which will give most economical results under average conditions.

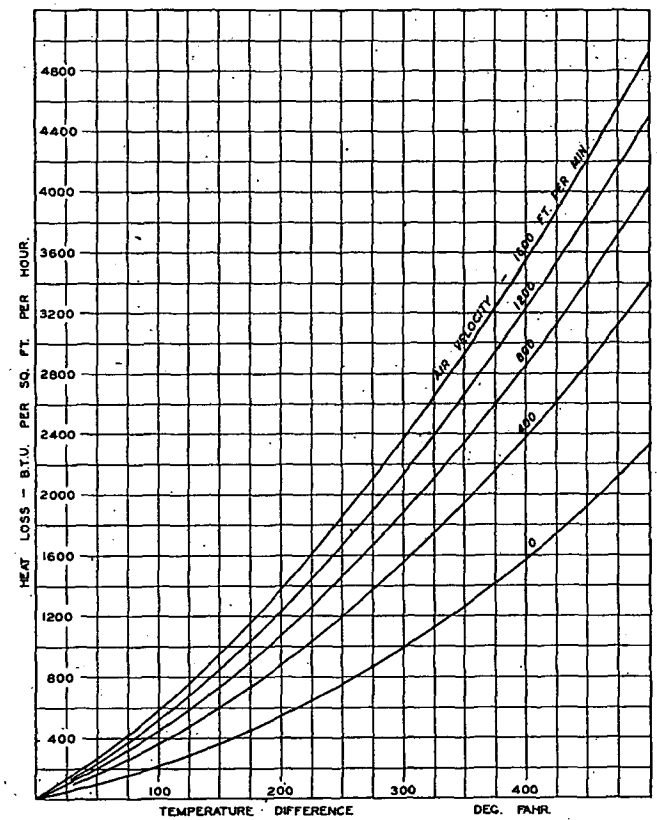


FIG. 70. HEAT LOSSES FROM SURFACES EXPOSED TO VARIOUS AIR VELOCITIES

EFFECT OF AIR VELOCITY ON SURFACE LOSSES

The rate of heat loss from a surface maintained at constant temperature is greatly increased by air circulation over the surface. Fig. 70 (*Iron & Steel Engineer*, July, 1925), is based on Langmuir's equations (*Trans. Am. Electro Chem. Soc.*, Vol. 23). Other investigators have shown even greater increases in rates of heat loss from bare surfaces due to air velocity.

EFFECT OF AIR VELOCITY ON LOSSES FROM INSULATED SURFACES

In the case of well-insulated surfaces the increases in losses due to air velocity are very small as compared with increases shown above for bare surfaces, because of the fact that air flowing over the surface of the insulation can increase only the rate of heat transfer from surface to air, and cannot change the internal resistance to heat flow inherent in the insulation itself. The maximum increase in heat loss due to air velocity ranges from about 30 per cent in the case of 1 in. thick insulation, to about 10 per cent in the case of 3 in. thick insulation, provided that the insulation is thoroughly sealed so that air can flow only over the surface. If the conditions are such that the air may circulate through cracks and crevasses in the insulation, the increases may be far greater than those given above. Therefore, it is essential that insulation be sealed as tightly as possible. Pipe insulation out of doors should be provided with a weatherproof jacket, and other outdoor insulation should be thoroughly weatherproofed.

HEATING CONDUITS

When steam pipes are run between buildings they should be placed in some form of waterproof conduit which will withstand earth loads and take care of the expansion and contraction of the piping without strain or stress on the couplings, and without affecting the insulation or conduit. Expansion of the piping must be carefully controlled by means of anchors and expansion joints or bends so that the pipes can never come in contact with the conduit. The anchors used are usually U-shaped steel straps which partially encircle the pipes and are firmly bolted to a short length of structural steel set in concrete.

TEN IMPORTANT POINTS ABOUT INSTALLATION

In laying out conduits of this type the following points should be borne in mind:

1. The conduit should be laid out in successive straight runs between manholes or anchor pits.

2. An anchor should be placed wherever the line changes direction.

3. An expansion joint or bend must be placed between each two anchors.

4. Manholes should be provided at each expansion joint. Where slip joints are used manholes should be vented.

5. Branches should be taken off at or near an anchor.

6. If the distance between buildings is less than 150 ft. and the steam line contains high pressure steam, it may be anchored in the basement of one building and allowed to expand into the basement of the second building. If the steam line contains low pressure steam (up

to 4-lb. pressure), this method may be used if buildings are less than 250 ft. apart.

7. If the distance between buildings is between 150 ft. and 300 ft. and the steam line contains high-pressure steam, the lines should be anchored midway between the buildings and allowed to expand into the basements of both buildings. If the steam line contains low-pressure steam this method may be used if buildings are between 250 ft. and 500 ft. apart. No manhole is required at the anchor, and a blind pit is all that is necessary.

8. For longer lines manholes must be located according to judgment and depending upon the expansion value of the type of expansion joint or bend that is used. The minimum number of manholes will be required when an expansion bend or an anchor with double expansion joint is placed in each manhole, and the pipes are anchored midway between manholes.

9. Stabilizers to maintain alignment of pipes should be placed on each side of each expansion bend.

10. A proper hydrostatic test should be applied to the piping before top of conduit is applied and before application of insulation. The pressure used in this test should be greater than the pressure used in service, and should be not less than 100 lb. per square inch in any case.

STYLES AND CONSTRUCTION OF CONDUITS COMMONLY USED

Filler Type.—The pipes are supported on rollers placed on a steel rod which rests on an iron frame. The frame is set on a concrete or mortar base. The pipes are protected by a split tile conduit, and the entire space between the pipes and the tile is filled with an insulating filler. Thus the pipes are nested and the insulation between them and the tile effectively prevents circulation of air. The conduit is placed on a bed of gravel or crushed rock from 4 to 6 in. thick, which is extended upward so as to come about 2 in. above the parting lines of the tile. A tile underdrain is placed beneath the conduit throughout the entire length and is connected to existing sewers led to some other point of free discharge.

Insulated Tile Type.—The insulating material, which is diatomaceous earth, is molded to the inside of a split tile conduit. The pipes are supported on rollers, which in turn are supported by an iron frame which extends through the conduit and rests on a tile base which also serves as an underdrain. The space between the pipes and the insulating conduit lining may also be filled with an insulating filler. The conduit, insulation, piping and earth load are supported by the base drain. A few inches of gravel or crushed rock are placed about the conduit and the base drain.

Sectional Insulation Type (Tile Conduit).—Each pipe is insulated in the usual way with any desired type of sectional pipe insulation over which is placed a jacket of standard asphalt waterproof roofing with cemented joints. The pipes are enclosed in a split tile conduit which is placed on a bed of crushed rock or gravel from 4 to 6 in. thick. This

gravel bed is extended upward so as to come about 2 in. above the parting lines of the tile. Underdrains are sometimes omitted where this type is used, any water which seeps into the conduit being allowed to flow down the bottom of the conduit to the nearest manhole. Drains are laid from the floor of each manhole to some point of free discharge. The pipes are supported on roller frames and these, according to the type of conduit used, are either supported by the conduit itself or have their lower parts set in concrete thus supporting the pipes independent of the conduit.

Sectional Insulation Type (*Bituminized Fibre Conduit*).—Each pipe is individually insulated and encased in a bituminized fibre conduit. The insulating material is 85 per cent carbonate of magnesia sectional pipe covering, applied in the usual manner as on overhead pipes, except that bands are omitted. After every fifth section of magnesia covering there is applied a short, hollow section of very hard asbestos material in the bottom portion of which rests a grooved-iron plate carrying ball-bearings upon which the pipe rides when expanding or contracting. This short expansion section is of the same outside diameter as the adjacent 85 per cent magnesia covering. Over the pipe covering and expansion device there are placed two layers of bituminized fibre conduit with all joints staggered and the surface of each conduit finished with liquid cement. Conduits are placed on a bed of crushed rock or gravel, approximately 6 in. deep, and this is extended upward to about the center line of the conduit when trench is backfilled. Underdrains leading to points of free discharge are placed in the gravel or crushed rock beds.

Wooden Conduit.—Each pipe is enclosed in a tin-lined wooden casing. Sufficient space is allowed between the pipe and the casing to provide for the insertion of pipe guides or rollers which rest on the bottom of the casing. The casings are bedded in gravel or broken stone and one or more tile underdrains are laid beneath them.

PART II

CHAPTER XIV

VENTILATION

By PERRY WEST, Member

VENTILATION is the science which has to do with the maintenance of such indoor air conditions as are most conducive to proper health and comfort. Practical ventilation results may mean anything from the very best to the very poorest in quality and from the maximum to nothing in quantity. Ventilation perfection is, however, a very definite thing which may be defined as follows:

That atmospheric condition in every part of indoor space occupied by human beings which is continually maintained with a proper amount of oxygen; free from dust, bacteria, objectionable odors, poisonous and other objectionable substances; with suitable air movements and at the temperature and humidity quality shown within the zone of human comfort as defined by the joint research work of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, the United States Bureau of Mines and the United States Bureau of Public Health.

Taking this as the highest aim of ventilation and calling it 100 per cent the other extreme of 0 per cent of ventilation may be defined as follows:

That atmospheric condition in any part of indoor space occupied by human beings where one or more of the above enumerated factors is or are maintained so as to separately or collectively inflict death or permanent injury upon human beings.

Between these two extremes are the wide range of conditions met with in practice.

Good ventilation may be defined as follows:

That percentage of perfection of the above factors which is warranted by the requirements of human health, comfort and efficiency on the one hand and expense and labor to produce these conditions (wherever they do not naturally exist) on the other.

The science of ventilation began its existence with, and is still growing out of, the fact that wherever human beings assemble within an enclosed space the atmosphere within this space will become vitiated, unless proper provisions are made to prevent it. It is the difficulty of determining and applying these proper provisions of prevention that has kept physiologist and ventilating engineers busy for so many years endeavoring to produce anything like satisfactory results.

The commonly accepted usage of the term *vitiated atmosphere* has for a long time continued to designate conditions which cause unpleasant, uncomfortable or unhealthful physiological reactions, but our interpretations of the true causes and meanings of these reactions have undergone many vital changes with the progress of the art and our growth in its knowledge.

In other words the physiological effects of poor ventilation have continued to manifest themselves in much the same way but our knowledge of these manifestations are continually changing.

Among the effects, which have received the greatest amount of study and which are now generally recognized as direct results of poor ventilation, are the following: Drowsiness, headache, loss of physical vitality, feeling of suffocation, temperature discomfort, brain fag, irritation of the membranes of throat, nose and lungs, infection, drying and cracking of and the causing of unnatural discharges from these membranes, disagreeable odors, loss of appetite, nervousness and general nausea.

OLD VENTILATION THEORIES DISCARDED

It is only within the last 20 years that all of these manifestations of poor ventilation have been definitely recognized and our present era of ventilation started. Prior to this time practically all artificial ventilation was attempted on what might be termed a quantity basis. This, on the theory that the carbon dioxide exhaled by persons in an occupied space was the primary cause of such of these manifestations as were then recognized. As a result of this theory it was believed that the all important thing about ventilation was the quantity of air necessary to be brought in from the outside in order to maintain an atmosphere containing not more than ten parts of carbon dioxide per 10,000 parts, by volume, within any properly ventilated space.

This, as the basic theory of artificial ventilation, has long been deposed and discredited among engineers, scientists and physiologists, but there are those who still cling to this theory, either in its original form or in one of its many modifications. When it was first learned that the quantity of carbon dioxide ordinarily found in even poorly ventilated spaces could not, of itself, be entirely responsible for the unsatisfactory conditions met with under such circumstances, the possibility of other causes began to be seriously investigated. There followed a period in which it was believed that some form of poisonous effluvia was exhaled with the human breath and that this was responsible for the vitiation of the atmosphere within spaces occupied by human beings.

Later this idea was disproven and then it was believed that something might be excreted from the pores of the skin or that small particles might be given off from the body or the internal membranes so that the atmosphere became thus contaminated with matter, which upon decomposition formed toxins or poisons to cause the effects noted. This rather fanciful theory was soon discredited, however, and then began the real study of the subject which has finally brought us to the conclusions upon which we are now working.

QUALITY VS. QUANTITY

It may be noted here that the basic idea of ventilation today is quality rather than quantity, or the proper conditioning and distributing of a small quantity of air by efficient compact means rather than the poor conditioning and poor distributing of larger quantities with apparatus too cumbersome and expensive to be kept in operation.

THE PRESENT STATUS OF VENTILATION

The result of all of this has brought us down to the present status of the art where it is no longer felt that the chemical composition of the air is the important factor but that proper ventilation depends more largely upon a number of other factors which may be stated in the order of their importance as follows:

1. Air Supply
2. Air Temperature
3. Air Cleanliness in reference to its freedom from dust and other suspended matter
4. Air Sanitation with reference to its freedom from bacteria
5. Relative Humidity
6. Distribution
7. Air Motion
8. Freedom from odors
9. Freedom from other injurious substances.
10. Freedom from monotony, with reference to noise and too much regularity of indoor conditions

Air supply is still put at the head of the list for the simple reason that while this is no longer considered to be the all important factor in ventilation the amount of air to be supplied per person or the number of air changes to be furnished for any particular space will always be the starting point, for without air supply there can be no artificial ventilation.

The air supply is so vitally effected by the other factors mentioned that it cannot be determined independently and it will be seen that while this item is placed at the head of the list for the reason that it is the natural vehicle upon which the structures is carried, its importance beyond this point becomes subordinate to these other factors.

Air temperature is second for the reason that it has been proven by practically all of the accredited experimenters that over-heating is more detrimental to the quality of ventilation than any other one thing.

Air cleanliness is third for the reason that it has to do with human health both from the standpoint of freedom from dust and other suspended substances, which irritate and clog the air passages, and from the standpoint of freedom from bacteria and other infectious media carried along with these substances which constitute the dirt in air.

Air sanitation is fourth as it also has to do with human health and is correlated with the third item.

Relative humidity is fifth, not because it is of so much less importance than air supply and temperature but because it also bears such an intimate relationship with these two items that it receives a part of its due consideration in their determination. This will be further referred to in connection with air supply and air temperature in connection with which other factors are involved.

Distribution is sixth for a similar reason, for while it occupies a much more important place than this position might indicate, it is so intimately connected with the effective air supply that it receives a part of its consideration therewith.

Air motion is seventh in the same way, as it too receives a certain amount of its consideration in connection with effective temperature.

Freedom from odors is eighth for the reason that while odors may become

quite disagreeable and even nauseating they are seldom dangerous or permanently detrimental to health.

Freedom from other injurious substances is ninth, not because this might not be of more importance but because these substances are met with so seldom in ordinary ventilating practice and must be practically eliminated in any case.

Freedom from monotony is tenth because it has to do with the last refinements and the psychology of ventilation only.

These were the first two steps in the new era of ventilation, *first*—the discovery and admission of our ignorance and *second*—the recognition of these important factors.

The next step was to determine what bearing each of these factors had upon ventilation and to devise some effects in comparable terms.

This work was undertaken by Dr. E. Vernon Hill, who assisted by O. W. Armspach, devised the Synthetic Air Chart which was adopted as the Society's standard in 1920.

The synthetic air chart is a convenient means by which the ventilating engineer can determine the percentage of perfection of ventilation in any occupied space. The percentage of perfection desirable depends upon the purpose for which the room is occupied. Dr. E. Vernon Hill suggests the percentages indicated in Table 89 as minimum requirements.

TABLE 89. DR. E. VERNON HILL'S RECOMMENDED PERCENTAGES OF VENTILATION PERFECTION FOR DIFFERENT CLASSES OF BUILDINGS WHEN TESTED ACCORDING TO THE SYNTHETIC AIR CHART

SCHOOLS	NEW BUILDINGS PER CENT	EXISTING BUILDINGS PER CENT
Class Rooms	95	90
Manual Training Rooms	90	85
Domestic Science Rooms	90	85
Assembly Rooms	90	85
Toilet Rooms	85	80
Corridors	85	80
Churches	85	80
HOSPITALS		
Wards	95	90
Operating Rooms	98	93
Other Rooms	90	85
THEATRES		
Seating Sections	90	85
Dressing Rooms, etc.	85	80
Dance, Lodge and Assembly Halls	88	83
OFFICE BUILDINGS		
Offices in office buildings or other buildings where persons are continuously employed	90	85
FACTORY BUILDINGS		

The percentage desirable for factory buildings will vary over a considerable range, depending upon the character of the work and of the process employed, modified to a considerable degree by the dust content of the air and the possibility of maintaining it free from objectionable dust and fumes. This will require a careful classification and considerable study.

FIVE CLASSIFICATIONS FOR EQUIPMENT

Engineering data is available for designing to meet these requirements. The following five classes of equipment suggested by Dr. Hill will give the percentage of perfection indicated when properly proportioned.

Class A—100 per cent equipment.—A mechanical supply and exhaust system consisting of the following:

1. Positive air supply having a maximum capacity of 30 c.f.m. per occupant.
2. Mechanical exhaust equipment with exhaust registers effectively located.
3. Perfect air distribution.
4. Accurate automatic temperature control.
5. Efficient humidifying devices.
6. Accurate automatic humidity controlling apparatus.
7. Efficient air washers, filters or other air cleaning devices, having an efficiency not less than 99 per cent.

It is understood that a 100 per cent efficient equipment is an impossibility owing to the fact that to secure a 100 per cent result would necessarily mean that air cleaning devices be 100 per cent efficient; that temperature and humidity control maintain temperature and humidity conditions absolutely on the comfort curve; that air distribution be perfect, etc. All these results cannot be obtained although a 99 per cent apparatus and an approximately 99 per cent test by the Synthetic Air Chart is possible.

Class B—95 per cent equipment.—Mechanical supply consisting of the following:

1. A positive air supply with a maximum capacity of 30 c.f.m. per occupant.
2. A well designed gravity exhaust system.
3. Efficient air distribution.
4. Accurate temperature control.
5. Adequate humidifying apparatus.
6. Adequate humidity control.

Air cleaning devices have been omitted in the 95 per cent equipment as this percentage can be obtained under ordinary conditions without air washers or filters. In an exceptionally clean locality, much higher percentages can be obtained.

Class C—90 per cent equipment.—A mechanical supply system consisting of the following:

1. An adequate air supply with 30 c.f.m. per occupant.
2. Gravity exhaust.
3. Efficient air distribution.
4. Automatic temperature control.
5. Adequate humidifying apparatus.
6. Humidity control in the main duct only or from a typical room.

Note.—Synthetic Air Chart—The final form of the Chart and the text will be revised and comfort based upon the equivalent temperature curve rather than on the wet bulb.

Class D—85 per cent equipment.—A mechanical system consisting of the following:

1. An accurate air supply with a maximum capacity of 30 c.f.m. per occupant.
2. Gravity exhaust or exhaust openings.
3. Good air distribution.
4. Automatic temperature control.

Class E—80 per cent equipment.

1. A positive air supply with gravity exhaust but without air cleaning devices, humidifying apparatus, temperature or humidity control.
2. Direct-indirect systems with either mechanical or gravity exhaust.
3. Open window or other so-called natural systems of ventilation.

A comprehensive discussion of the requirements of ventilation has been published[1] which suggests the following quantities of air to be supplied, under different conditions, to space used for various purposes as given in Table 90:

TABLE 90. AMOUNT OF NEW AIR TO BE SUPPLIED PER PERSON

	Cubic Feet per Minute			
	Without Humidification or Recirculation	With Humidification but Without Recirculation	With Humidification and Recirculation	Number of Air Changes per Hour
SCHOOLS—				
Class Rooms	30	20	5 to 10	
Assembly Rooms	15 to 20	10 to 15	5 to 10	
Gymnasiums	30	25	15 to 20	
Toilets				10 to 20
Locker Rooms				5 to 10
Kitchens				20 to 60
Lunch Rooms				10 to 20
THEATERS—				
Seating Space	30 to 50	20 to 30	10 to 15	
HOSPITALS—				
Wards	30 to 40	20 to 30		
Kitchens				20 to 60
Dining Rooms				10 to 20
Toilets				10 to 20
HOTELS—				
Dining Rooms				10 to 15
Kitchens				20 to 60
Ball Rooms				5 to 10
Work Space				5 to 10
Assembly Rooms	20 to 30	15 to 20	10 to 15	

[1]See paper Modern Trend in the Science of Ventilation, Perry West, JOURNAL, A. S. H. & V. E., June, 1924.

VENTILATION REQUIREMENTS

In a crowded place of assemblage the heat given off by the occupants together with that given off by the lighting and power equipment is usually more than the normal heat loss through the structure to the

outside air, even in winter under cold climatic conditions. This means that in order to preserve an equilibrium of effective temperature the entering air must be cooler than the leaving air, so that the problem is usually one of cooling and ventilating rather than of heating and ventilating.

A typical case for winter might show about 300 B.t.u. of body heat plus 100 B.t.u. from light etc., being given up to the building against 200 B.t.u. heat loss from the building, per person per hour. This would mean that 200 B.t.u. per person must be carried away by the air.

If the flow of air is upward, or from the side, so as to bring the incoming air into direct contact with the occupants the temperature of the incoming air should not be more than 5 deg. below the temperature of the air leaving the occupant (for ceilings 10 ft. or less in height) otherwise the ventilation will be drafty and uncomfortable. This difference may be increased 1 deg. for each 2 ft. of added ceiling height provided the rising air does not come into direct contact with another tier of occupants.

For 10 ft. and lower ceilings the quantity of air per person to dissipate this excess heat is $\frac{200}{60 \times .02 \times 5} = 33$ cu. ft. per person per min.

This amount may be reduced somewhat on the assumption that the component of heat from lights is usually introduced near the ceiling and may be allowed to heat the outgoing air to a greater difference.

In the practical work of engineers who design ventilating systems and of architects and owners who have to pass up on these systems, the one item involving standards which is the basis of all calculations and layouts, is the quantity of air to be handled by the system to be used, for producing the results desired. The functions of the air handled in connection with ventilated spaces are: (1) to supply the necessary oxygen for respiration, (2) to keep the dilution of CO_2 and other objectionable substances down to the proper point, and (3) to maintain the proper effective air temperature.

The air handled may consist entirely of air taken in from the outside or it may consist partly of new air and partly of recirculated air. On the basis that the air brought in from the outside is for oxygen supply and dilution only. The following cubic feet per minute per person would be required for the ventilation percentages shown, if all other factors are 100 per cent perfect.

TABLE 91. AIR REQUIRED FOR VARIOUS PERCENTAGES OF VENTILATION PERFECTION

Percentage of Perfection	Cu. Ft. of Air per Minute Required per Person at Rest	Cu. Ft. of Air per Minute Required per Person at Hard Work
98%	15.0	30.0
96%	7.5	15.0
94%	5.0	10.0
92%	3.75	7.5
90%	3.0	6.0

In theatres, assembly rooms, auditoriums and other places of public amusement and assemblage there are usually several other factors to consider, such as the removal of excess heat, excess moisture, dust raised by the movement of the occupants and odors.

WHEN TEMPERATURE AND HUMIDITY ARE HIGH

For 85 deg. outside air and 70 per cent relative humidity in the summer the percentage of perfection would drop to 57 per cent without any change in the air from outside conditions.

Assuming that the air supply is 30 cu. ft. per person and that the body heat and heat from equipment will raise this 5 deg. Also that the vapor added per person is 10 grains per min. or 0.33 grains per cu. ft. of air handled, the effective temperature difference will be raised about 20, so that the percentage of ventilation, would drop about 5 more, leaving 52 per cent ventilation. It will be seen, therefore, that it would be difficult to get better than 40 to 60 per cent ventilation in summer without some method of air cooling.

Air motion will assist but unless increased beyond the usual 10 to 20 ft. per minute ordinarily obtained from the movement of the air through the room it will not improve the percentage of ventilation more than 1 to 2 per cent. By the use of refrigerating and dehumidifying apparatus the effective temperature can be maintained at any desired percentage of perfection.

The use of a good air washer should reduce the temperature about 70 per cent of the difference between the wet and dry bulb temperature. This for the case cited would reduce the effective temperature difference about 2 deg. corresponding to an increase of 5 per cent in the final percentage of the ventilation.

It will be understood that the example cited is an extreme case of temperature and humidity and that the final percentage will be improved by the air washer in a greater proportion if the relative humidity of the outside air is lower.

For a condition of 80 deg. dry bulb and 50 of relative humidity, the percentage for the entering air would be 77 per cent, the percentage leaving the occupants would be 70 per cent and the air washer would improve this to 81 per cent.

Assuming that 90 per cent ventilation is desired for places of assemblage, that distribution will be 75 per cent, dust 96 per cent, bacteria 98 per cent and odors 85 per cent, there will be a deduction of 1 per cent for dust plus 1 per cent for bacteria plus 1.5 per cent for odor making a total of 3.5 per cent and leaving a deduction of 6.5 per cent for effective temperature plus effective air supply.

Assuming that the effective temperature can be controlled in winter to within 1 deg. above or below the comfort line there would be a deduction of 2½ per cent for this, leaving a deduction of 4 per cent for effective air supply. With 75 per cent distribution this would leave 3 per cent deduction for CO_2, corresponding to an air supply of 10 cu. ft. per min. per person.

It will be seen then that 10 cu. ft. of air taken in from the outside, per person per minute, is sufficient for winter conditions but inadequate for summer weather, where heat and humidity are the determining factors, unless refrigeration is used. Increasing the air supply from 10 to 50 cu. ft. per person per minute gives little improvement unless some form of artificial cooling is used.

EFFECT OF SUMMER CONDITIONS

It would seem that about 75 per cent ventilation is possible under reasonably severe summer conditions with an air supply of 30 cu. ft. per person, using an air washer, and that beyond this point there is little to be gained by increasing the air supply. The figures given are based on upward ventilation and that the cooling effect of from 5 to 10 deg. with air washers and of perhaps twice this amount with refrigeration will produce uncomfortable drafts on the occupants at times.

For this reason and for the additional reasons of sanitation and control, the downward system of ventilation is perhaps more efficacious in large and intensely used places of assemblage.

On account of transporting all of the heat from lights downward and of forcing the body-heated air back over the occupants it is usually necessary to do much more cooling of the air than can be done with the air washer, without refrigeration. On the other hand the air is brought in high enough to permit of its being diffused and brought to the proper condition before coming into contact with the occupants. It can be seen, therefore, that the air supply per person per minute for assembly-rooms could be 10 cu. ft. in winter, 30 cu. ft. in summer with air washers and anywhere between these two figures for the entire year with refrigeration.

Also that nothing better than about 75 per cent ventilation can be obtained in hot sultry summer weather without artificial cooling but that with such cooling especially if the air supply is taken from overhead and exhausted from below, most any desired percentage of perfection can be maintained.

RECIRCULATION

The foregoing does not take into consideration the matter of recirculation, but it can readily be seen that there is little to be gained by recirculation unless an appreciable amount of CO_2 and attendant impurities which get into the air can be taken out during recirculation. The handling of the larger quantity of air may be of value either to produce air motion or for use as a better cooling medium with less temperature difference between incoming and outgoing air. Recirculation may also be used as a purely economic feature during the warming up of the building or during periods when the space is only partly occupied and the mechanical arrangements are inadequate for properly varying the quantity of air handled to suit.

A good arrangement is to provide apparatus for handling 30 cu. ft. of air per person per minute with provisions for recirculating any amount up to as much as two-thirds of this.

The percentage of air recirculated may be varied to suit the seasonal changes so as to conserve heat in winter and refrigeration in summer. The schools where the requirements are not so severe and it is not necessary to provide for summer conditions as much as 90 per cent of the air can be successfully recirculated. The use of ozonation for eliminating odors and for otherwise refreshing the air is advisable wherever recirculation is regularly and intensively employed.

Present methods of measuring and comparing qualities of ventilation not taking into account any of the functions of the relative humidity of the air except that bearing upon effective temperature. This means that air of any temperature and relative humidity, within proper physical range, *i.e.*, below 64 deg. wet bulb, may be made to meet the comfort line by either heating or cooling without addition or deduction of moisture.

Absolutely dry air may be heated or cooled to 78 deg. and be 100 per cent perfect as far as effective temperature is concerned and still be far from desirable in its effects on the membranes of nose, throat and lungs. Such dry air is also very conducive to the increase of dustiness in the atmosphere of a room from the standpoints of dryness and electrostatic agitation.

The air washer and humidifier correct these difficulties and there should be some definition of limits for the relative humidity in the measure of ventilation.

It is not unusual to find from 1 to 2 million particles of dust per cu. ft. in the outside air surrounding city buildings and unless this is eliminated it will give dust counts in rooms equivalent to a deduction of from 5 to 20 per cent in the perfection of ventilation.

A good air washer should eliminate 80 to 90 per cent of the dust entering the intake and perhaps reduce the dust penalty in the rooms to less than one-half of the figure given. It will be seen, therefore, that air washing and humidification may improve the quality of ventilation about 10 per cent in the effective temperature department, plus another 10 per cent in the dust department, plus other improvements in the quality of ventilation by maintaining proper humidity and removing other injurious substances and odors.

Where effective temperature is controlled, according to the usual method, from the dry bulb temperature in the room there may be a wide variation in this effective temperature due to the varying amounts of moisture in the air, unless humidifying apparatus with accurate humidity control is employed. Between the condition of absolute dry air at 70 per cent and absolutely saturated air at 70 deg. there is a difference of 10 deg. in effective temperature which means an average difference of 25 per cent in the quality of ventilation. This may be taken to mean about 10 per cent on each side of the neutral point for ordinary ventilating conditions so that the air washer and humidity should improve the ordinary ventilating plant another 10 per cent on this count.

Good dry air filters will of course serve the same purpose for cleaning the air of suspended matter, and may improve the ventilation about 10 per cent.

SPECIAL CONDITIONS

In connection with the ventilation of schools the condition in the class-rooms for average winter weather is that the body heat given up to the room from the occupants is less than the heat loss from the building to the outside air so that the incoming air may be maintained at a higher temperature than that of the air surrounding the occupants. This means that the effective temperature may be controlled within 1 deg. above or below the comfort line.

Assuming that 95 per cent ventilation is required for class-rooms, that the distribution is 85 per cent and there is no deduction for dust, bacteria or odors, could have a deduction of 85 per cent of 2.5 per cent which is equivalent to about 2 per cent for CO_2. This would mean 15 cu. ft. of air per pupil per minute.

The usual requirements of state laws is 30 cu. ft. per pupil which would mean a deduction of 1 per cent for CO_2 leaving a 4 per cent deduction for effective temperature, dust, bacteria and odors.

Allowing a deduction of 2½ per cent for effective temperature there would be a possible deduction of 1½ per cent for these other items. It will depend therefore upon the quality that can be maintained for these other items as to the actual quantity of air required between 15 and 30 cu. ft. per minute per pupil.

Where intensive recirculation is employed the extent of the recirculation will depend on the quantity of CO_2, odors and other objectionable factors which can be removed from the recirculated air and also upon the ability to keep the relative humidity from rising to an undesirable point on account of the vapor given up to the air by occupants of the building.

The ventilation of school auditoriums where the occupancy of the rooms is of a relatively short duration of from 1 to 2 hours the initial air in the rooms may be relied upon to reduce the intensity of ventilation required so that from 15 to 20 cu. ft. of air per person per minute is usually sufficient. In the ventilation of hospitals the wards may be treated much the same as the class-rooms of a school with the exception that it is inadvisable to use recirculation on account of the danger of contagion.

School toilets should be separately ventilated with an air change of from 2 to 5 min. employing mechanical supply and exhaust with the exhaust in excess of the supply in order to prevent objectionable odors from diffusing into other parts of the building.

Kitchen and lunch rooms should be ventilated with about a 5 min. air change for lunch rooms and a 1 to 3 min. air change for kitchens with at least a part of the exhaust taken from the lunch rooms through the kitchen so as to keep all of the air travel towards the kitchen, thus preventing the kitchen odors from diffusing into the lunch rooms.

Exhaust from kitchen range hoods should be discharged by a separate exhaust fan through a fireproof metal duct extending above the roof of the building and provided with automatic fire damper and steam jet fire extinguisher for use in case of emergency as the accumulation of the grease vapors in this flue frequently cause a fire.

After a good ventilating system is designed the engineer is only fairly well started on the road to good ventilation. A system is not a ventilating system until it ventilates. Here is where the operating man and proper supervision come in. Of all the things that go to make up success or failure these two are the most important. The one who lays out the plant should supervise, not only its installation, but testing and watch it until it is operating properly. Beyond this it must be kept in the hands of competent operators under the right supervision. Then and not until then, will good ventilation be obtained.

CHAPTER XV

THE HILL SYNTHETIC AIR CHART

PERFECTION in ventilation depends upon the condition of the air in a room as affecting health and comfort rather than upon the quantity of outside air supplied. The known conditions of air which may affect human health and comfort are its temperature, humidity, air motion, dustiness, odor, bacterialogical content and carbon dioxide content.

The synthetic air chart, devised by Dr. E. Vernon Hill, and revised as a result of investigations by the Society's Research Laboratory is the accepted standard for grading the perfection of ventilation in any room by the conditions of the air itself.

According to the synthetic air chart Fig. 71 each of the conditions of the air which affect human health is rated in percentage of perfection in a separate column. The percentage of perfection as regards each factor is indicated by the height of the shaded area in that column. The percentage of penalization for imperfection as regards that factor is given by the difference between 100 per cent and the indicated per cent of perfection. The effect which the penalization for each factor will have on the composite penalization for all factors of ventilation of the room is given at the right hand side of the column. The sum of the penalizations for each of the factors as given in the right hand side of the various columns is taken as the total percentage of penalization representing the imperfection of ventilation for the room. The percentage of perfection of ventilation is 100 per cent minus this total and is indicated by the height of the shaded area in the last column to the right. The percentage of perfection for any factor is determined by crediting an ideal condition with 100 per cent and a condition impossible for life with zero per cent perfection. In other words, a condition, as pertains to any one of the five factors, that will produce death or permanent disability is rated at zero per cent perfect.

CONDITIONS OF MAXIMUM COMFORT

Temperature Humidity and Air Motion.—A person's feeling of warmth is determined, by the temperature, humidity and motion of the air. A single index of a person's feeling of warmth is given by a scale of effective temperature, which takes into consideration these three factors. This scale of effective temperature (abbreviated E. T.) has been determined by the Society's Research Laboratory and is discussed in Chapter XVI. For the average human being at rest an effective temperature of 64 deg. gives maximum comfort. Persons working at various rates are most comfortable at effective temperatures below 64 deg. The exact effective temperatures giving maximum comfort for persons working at various

rates have not yet been determined by the Research Laboratory but from the best data available, they are as follows:—

At rest	64 deg. E. T.
Light Work	62.5 deg. E. T.
Moderate Work	62 deg. E. T.
Hard Work	59.5 deg. E. T.

One hundred per cent perfection in ventilation, for people at rest exists when the effective temperature is 64 deg. Life is impossible for any

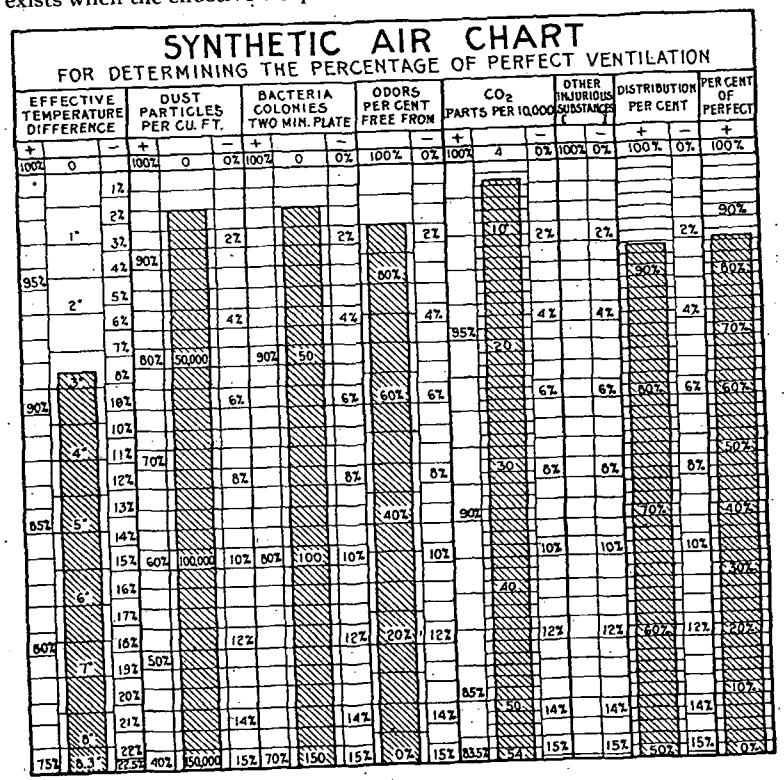


FIG. 71. SYNTHETIC AIR CHART

considerable length of time in an effective temperature of 97⅓ deg. and a condition having this effective temperature is therefore, rated zero per cent perfect, is penalized 100 per cent as regards this factor and 90 per cent for imperfection in ventilation. The penalization for variation in temperature from the ideal is therefore 3 per cent per deg. E. T. It will be noticed that this will give zero per cent perfection for 31 deg.—a condition at least nearly impossible for life for a person normally clothed and at rest.

Dust.—Dust is inimical to health and comfort. It is, however, more difficult to arrive at a basis of penalization since it is hard to say that any degree of dustiness is impossible for life. Dust free air is 100 per cent perfect and 250,000 particles per cu. ft. of air as determined by the Hill counter is considered zero per cent perfect, or is penalized 100 per cent as regards the dust factor and 25 per cent for imperfection of ventilation. The percentage of perfection is reduced by 1 per cent for each 2500 particles.

Odors.—In the case of odors it is even more difficult to arrive at a basis for penalization. The following arbitrary scale has been adopted:—

Free from odor	100 per cent perfect
Very faint odor	95 " " "
Faint odor	90 " " "
Noticeable odor	85 " " "
Distinct odor	80 " " "
Decided odor	75 " " "
Strong odor	70 " " "

Penalization for imperfection of ventilation is 0.15 of that for the odor factor.

Bacteria.—While all bacteria are not harmful and some may be desirable, the number of bacteria in the air generally indicates the surrounding sanitary condition and the chances for harmful bacteria may be assumed to be roughly proportional to the total number of bacteria in the air. According to the synthetic air chart, the percentage of perfection depends upon the number of bacteria in the air as determined by the number of growth appearing in a culture which has been exposed to the air for two minutes in a 4 in. petri dish and then incubated for 48 hrs. at 72 deg. If no colonies appear the condition is rated at 100 per cent and if 500 colonies appear it is rated at zero per cent perfect. The percentage of perfection is reduced by one for each 5 colonies for this factor while penalization for poor ventilation is one-half as great.

Carbon Dioxide.—The carbon dioxide content of the air may be taken as an indication of its purity. The percentage of perfection is 100 per cent if the carbon dioxide content is the same inside and outside and is reduced by 1 per cent for every three parts per 10,000 over that found in outside air. This gives 100 per cent penalization for 300 parts CO_2. Penalization for imperfect ventilation is 0.9 that for the CO_2 factor.

Distribution.—The distribution of the air throughout the room is an important factor in ventilation. Imperfection in this factor is determined by the variation in percentage of carbon dioxide in various parts of the room. In operating the synthetic air chart as many samples, as there are 200 sq. ft. of floor space in the room, or not less than four, of air from different parts of the room are analyzed. The percentage, which the average variation, of the various samples, is of the average CO_2 content, is the percentage penalization for poor distribution. Penalization for imperfect ventilation is 0.3 that for the distribution factor.

EXAMPLE IN THE USE OF THE CHART

Determine the percentage of perfection of ventilation in a room where the following conditions are observed. The room to be occupied by persons normally clothed and doing light work.

Dry Bulb Temperature	74 deg.
Wet Bulb Temperature	62 deg.
Air Velocity	50 ft. per min.
Dust Count by Hill Counter	10,000 particles per cu. ft.
Bacteria colonies developed in a 2 min. plate	10
Odors	Faint
CO_2 analysis inside Station No. 1	6 parts in 10,000
CO_2 analysis inside Station No. 2	6.3 parts in 10,000
CO_2 analysis inside Station No. 3	5.5 parts in 10,000
CO_2 analysis inside Station No. 4	5.0 parts in 10,000
CO_2 analysis outside	4.0 parts in 10,000
Other objectionable substances	None

The effective temperature for the observed wet and dry bulb temperature and air motion is determined from the Table 96 to 102 in Chapter XVI. From Table 97 (See Chapter XVI) for 50 ft. per min. air velocity the intersection of the line for 74 deg. dry bulb and the column for 62 deg. wet bulb gives 65.3 deg. as the E. T. of the condition. For 100 per cent perfection 62.5 deg. E. T. is required for persons doing light work whereas the existing condition is 65.3 deg. E. T. or 2.8 deg. too high, which gives according to the chart, 91.6 per cent perfection and 8.4 per cent penalization for this factor and a penalization of 7.6 per cent for imperfect ventilation. This is indicated in the chart, Fig. 71.

10,000 dust particles per cu. ft. of air gives according to the chart 96 per cent perfection and 4 per cent penalization for this factor and 1 per cent penalization for imperfect ventilation.

10 bacterial colonies on a 2 min. plate gives 98 per cent perfection for this factor and a penalization of 1 per cent for imperfect ventilation.

A faint odor or 90 per cent free from odors calls for a 10 per cent penalization for this factor and 1.5 per cent penalization for imperfection of ventilation.

The average carbon dioxide content of the 4 samples taken in the room is 5.7 or 1.7 parts more than the outside sample, which, according to the chart, is 99.5 per cent perfect for this factor and calls for 0.4 per cent penalization for imperfection of ventilation.

There are no other injurious substances indicated hence no penalization is given for such factors.

The variations of the carbon dioxide content of the four stations from their average are as follows:—

Station No. 1	6.3 − 5.7	= 0.6	parts per 10,000
" " 2	6.0 − 5.7	= 0.3	" " 10,000
" " 3	5.7 − 5.6	= 0.1	" " 10,000
" " 4	5.7 − 5.0	= 0.7	" " 10,000
		$4\overline{)1.7}$	

The average variation is ..... 0.42, and the percentage of variation is $\frac{0.42}{5.7} \times 100 - 7.4$ per cent. Therefore the percentage distribution is 100 − 7.4 = 92.6, and the percentage penalization for imperfect ventilation is 2.2.

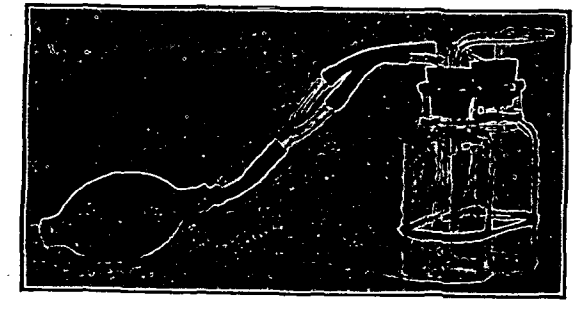


FIG. 72. AMMONIUM-CHLORIDE APPARATUS FOR DETERMINING VELOCITY AND DIRECTION OF AIR CURRENTS

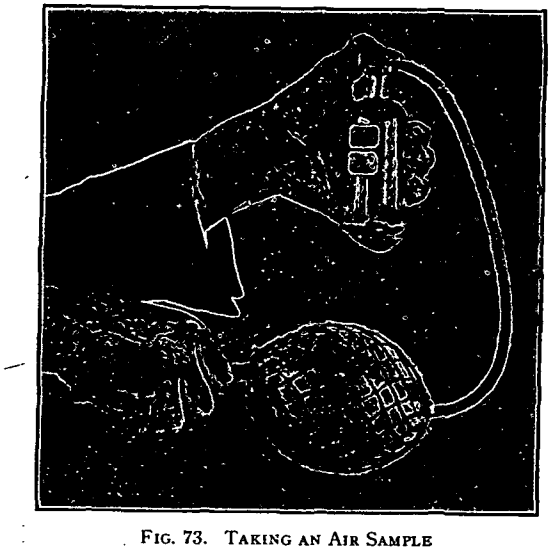


FIG. 73. TAKING AN AIR SAMPLE

The percentage of perfection for each factor is indicated in the chart, Fig. 71 and are summed up in Table 92. The sum of all the penalizations for imperfection in ventilation is 13.7 and the percentage of perfection of ventilation is 100 minus 13.7 or 86.3 which is shown in the last column of the chart.

TABLE 92. TYPICAL RESULTS OF ANALYSIS BY HILL SYNTHETIC AIR CHART

FACTOR	PERCENTAGE OF PERFECTION FOR FACTOR	PERCENTAGE OF PENALIZATION FOR FACTOR	PERCENTAGE OF PENALIZATION FOR IMPERFECT VENTILATION	PERCENTAGE OF PERFECTION FOR VENTILATION
Effective Temperature	9.6	8.4	7.6	.....
Dust	96.0	4.0	1.0	.....
Bacteria	98.0	2.0	1.0	.....
Odor	90.0	10.0	1.5	.....
Carbon Dioxide	99.5	0.5	0.4	.....
Distribution	92.6	7.4	2.2	.....
Total			13.7	86.3

The above observations are made as follows: The wet and dry bulb temperatures are determined with a sling psychrometer, the air velocity is determined by observing the speed of a smoke cloud with the aid of a stop watch. The smoke cloud may be caused by means of an ammonium cloud apparatus, Fig. 72 or by exploding a smoke bomb, or by other means.

The dust count is made by means of the Hill dust counter. In this instrument a given volume of air is made to impinge against a glass microscope cover slip coated with an adhesive. The particles are counted under a microscope of definite magnification and the number corrected per cu. ft. of air.

Carbon dioxide samples are taken in 120 cc. rubber stoppered bottles by exhausting air from the bottles with an atomizing bulb, Fig. 73. The bottle should be held at arms length while sampling so as not to be contaminated with the observer's breath and then tightly stopped until the sample can be analysed on a Petterman-Palmquist apparatus for carbon dioxide.

CHAPTER XVI

HOW TEMPERATURE, HUMIDITY AND AIR MOTION AFFECT HUMAN COMFORT

By F. C. HOUGHTEN, Member

THE sense of warmth experienced by the human body is not due alone to the temperature indicated by the dry bulb thermometer, neither does it depend solely upon the wet bulb temperature. Dry air at a relatively high temperature may feel cooler than air of considerably lower temperature with high moisture content.

Human comfort or discomfort depend largely on body temperature and therefore on the relation between the rate of heat production and dissipation. By the process of metabolism heat is constantly generated within the body, while on the other hand, loss of heat is constantly occurring from the surface of the body by radiation, convection and evaporation. To maintain a constant body temperature the loss of heat must equal the heat produced. It is therefore apparent that any interference with the elimination of heat from the body is accompanied by a rise in temperature and a feeling of discomfort.

There are three principal factors affecting loss of body heat:

1. Temperature. 2. Humidity. 3. Air motion.

As the temperature of the air and surrounding objects rises, the loss of heat by convection and radiation decreases. When the temperature reaches that of the body, the loss by radiation and convection ceases. Finally as the air temperature exceeds that of the body, heat passes from the air to the body.

If on the other hand, the relative humidity is increased the heat loss by evaporation decreases. If while the dry bulb temperature increases, the wet bulb temperature decreases sufficiently, the increase in loss of heat by evaporation may be made equal to the decrease in loss of heat by radiation and convection, resulting in no change in body temperature or comfort.

From the above, it is concluded that there must necessarily exist certain combinations of temperatures and humidities, which produce the same total body heat loss by radiation, convection and evaporation and therefore the same feeling of comfort or discomfort. Lines passing through such air conditions plotted as a psychrometric chart may be called equal comfort lines. The fact is further substantiated by the general experience of heating engineers in observing that the lower the humidity the higher the dry bulb temperature required for the same degree of comfort.

A series of tests have been made in the two psychrometric rooms of the Research Laboratory of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, in order to locate these lines on the psychrometric chart, both for still and moving air.

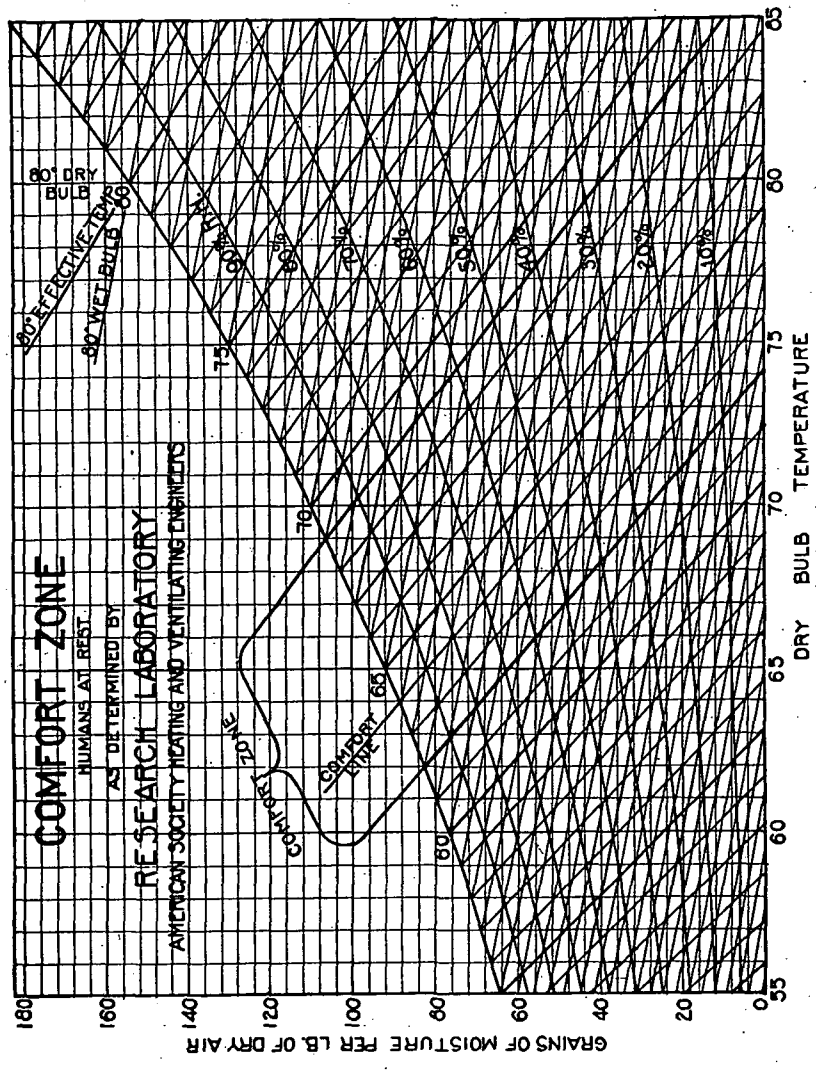


FIG. 74. THE COMFORT CHART FOR HUMANS AT REST

The relation of temperature and humidity to comfort in still air is given in Figs. 74 and 75.

air is

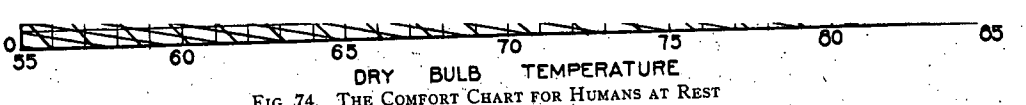
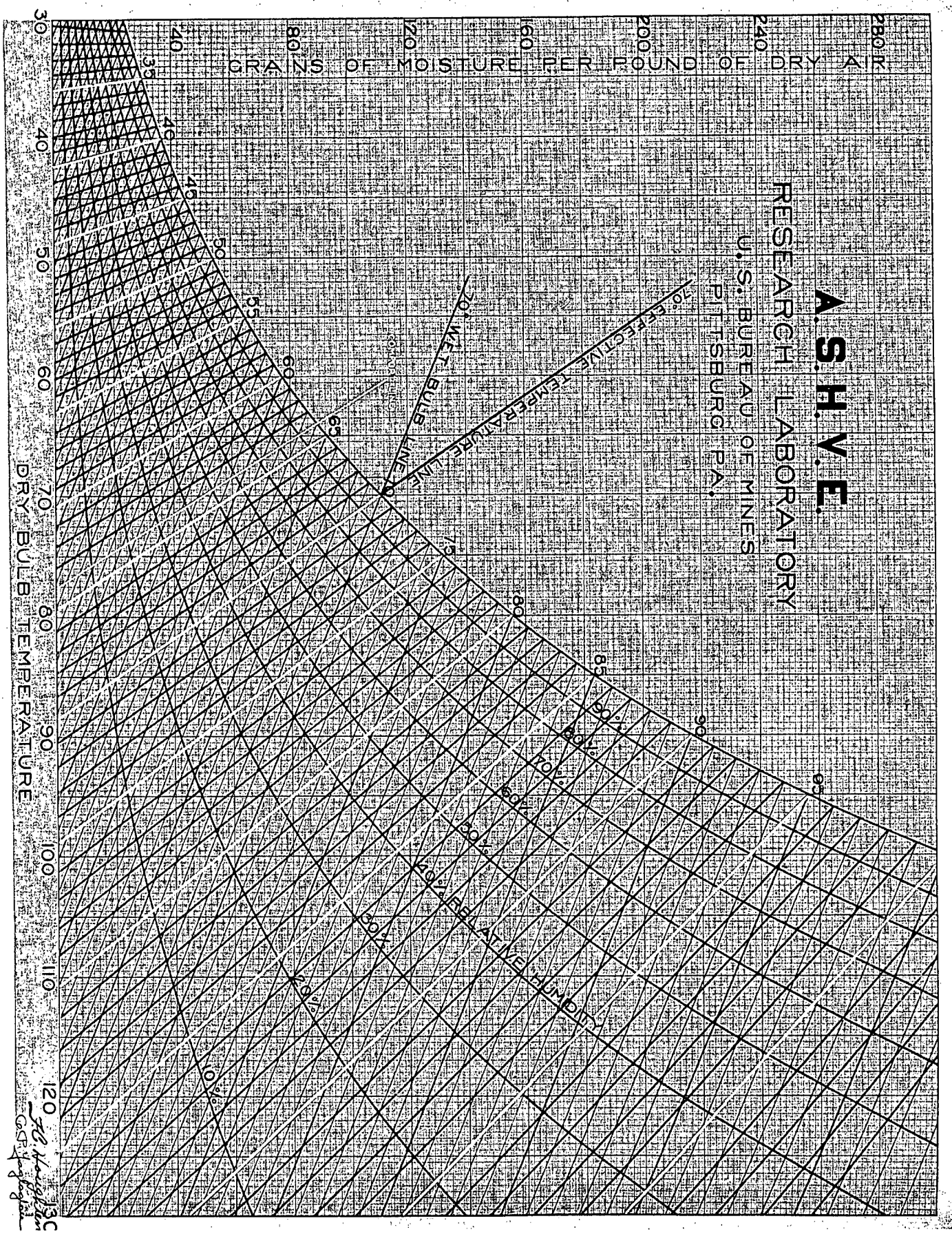


FIG. 74. THE COMFORT CHART FOR HUMANS AT REST



HOW TO USE THE COMFORT CHART

In the Psychrometric Chart, dry bulb temperature is plotted as abscissae and grains of moisture per pound of dry air as ordinates. The maximum moisture which the air can hold at any temperature gives the saturation or 100 per cent relative humidity curve. Relative humidities between 0 and 100 per cent are given by a series of curved lines similar to the saturation curve. The wet bulb temperatures for all atmospheric conditions are given by a series of nearly parallel oblique lines. Effective temperature is given by a series of oblique but not parallel lines which approach being parallel to the wet bulb lines at high temperatures and humidities, and dry bulb lines at low temperatures. The numerical value of the wet and effective temperature lines is given by the dry bulb temperature of their intersection with the saturation curve.

Dry bulb temperature is the true temperature of the air as determined by an ordinary thermometer. It does not, however, accurately indicate a person's feeling of warmth. If the humidity is high a person will feel warmer at the same dry bulb temperature than he will if the humidity is low.

Wet bulb temperature is not the temperature of the air but that which a thoroughly wet body will attain if the air passes over it for a sufficient length of time and with a high enough velocity. A person is not thoroughly wet and hence does not react entirely in accordance with the wet bulb temperature. At high temperatures when the body is wet with perspiration, it reacts more nearly to wet bulb temperature while at low temperatures the body is comparatively dry and reacts more nearly in accordance with the dry bulb temperature.

Effective temperature is an experimentally determined scale which unlike the dry bulb and wet bulb scales is a true measure of index of a person's feeling of warmth in all combinations of temperature and humidity. In other words with any given effective temperature a person will always feel the same degree of warmth or coldness regardless of the dry bulb or wet bulb temperature.

That range of effective temperatures over which 50 per cent of people feel comfortable, namely 62 deg. effective temperature to 69 deg. effective temperature, is called the Comfort Zone.

That particular effective temperature at which a maximum number of people feel comfortable is 64 deg. effective temperature and is called the comfort line. While at rest in still air, 97 per cent of all people are comfortable at this temperature.

Tables 93 to 99 give the relation between dry and wet bulb temperatures, and effective temperature for still air, and various air velocities up to 700 ft. per min.

Example 1.—Given dry bulb and wet bulb temperatures of 75 and 68 deg. First: what is the effective temperature? Second: is this condition warmer or cooler than 80 deg. dry bulb and 63 deg. wet bulb?

Answer.—The first condition is given by the intersection of the 75 deg. dry bulb line and the 68 deg. wet bulb line. The effective temperature is given by the numerical value of the effective temperature line, passing through this point and indicated by the scale along the saturation curve, and is 71.1 deg. effective temperature. The second condition is given by the intersection of 80 deg. dry bulb and 63 deg. wet bulb and is

TABLE 93. RELATION BETWEEN DRY AND WET BULB TEMPERATURES AND EFFECTIVE TEMPERATURE FOR STILL AIR

Wet Bulb Temperature

DRY BULB TEMP.	25	30	35	40	45	49	52	54	56	58	60	62	64	66	68	70	72	74	77	80	85	90	95	100
Effective Temperature																								
30	30.5	30.0																						
35	34.4	34.7	35.0																					
40		38.6	39.2	40.0																				
45		42.1	42.9	43.8	45.0																			
50			46.3	47.3	48.6	49.7																		
54			48.8	49.9	51.1	52.4	53.3	54.0																
57				51.7	53.0	54.1	55.1	55.9	56.6															
60				53.4	54.7	55.9	56.9	57.6	58.3	59.1	60.0													
62				54.5	55.8	57.0	58.0	58.7	59.4	60.2	61.1	62.0												
64					56.8	58.1	59.0	59.7	60.5	61.3	62.1	63.0	64.0											
66					57.9	59.1	60.0	60.8	61.5	62.2	63.1	64.0	65.0	66.0										
68					58.9	60.1	61.1	61.8	62.5	63.3	64.1	65.0	66.0	66.9	68.0									
70					59.9	61.1	62.0	62.7	63.4	64.2	65.1	66.0	66.9	67.9	68.9	70.0								
72					60.9	62.0	63.0	63.7	64.4	65.2	66.0	66.9	67.8	68.8	69.9	70.9	72.0							
74						63.0	64.0	64.6	65.4	66.1	66.9	67.8	68.7	69.7	70.7	71.8	72.9	74.0						
76						63.9	64.9	65.5	66.2	67.0	67.8	68.6	69.6	70.5	71.5	72.5	73.8	74.8						
78						64.8	65.7	66.3	67.1	67.9	68.6	69.6	70.4	71.3	72.3	73.3	74.4	75.6	77.3					
80						65.6	66.5	67.2	67.9	68.7	69.5	70.4	71.2	72.1	73.1	74.1	75.2	76.3	78.0	80.0				
83							67.8	68.4	69.1	70.0	70.7	71.5	72.4	73.2	74.2	75.2	76.2	77.4	79.1	81.0				
86							69.0	69.7	70.3	71.1	71.8	72.6	73.4	74.3	75.3	76.2	77.3	78.4	80.0	81.8	85.3			
90								71.1	71.8	72.6	73.3	74.1	74.9	75.8	76.7	77.6	78.6	79.6	81.3	83.0	86.4	90.0		
95									73.6	74.3	75.0	75.7	76.6	77.4	78.2	79.1	80.1	81.1	82.7	84.4	87.6	91.1	95.0	
100										75.8	76.6	77.3	78.1	78.8	79.7	80.6	81.6	82.4	84.0	85.7	88.8	92.2	95.9	100.0
105											78.0	78.7	79.5	80.3	81.1	81.9	82.8	83.8	85.3	86.9	90.0	93.1	96.7	100.6
110												80.2	80.7	81.6	82.4	83.3	84.1	85.0	86.5	88.1	91.0	94.2	97.6	101.3
120														84.1	84.8	85.6	86.4	87.3	88.7	90.3	92.8	95.7	98.8	102.6

TABLE 94. RELATION BETWEEN DRY AND WET BULB TEMPERATURES AND EFFECTIVE TEMPERATURE FOR 50 FT. AIR VELOCITY

Wet Bulb Temperature

DRY BULB TEMP.	25	30	35	40	45	49	52	54	56	58	60	62	64	66	68	70	72	74	77	80	85	90	95	100
Effective Temperature																								
30																								
35																								
40		31.7	31.3	31.0																				
45		35.9	36.1	36.5	37.2																			
50			41.4	41.6	42.2	43.1																		
54			45.0	45.3	46.0	46.8	47.6	48.3																
57				47.9	48.8	49.8	50.6	51.1	51.6															
60				50.3	51.2	52.2	52.9	53.5	54.0	54.6	55.4													
62				51.4	52.7	54.0	54.4	55.0	55.5	56.3	57.0	57.8												
64					54.0	55.0	55.7	56.2	56.8	57.6	58.4	59.1	60.1											
66					55.0	55.8	57.0	57.3	57.8	58.6	59.5	60.3	61.0	62.4										
68					56.5	57.4	58.3	58.5	59.4	60.0	60.5	61.4	62.3	63.2	64.7									
70					58.2	59.0	59.7	60.2	60.8	61.5	62.3	63.2	64.0	65.0	66.0	67.1								
72					59.5	60.5	61.0	61.5	62.3	62.8	63.6	64.5	65.2	66.0	67.0	67.8	69.4							
74						61.5	62.0	62.6	63.2	63.7	64.4	65.3	66.0	67.0	68.0	69.3	70.4	71.7						
76						62.7	63.4	64.0	64.4	64.8	65.5	66.3	67.0	68.0	68.9	70.0	71.3	72.5						
78						64.2	64.7	65.2	65.5	65.9	66.5	67.4	68.2	69.1	69.9	71.0	72.0	73.8	75.3					
80						65.2	65.7	66.2	66.6	67.3	67.8	68.5	69.5	70.3	71.3	72.4	73.4	74.5	76.5	78.5				
83							66.6	67.2	67.8	68.6	69.4	70.3	71.0	72.0	73.0	73.9	75.0	76.0	77.8	79.8				
86							67.8	68.8	69.5	70.3	70.8	71.6	72.4	73.1	74.0	75.0	75.9	77.0	78.8	80.6	84.5			
90								71.5	72.0	72.5	73.0	73.6	74.2	74.9	75.6	76.5	77.4	78.4	80.0	81.8	85.3	89.4		
95									74.0	74.5	75.0	75.6	76.2	77.0	77.7	78.5	79.4	80.5	81.8	83.6	86.7	90.3	94.3	
100										77.3	77.4	77.8	78.3	78.8	79.5	80.4	81.0	81.8	83.3	84.8	87.8	91.3	95.3	100.0
105											78.5	78.8	79.4	79.8	80.5	81.4	82.4	83.3	84.8	86.4	89.3	92.5	96.3	100.4
110												79.7	80.5	80.9	81.7	82.6	83.6	84.5	86.0	87.6	90.4	93.5	97.0	101.1
120															85.0	85.7	86.5	87.3	88.5	90.0	92.5	95.4	98.5	102.3

TABLE 95. RELATION BETWEEN DRY AND WET BULB TEMPERATURES AND EFFECTIVE TEMPERATURE FOR 100 FT. AIR VELOCITY

Wet Bulb Temperature

Dry Bulb Temp.	25	30	35	40	45	49	52	54	56	58	60	62	64	66	68	70	72	74	76	80	85	90	95	100
Effective Temperature																								
30																								
35																								
40																								
45		32.2	31.7	31.2	30.7																			
50		36.9	37.7	38.5	39.3	39.8																		
54			41.6	41.7	41.9	42.3	42.6	43.0																
57				44.9	45.1	45.5	45.7	46.3	46.7															
60				47.6	48.1	48.5	49.1	49.5	49.8	50.5	51.0													
62				49.5	49.8	50.4	51.2	51.5	52.0	52.8	53.2	53.8												
64					51.7	52.3	52.9	53.5	54.0	54.3	54.8	55.5	56.4	57.0										
66					52.8	53.5	54.3	55.0	55.5	56.2	56.7	57.4	58.0	59.0	59.7									
68					55.2	55.7	56.2	56.6	57.1	57.6	58.4	59.2	60.0	60.7	61.7									
70					57.0	57.4	57.8	58.3	58.7	59.3	60.0	60.7	61.5	62.5	63.6	64.8								
72					56.8	58.7	59.5	60.0	60.5	61.0	61.7	62.4	63.0	63.9	64.8	65.7	66.8							
74						60.0	60.7	61.2	61.8	62.3	62.8	63.6	64.3	65.2	66.1	67.0	68.2	69.3						
76						61.3	62.0	62.6	63.2	63.8	64.5	65.1	65.7	66.6	67.5	68.5	69.5	70.7	72.0					
78						62.2	63.0	63.6	64.3	65.0	65.7	66.3	67.1	67.8	68.7	69.7	70.6	71.7	74.0	75.6				
80							64.3	65.0	65.6	66.3	67.0	67.6	68.3	69.1	70.0	71.0	72.0	73.0	74.2	77.0				
83							65.7	66.5	67.2	67.7	68.4	69.2	70.0	70.7	71.6	72.5	73.5	74.5	75.5	78.5				
86							69.0	69.3	69.5	69.8	70.2	70.7	71.3	71.8	72.6	73.5	74.5	75.5	77.0	77.7	83.0			
90								72.0	72.1	72.4	72.7	73.0	73.5	74.2	74.7	75.5	76.7	77.4	78.4	80.7	84.3	89.0		
95									74.8	75.0	75.3	75.5	75.8	76.2	77.0	77.5	78.5	79.5	80.5	82.7	86.5	90.0	95.0	
100										76.3	76.7	77.3	77.7	78.2	78.8	79.5	80.4	81.4	82.3	84.2	87.0	90.4	95.0	100.0
105											77.7	78.5	79.2	80.0	80.6	81.5	82.3	83.0	84.0	85.7	88.5	91.7	95.7	100.4
110												80.5	81.3	81.8	82.0	83.3	83.8	84.7	85.5	87.2	89.7	92.5	96.5	101.3
120														86.6	87.0	87.5	88.0	88.6	89.1	90.1	91.7	93.4	97.4	101.8

TABLE 96. RELATION BETWEEN DRY AND WET BULB TEMPERATURES AND EFFECTIVE TEMPERATURE FOR 200 FT. AIR VELOCITY

Wet Bulb Temperature

Dry Bulb Temp.	25	30	35	40	45	49	52	54	56	58	60	62	64	66	68	70	72	74	76	80	85	90	95	100
Effective Temperature																								
30																								
35																								
40																								
45																								
50			32.2	31.5	30.5	28.7																		
54			37.4	36.8	36.5	35.8	35.5	35.2																
57				40.4	40.3	40.1	40.0	39.9																
60				44.0	44.1	44.2	44.3	44.4	44.4	44.5														
62				46.1	46.2	46.4	46.5	46.7	47.0	47.1	47.4	47.5												
64				48.0	48.2	48.5	49.0	49.4	49.7	50.0	50.2	50.5	50.7											
66					50.4	50.6	51.0	51.2	51.6	52.0	52.5	52.7	53.3	53.7										
68					52.5	52.6	53.0	53.3	53.6	54.1	54.5	55.0	55.5	56.0	56.7									
70					54.4	54.5	54.8	55.2	55.6	56.0	56.4	56.8	57.4	58.0	58.8	59.8								
72					56.4	56.5	56.8	57.3	57.6	58.0	58.3	58.8	59.3	60.0	60.8	61.8	63.0							
74						58.5	58.7	59.0	59.3	59.7	60.1	60.7	61.3	62.2	62.9	63.8	64.7	65.7						
76						60.2	60.4	60.6	61.0	61.5	61.8	62.4	63.0	63.3	64.5	65.3	66.5	67.5	68.7					
78						61.2	61.7	62.0	62.4	63.0	63.5	64.0	64.8	65.5	66.3	67.1	68.0	69.0	70.3					
80						63.5	63.6	63.8	64.2	64.5	65.0	65.5	66.2	66.8	67.5	68.5	69.4	70.5	71.5	74.5				
83							66.6	66.6	66.7	66.8	67.1	67.5	68.0	68.7	69.5	70.5	71.4	72.5	73.5	76.2				
86							68.7	68.7	68.8	69.0	69.1	69.6	70.0	70.5	71.3	72.1	73.0	73.7	76.1	77.5	81.5			
90								71.5	71.6	71.7	71.8	71.9	72.3	72.8	73.4	74.2	75.0	76.0	77.0	79.5	83.0	88.0		
95									74.3	74.5	74.5	74.9	75.2	75.5	76.2	76.9	77.6	78.4	79.5	81.7	85.2	89.2	93.7	
100										76.7	76.8	77.1	77.8	78.3	78.6	79.3	80.0	80.7	81.7	84.5	86.2	90.0	95.7	100.0
105											79.4	79.8	80.3	80.7	81.3	81.6	82.1	82.8	84.7	85.5	88.2	91.5	95.7	100.7
110												82.0	82.2	82.5	83.2	83.7	84.3	85.0	85.6	87.0	89.5	92.2	96.0	101.4
120														85.0	85.6	86.3	86.7	87.4	88.2	89.8	92.2	95.0	98.0	102.5

TABLE 97. RELATION BETWEEN DRY AND WET BULB TEMPERATURES AND EFFECTIVE TEMPERATURE FOR 300 FT. AIR VELOCITY

Wet Bulb Temperature

DRY BULB TEMP.	25	30	35	40	45	49	52	54	56	58	60	62	64	66	68	70	72	74	77	80	85	90	95	100
Effective Temperature																								
30																								
35																								
40																								
45																								
50																								
54			35.7	34.8	33.5	32.5	31.2	30.3																
57				35.2	37.9	37.1	36.7	36.3	35.7															
60				41.9	41.7	41.4	41.1	41.0	40.9	40.6	40.2													
62				44.1	44.0	44.0	43.9	43.9	43.8	43.8	43.6	43.5												
64					46.0	46.1	46.2	46.2	46.3	46.4	46.6	46.7	46.9											
66					48.1	48.6	48.8	48.9	49.0	49.1	49.3	49.7	49.9	50.0										
68					50.1	50.7	50.9	51.0	51.1	51.5	51.8	52.6	52.3	52.8	53.1									
70					52.1	52.7	53.0	53.1	53.5	53.9	54.1	54.5	55.0	55.2	55.9	56.2								
72					54.1	54.8	55.0	55.2	55.7	56.0	56.3	56.7	57.0	57.7	58.0	58.8	59.8							
74						56.5	56.9	57.1	57.5	57.9	58.2	58.7	59.1	59.8	60.2	61.0	61.8	62.9						
76						58.1	58.8	59.0	59.4	59.8	60.0	60.6	61.1	61.7	62.3	63.0	63.9	64.8						
78						60.0	60.3	60.8	61.1	61.5	61.9	62.3	63.0	63.6	64.2	64.9	65.7	66.6	68.2					
80						61.7	62.0	62.3	62.8	63.2	63.8	64.1	64.8	65.1	65.9	66.7	67.4	68.3	70.0	72.1				
83							64.3	64.9	65.1	65.7	66.0	66.6	67.1	67.8	68.3	69.1	69.9	70.7	72.1	74.2				
86							66.3	67.0	67.5	67.9	68.3	68.8	69.3	69.9	70.4	71.1	71.9	72.8	74.1	76.1	80.1			
90								69.8	70.1	70.5	71.0	71.4	72.0	72.6	73.2	73.8	74.6	75.3	76.7	78.3	81.9	86.7		
95									73.1	73.6	74.0	74.4	74.9	75.4	76.0	76.7	77.4	78.1	79.4	80.8	83.9	88.0	93.0	
100										76.0	76.5	77.0	77.4	78.0	78.6	79.2	79.8	80.4	81.7	83.0	85.8	89.4	94.4	100.2
105											78.8	79.2	79.8	80.2	80.8	81.4	82.0	82.7	83.8	85.1	87.5	90.8	95.3	100.8
110												81.3	81.8	82.1	82.8	83.3	83.9	84.5	85.6	86.7	89.1	92.0	96.3	101.4
120														85.7	86.0	86.6	87.1	87.7	88.6	89.7	91.7	94.5	97.9	102.8

TABLE 98. RELATION BETWEEN DRY AND WET BULB TEMPERATURES AND EFFECTIVE TEMPERATURE FOR 500 FT. AIR VELOCITY

Wet Bulb Temperature

DRY BULB TEMP.	25	30	35	40	45	49	52	54	56	58	60	62	64	66	68	70	72	74	77	80	85	90	95	100
Effective Temperature																								
30																								
35																								
40																								
45																								
50																								
54				31.1	29.0	26.0																		
57				35.3	34.1	32.8	31.4	30.3	29.0															
60				39.2	38.4	37.6	36.9	36.2	35.5	34.7	33.3													
62				39.7	41.1	40.4	40.0	39.6	39.0	38.3	37.8	37.0												
64					43.6	43.1	42.9	42.7	42.3	42.0	41.6	41.0	40.5											
66					45.9	45.7	45.4	45.3	45.1	45.0	44.9	44.7	44.3	44.0										
68					48.0	48.0	48.0	48.0	48.0	47.9	47.9	47.9	47.8	47.8	47.7									
70					50.0	50.0	50.1	50.1	50.2	50.3	50.4	50.5	50.8	50.9	51.0	51.0								
72					52.0	52.2	52.4	52.4	52.6	52.8	52.9	53.0	53.2	53.4	53.8	54.0	54.5							
74						54.1	54.4	54.6	54.8	54.9	55.1	55.3	55.7	56.0	56.3	56.9	57.3	58.0						
76						56.0	56.2	56.4	56.8	57.0	57.2	57.6	58.0	58.3	58.8	59.1	59.9	60.6						
78						57.8	58.2	58.5	58.8	59.0	59.3	59.8	60.0	60.3	60.8	61.3	62.0	62.9	64.1					
80						59.7	60.0	60.3	60.5	60.8	61.1	61.4	61.9	62.4	62.9	63.4	64.0	64.9	66.3	68.2				
83							62.6	62.9	63.0	63.4	63.8	64.1	64.7	65.1	65.6	66.1	66.8	67.6	69.0	70.8				
86							65.0	65.3	65.7	66.0	66.3	66.7	67.1	67.6	68.1	68.8	69.3	70.0	71.4	73.2	77.1			
90								68.3	68.8	69.1	69.5	69.9	70.2	70.8	71.3	72.0	72.6	73.3	74.5	75.9	79.6	84.6		
95									72.2	72.5	73.0	73.5	74.0	74.5	75.0	75.5	76.2	76.8	77.8	79.1	81.9	86.4	92.4	
100										76.0	76.4	76.7	77.1	77.6	78.0	78.6	79.1	79.7	80.7	81.8	84.5	88.3	93.3	100.4
105											78.9	79.4	79.8	80.1	80.6	81.1	81.6	82.2	83.2	84.4	86.7	90.0	94.5	101.1
110												81.5	81.9	82.3	82.8	83.3	83.9	84.4	85.3	86.4	88.7	91.6	95.7	101.9
120													85.5	85.9	86.3	86.7	87.2	87.7	88.6	89.6	91.4	94.1	97.9	103.3

TABLE 99. RELATION BETWEEN DRY AND WET BULB TEMPERATURES AND EFFECTIVE TEMPERATURE FOR 700 FT. AIR VELOCITY

Wet Bulb Temperature

Dry Bulb Temp.	25°	30	35	40	45	49	52	54	56	58	60	62	64	66	68	70	72	74	77	80	85	90	95	100
Effective Temperature																								
30																								
35																								
40				31.4	29.2	27.3	26.0	25.0	31.0	29.4	30.5	27.5	34.5	38.3	42.0	45.9	49.9	53.5	57.0	64.0	73.7	82.0	91.5	100.7
45				37.5	35.4	33.8	32.5	31.8	34.3	32.8	36.2	35.4	39.0	42.5	46.0	49.9	53.3	56.4	59.6	67.1	76.5	85.7	92.5	101.5
50				39.2	38.3	37.3	36.1	35.3	38.0	37.0	40.4	39.7	43.3	46.3	49.9	53.0	56.1	59.0	62.1	70.3	81.2	87.3	93.7	102.6
54				41.5	41.2	40.5	39.7	39.0	41.6	41.0	43.7	43.3	46.5	49.9	53.1	55.6	58.5	61.5	65.4	73.3	83.7	89.3	95.0	103.7
57					43.2	43.0	42.7	42.3	44.9	44.3	47.2	46.9	49.9	52.8	55.4	58.3	60.8	64.3	68.9	76.5	86.1	91.0	97.7	
60					45.7	46.0	45.7	45.4	47.6	47.4	50.0	50.0	52.7	55.3	58.0	60.4	63.6	67.0	72.0	78.4	88.4	94.3		
62					47.6	47.9	48.0	47.7	47.6	50.0	50.0	52.6	55.1	57.6	60.3	63.3	66.7	70.4	74.2	81.7	91.4			
64						50.0	50.0	50.0	50.0	50.0	52.5	54.9	57.4	59.8	63.0	66.4	69.8	73.6	78.0	85.6				
66						52.0	52.2	52.3	52.4	52.5	54.7	57.0	59.6	62.6	65.7	69.3	73.0	77.6	82.6					
68						53.9	54.2	54.3	54.5	54.6	56.8	59.3	62.1	65.4	68.7	73.3	77.0	81.7						
70						56.2	56.3	56.4	56.5	56.7	59.0	61.7	64.6	68.2	72.5	77.4	81.4							
72						57.8	58.2	58.4	58.6	58.8	61.1	64.4	67.8	72.3	76.8	81.7								
74							61.0	61.3	61.5	61.6	64.5	67.9	71.7	76.6	81.7									
76							63.4	63.7	64.0	64.3	67.9	71.7	76.0	81.4										
78								67.7	67.7	67.7	71.7	76.0	80.9											
80									72.0	72.2	76.0	80.9												
83										78.7	81.7													
86																								
90																								
95																								
100																								
105																								
110																								
120																								

70.8 deg. effective temperature. It is therefore 0.3 deg. effective temperature cooler than the first condition.

Example 2.—Given 76 deg. dry bulb and 61 deg. wet bulb how many degrees difference between this condition and the comfort line or 64 deg. effective temperature?

Answer.—The effective temperature of this condition is given by the intersection of the 76 deg. dry bulb and 61 deg. wet bulb lines and is 68.2 deg. effective temperature or 4.2 deg. effective temperature warmer than the comfort line.

Example 3.—Given the dry and wet bulb temperatures in a room of 78 and 64 deg. respectively, what air velocity will be necessary to make this condition ideally comfortable, that is, 64 deg. effective temperature?

Answer.—From Table 93 for still air it will be seen that this condition has an effective temperature of 70.4 deg. in still air. Looking through the various Tables 94 to 99 for moving air it will be found that with a 300 ft. velocity this condition will have an effective temperature of 63 deg., and with a velocity of 200 ft. (Table 96) it will have an effective temperature of 64.8 deg. Interpolating between these two velocities the desired velocity is found to be 244 ft. per min.

Example 4.—Given a condition having dry and wet bulb temperatures of 90 and 85 deg. respectively, how much cooler will this condition feel if 300 ft. air velocity is supplied instead of still air?

Answer.—From Table 93 it will be found that this condition in still air has an effective temperature of 86.4 deg., while if the air has 300 ft. velocity it will be found from Table 97 that it will have an effective temperature of 81.9 deg. Cooling of 4.5 deg. will be produced by the 300 ft. air velocity.

There are many applications for this data. In cases where air motion will produce a cooling effect it is a simple and inexpensive method. At high temperatures, however, the benefit is small and the effective temperature should be reduced in other ways before setting the air in motion.

In warm weather it is especially desirable to have greater comfort in school rooms, theaters, auditoriums, also factories, foundries, iron, steel and glass works, mines and other places where workers are subjected to extreme temperature conditions. Maintaining comfortable conditions indoors in summer when the thermometer registers about 95 deg. is a more complicated problem than maintaining the proper condition in winter. Incoming air diffusing into the rooms takes up heat from the bodies of occupants, and the heat liberated by operating machinery so that the temperature is increased considerably.

The cooling effect produced by the evaporation of water has been helpful in air conditioning work particularly where air is quite dry. When it comes in contact with water in passing through a humidifier an appreciable amount of heat is lost resulting in a considerable lowering of the air temperature. As an illustration of the value of saturation and air movement take the following average summer condition of 96 deg. dry bulb, 80 deg. wet bulb in practically still air, which corresponds to an effective temperature of 84.7 deg. A 300 ft. air velocity will improve conditions by only 3.5 deg. effective temperature. Saturating the air will reduce the dry bulb temperature to 80 deg. and with a 300 ft. air velocity applied the resulting condition will theoretically be 72 deg. effective temperature so that the improvement will be 84.7 deg.—72 deg. = 12.7 deg. effective temperature.

In practice these theoretical values will not be fully achieved. Therefore an allowance should be made for an increase in temperature and a decrease in humidity of the diffusing air before it strikes the occupants. The cloth-

ing worn and the kind of work done will also have a retarding effect. The experimental evidence now available, of the laws governing the cooling of the human body is of great value in predicting just what may be expected of a definite air velocity at a given temperature and moisture content when directed upon the body of lightly clothed individuals. Complete reports with other detailed examples of the use of Laboratory Comfort Data are to be found in the JOURNAL A. S. H. V. E.

CHAPTER XVII

SYSTEMS OF VENTILATION

VENTILATION whether natural or mechanical, means the displacement of vitiated air from any enclosure and its replacement with fresh air. The systems may be classified as follows:—

Method of Supply	Method of Exhaust
Window	Gravity
Gravity	Fan
Fan	Gravity
Fan	Fan (with or without recirculation)

The movement of air in natural ventilation systems is produced by the difference in density between the column of air in the ducts and the outside air. The greater the difference in temperature between the two columns of air the more rapid the air movement.

In mechanical systems the circulation of air is maintained positively and uniformly regardless of outside air conditions.

The Fan System for Heating and Ventilating consists of a combination of a fan operating in conjunction with a blast heater, with or without a system of air distributing ducts. An air washer or humidifier may be added when required without otherwise changing the type of system. For heating purposes only, the fan system may or may not be used, depending on circumstances and the requirements to be met. The fan system may be used to supply both heat and fresh air for ventilation, or it may be used in conjunction with some form of direct radiation which is to care for the heat losses. When used for ventilating purposes, the fan will be required to supply whatever amount of air is specified to meet the ventilation requirements. The system may be arranged so that the fan may blow the air through the heaters, or draw the air through the heaters. Each arrangement possesses its own peculiar advantages, but the selection depends largely upon the individual requirements of the installation.

The draw-through apparatus is usually employed in factory buildings on account of its compactness as well as the advantage gained by connecting directly to the piping system. In this case the temperature of the air delivered will be the same to all parts of the building. The blow-through apparatus is used in public buildings, or wherever different temperatures and independent temperature regulation are required for different rooms of the building. The use of the by-pass around the heating coils permits the mixture of hot and cold air in any desired proportions, by the use of a mixing damper at the point where the two ducts from the heater, and from the by-pass, join to form one duct leading to the room. In the case of public buildings, the fan frequently

blows the warm air into a space termed a plenum chamber, from which the air ducts radiate to the various rooms of the building; this arrangement is sometimes called the plenum system of heating and ventilating. They are often designated single or double type.

The air supply systems may be distinguished as upward and downward systems the former being used in such buildings, as theaters, auditoriums where people are closely associated. Air is supplied near the floor and exhausted through grilles in or near the ceiling. The downward plan is used in school-rooms, hospitals, and other public buildings, air being introduced 8 ft. or more above the floor and drawn out near the floor. The selection of either system depends upon conditions confronting the engineer.

UNIT SYSTEMS*

Unit systems consist of an individual unit incorporating all the apparatus necessary for providing, directing and controlling the necessary volume of air heated to the proper temperature for the purpose. Two types are in common use, one for public building work and the other for factory and industrial installations. They differ in design and construction in proportion to the service for which they are intended.

They may be located in the various rooms or parts of a building for discharging warmed air into the room or building, and either entirely or partially recirculating the air, or else having a fresh-air connection for special ventilation purposes. These units, in the case of a school-room and sometimes in factories, are set on the floor but frequently in factories are suspended from the roof trusses so as to leave the floor spaces unobstructed.

Public Building Work

Unit heating and ventilating systems intended for public building work consist of a small rectangular steel cabinet, enclosing the following essential parts:—

1. A fresh air inlet.
2. An air filter.
3. A motor and fan assembly.
4. A radiator or heating element.
5. A cold air or by-pass chamber.
6. Mixing chamber.
7. Air discharge outlet.
8. Fresh air and recirculating control damper.
9. A by-pass or temperature control damper.

Note.—Both the recirculating control damper and the by-pass damper can be manually operated, or the recirculating control damper may be pneumatically controlled from some remote point. The by-pass or temperature control damper can be automatically operated on room temperature by means of thermostatic motor in connection with the use of any pneumatic automatic temperature control system. (See also Chapter XII.)

When the fresh air inlet damper is open the fresh air is drawn immediately from out of doors, having the dust and dirt removed by means of the air filters. From this point the air is driven by means of the motor and fan assembly and forced up through the machine, using either polyphase, alternating current or direct current motor.

All of the air may be driven through the radiator to be heated and thence to the room, or all of the air may be driven through the cold air or by-pass chamber and thence to the room, or part of the air may be driven

Data on Unit Systems contributed by H. B. Hedges, G. E. Otis and A. J. Nesbitt, Members.

through the radiator and part through the cold air chamber in any desired proportion, depending upon the position of the by-pass damper.

The air is driven from the machine in a vertical direction at a velocity ranging from 800 to 1000 ft. per minute. This high velocity drives the air against the ceiling of the room, thereby diffusing it and spreading it in a downward movement to all parts of the room.

The closing of the fresh air damper simultaneously opens the recirculating grille at the floor line, so that there is a free path for the air to circulate by gravity through the radiator. Thus, when the motor is not operating and the fresh air damper is closed, the radiator of the unit becomes an enclosed direct radiator, functioning in the same manner, as any other enclosed direct radiator. By starting the motor during heating-up period in the morning, the air may be drawn from the room at the floor line, heated, discharged, recirculated, reheated and redischarged, this process continuing until the room has reached the desired temperature, thus effecting a tremendous saving in time and fuel in preparation of the room for occupancy.

With this system of ventilation, the air outlets for the room serve strictly in the capacity of vents to permit of displacement and they should be small with as little exhausting effect as possible. Under such conditions their location is unimportant further than that they be placed at or very near the floor. In the typical layout they are usually placed in the wall opposite the ventilator. This is not necessary but it has been proven a very satisfactory location and where vent flues are used it is advisable to locate them on inside walls to prevent downdrafts.

In school work where it is desired to circulate air through adjoining wardrobes, room outlets should be in low panels of doors or near floor in partitions. Wardrobe outlets may be either at floor or ceiling. The latter arrangement is usually preferable from a purely ventilation standpoint but the former provides a better heating effect. By such a plan direct radiation may usually be omitted from such rooms. When half doors or no doors are used between class-rooms and wardrobes, outlets from latter must be at floor.

With the mechanical unit ventilation system exhaust fans or aspirating coils in vent flues are neither necessary nor desirable, it being the idea to force the air out of the rooms under back pressure. Where the outlets are properly proportioned this has an inflation effect that retards infiltration and assists in diffusion. One vent for each machine is sufficient and both the grille and flue should have a net free area of about 18 sq. in. for each 100 cu. ft. of air delivered per minute by the ventilator.

In cases where state laws have failed to anticipate this system of ventilation and demand larger vent flues, arrangements can usually be made to provide throttling dampers in same to secure the desired effect.

The so-called corridor system of venting is frequently employed with unit ventilators and is favored by many engineers with this system of ventilation. Vent flues are dispensed with and room outlets are directly into corridors, which serve for conducting the air to roof ventilators connected with grilles located in the ceiling of the top story corridor.

In order to carry out the principle of diffusion and get proper results from the unit system of ventilation, consideration must be given to the

number, size, location and general application of the mechanical ventilators. With a correctly designed system and proper equipment, good diffusion will be effected if the frequency of air change in the room ventilated is equivalent to five or more volumes per hour but the extent to which the desirable effect of air motion is present will be governed both by the frequency of air change and the ceiling height.

On the same principle that underlies the necessary distribution of direct radiation there is a limit to the amount of air which can be distributed from a single point in ventilation work if good results are to be expected. Practical experiments seem to indicate that this limit is about 1500 cu. ft. per min. with this type of apparatus, for this reason mechanical unit ventilators are not built with capacities greater than 1500 cu. ft. per min. and should never be used except in rooms with very

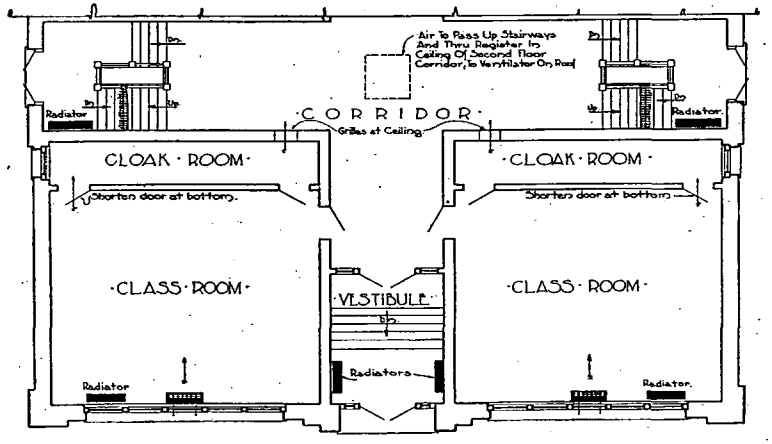


FIG. 76. SCHOOL ROOM PLAN SHOWING LOCATION OF UNITS

high ceilings. In a practical way this determines the number of ventilators to be used in a given case. Where the very best results are desired it is recommended that the capacity of any single machine be limited to 100 cu. ft. per min. per foot of ceiling height.

Mechanical unit ventilators should be centrally located on the outside wall of the room which they serve. Corner locations are liable to result in inefficient and unbalanced distribution. In fact, under adverse conditions, drafts may result from such a location.

Unit ventilators may be recessed but they should never be enclosed or concealed. Not only are enclosures liable to affect the jet action but from a practical standpoint they interfere with proper care and attention by rendering the machine inaccessible. Moreover, there is a certain psychological value to an exposed machine. The occupants quickly learn its purpose and operation with the result that they appreciate its value and see that it is operated and properly cared for.

No single mechanical unit ventilator should be made to serve more than one room by the extension of ducts from the outlet since this is contrary to all the basic principles of the system. Adjacent rooms, if not sufficient in size and importance to be equipped with individual ventilating systems probably do not require any ventilation.

Where the total B.t.u. required for heating and ventilating is in excess of the rated capacity of the unit, the unit must be supplemented by direct radiation. Otherwise, the unit can be used for both heating and ventilating without direct radiation.

No special treatment of vent flues is required by this system, the vitiated air being discharged from the building in the same manner, as all other mechanical systems. It has been found that the best results have been obtained where the cross sectional area of the vent flue did not exceed 20 sq. in. per 100 cu. ft. of air.

Industrial Service

Unit heaters for industrial work consist of a heating element over which air is forced or drawn by means of a power driven fan which also distributed this heated air to the space to be heated. The area that can be served by one unit varies according to the type of unit and the location of the unit within the building. If the unit could always be located in the center of the area, which is the most ideal location from a standpoint of distribution, then one unit would most generally be capable of heating an area from 50 ft. square up to an area 150 ft. square.

Unit heaters may be divided into two classes: Namely, the Direct Fired Type and the Heating Coil Type.

The Direct Fired Type is constructed very much along the lines of the pipeless furnace used in house heating and burns coal, coke, wood, oil or gas fuel. A power driven fan connected to the base of the heater creates

TABLE 100. B.T.U. CONSTANTS FOR VARIOUS STEAM PRESSURES AND TEMPERATURES OF ENTERING AIR

STEAM PRESSURE LBS.	TEMPERATURE OF AIR ENTERING HEATER												
	−10°	0°	10	20°	30°	40°	45°	50°	55°	60°	65°	70°	75°
0	0.975	0.93	0.89	0.84	0.80	0.76	0.73	0.71	0.69	0.67	0.64	0.62	0.60
2	1.01	0.96	0.92	0.87	0.83	0.79	0.76	0.74	0.72	0.70	0.68	0.65	0.63
5	1.04	1.00	0.96	0.91	0.87	0.82	0.80	0.78	0.76	0.74	0.71	0.69	0.67
10	1.06	1.05	1.01	0.97	0.92	0.88	0.85	0.83	0.81	0.79	0.76	0.74	0.72
15	1.15	1.10	1.05	1.01	0.97	0.92	0.90	0.88	0.86	0.83	0.81	0.79	0.76
20	1.18	1.14	1.09	1.05	1.00	0.96	0.94	0.92	0.89	0.87	0.85	0.83	0.81
30	1.25	1.21	1.16	1.12	1.08	1.03	1.01	0.98	0.96	0.94	0.92	0.90	0.88
40	1.30	1.26	1.22	1.17	1.12	1.08	1.06	1.04	1.02	1.00	0.97	0.95	0.93
50	1.35	1.31	1.27	1.22	1.18	1.13	1.11	1.09	1.07	1.04	1.02	1.00	0.98
60	1.39	1.35	1.31	1.26	1.22	1.18	1.16	1.13	1.11	1.09	1.07	1.05	1.03
80	1.49	1.43	1.38	1.34	1.29	1.25	1.23	1.20	1.18	1.16	1.14	1.12	1.10
100	1.53	1.49	1.44	1.40	1.35	1.31	1.29	1.26	1.24	1.22	1.20	1.18	1.16
125	1.59	1.56	1.51	1.46	1.42	1.37	1.36	1.33	1.31	1.29	1.27	1.24	1.22
135	1.61	1.57	1.53	1.48	1.44	1.39	1.37	1.35	1.33	1.30	1.28	1.26	1.24
140	1.62	1.58	1.54	1.49	1.45	1.41	1.38	1.36	1.34	1.32	1.29	1.27	1.25
150	1.64	1.60	1.55	1.51	1.46	1.42	1.40	1.38	1.35	1.33	1.31	1.28	1.26

Note.—To get B.t.u.'s at any steam pressure and entering temperature, multiply constant from table by rated B.t.u.'s at 0 deg. entering and 5 lb. pressure.

a rapid circulation of air over the cast iron heating surface provided in the fire box. The air thus heated is discharged into the building from an outlet on top of the heater. Generally this type is used where steam or hot water is not available and where it is not desired or practical to install a boiler plant.

The Heating Coil Type unit heater consists of a bank of steam or hot water heating coils which may be made of steel pipe, cast iron, copper or brass over which air is blown or drawn by means of a power driven fan. The fan may be direct connected to the motor or pulley driven from motor or line shaft. This type Unit has two distinct classifications: Namely, the Horizontal and the Vertical types.

The Horizontal type as a general rule uses a propeller or disk fan for passing the air over the heating surface. Cast iron and copper tube heating surface are in most cases used in this type unit. The fan and heater are built into a sheet metal casing and the direction of flow of air is regulated by means of sheet metal baffle plates. An advantage of the Horizontal Unit is that it is comparatively light and can be suspended from columns or trusses of the building, thus conserving the floor space, and allowing return mains to be run overhead. The individual motor power requirements per unit are usually less than for other types.

The Vertical Type, as is implied by its name, provides for the air to enter near the floor level and pass vertically through a bank of steam or hot water heating coils. Movement of the air is produced by a power driven fan, and a sheet metal distributing outlet at the top directs the distribution. While this type unit is quite frequently suspended from overhead structural supports, it is primarily designed to rest on the floor level, from which position the most effective results are obtained.

The fans are of the multi-blade centrifugal type and are capable of operating against a static pressure of 1 in. of water or more.

When placed on the floor level these units take the air in at the lowest point where the air is coldest and discharge the heated air at a distance of from 8 to 12 ft. above the floor. The discharged warm air is dissipated in the space to be heated and as it cools, falls to the lower level and is again taken in at the base of the unit and reheated. When so desired the units may be provided with a fresh air connection so that either all outside, all inside, or a combination of both may be used through the heater. This arrangement proves most satisfactory for producing a circulation of outside air in the summer time for ventilation purposes, particularly in large open industrial buildings such as; machine shops, textile mills, foundries, warehouses, garages, mills, railway shops, armories and gymnasiums.

CHAPTER XVIII

AIR WASHERS AND FILTERS

By W. H. CARRIER, Member

THE cleansing of air for ventilation purposes is a very important phase of the art and is accomplished by two different means; washing and filtering. Both methods cleanse the air of solid or liquid matter in the form of dust or spray, while in addition the washer cleanses the air of soluble gases and vapors, and hence of many objectionable odors.

Air filters are distinguished from air washers in that they clean the air without the use of water or the addition of water vapor. They are of two types (1) the viscous filter depending upon the dirt impinging on surface covered with a viscous fluid or oil; (2) the true dry filter type which removes the dirt from the air by passing it through cloth or felt screens, the openings in which are too small to allow the passage of dirt.

TYPES OF AIR WASHERS

The washing of air is done by passing it over a large surface area of water which is accomplished in the various types of washers; (1) by passing it through a fine spray of water; (2) by passing it over wet surfaces; (3) by passing it both through a spray and over wet surfaces. After the air is washed it is freed from entrained water.

When air is cleansed by washing its humidity or moisture content is usually changed. In passing through the water spray or over the wet surfaces both the dry and wet bulb temperature of the air approaches that of the water at which temperature the air tends to become saturated. The moisture content of the air may, therefore, be controlled by controlling the water temperature. By using water at a very low temperature the washer becomes a dehumidifier or by heating the water the air may be humidified. By raising the dry bulb temperature of the air after leaving the washer its relative humidity may also be controlled. The humidifying efficiency of any air washer may be given as

$$E = 1 - \frac{\text{Final wet bulb depression}}{\text{Initial wet bulb depression}}$$

for example: With an initial wet bulb depression of 20 deg. and the final wet bulb depression of 6 deg., the humidfying efficiency is

$$E = 1 - \frac{6 \text{ deg.}}{20 \text{ deg.}} = 0.70$$

TEMPERATURE AND HUMIDITY CONTROL

Air washers require method of control of temperature to prevent freezing by too low temperature and of overhumidification by too high temperatures of the air entering and leaving the washer. There is available one method of hand control and five methods of automatic or semi-automatic control. The method of hand control is by tempering coils divided into two or more sections in series; the outer coil being turned on by hand whenever the outside temperature approaches freezing; the successive coils being turned on as the temperature drops below freezing. Where two sections are available it is usual to turn on the second section when the outside temperature goes below zero, and the third section, where provided, at temperatures below zero. The first, or outside section, must always be turned on full for all temperatures to prevent freezing of the coils. The steam supply to the second, or inside section, may be hand regulated at all temperatures above 10 deg. above zero.

The five systems of automatic regulation are:

1. Substitution of automatic regulation for hand regulation and operated in a similar manner; the coils being controlled both by variations in the outside temperature conditions and also by an auxiliary control for one inside coil from a thermostat located on the discharge side of the air washer. (It is not possible to control the temperature of the air entering the washer except where there is an unusually long tunnel or duct for the thorough mixture of the air leaving the tempering coils before coming in contact with the thermostat.)

2. By heating the spray water so as to maintain a temperature or dew point (as the air is then saturated), between 35 and 40 deg. of the air leaving the washer. This method does not necessarily require a tempering coil, it is preferable, however, to use one tempering coil for the purpose of tempering the air should the washer be shut down and prevent freezing of the water when the apparatus is not in operation. More than one tempering coil should never be used except where temperatures may go considerably below zero, then the tempering coils may be turned on, one at 20 deg. fahr. and the second at 0 deg. fahr. The tempering coil may be operated manually or by a thermostat connected with the outside air. The steam supply for water heating should be sufficient to heat and saturate the air from 10 to 35 deg. fahr., when water heating is used in conjunction with a tempering coil. This is to allow for sufficient margin for safety of operation. The steam requirements for this are given later.

3. By regulating the heat supplied either through tempering coils or through the spray water so that the water in the tank shall be kept well above the freezing point. Inasmuch as the wet bulb temperature of the air and the water in the tank are but few degrees apart when the water in the tank is not heated directly, it is a fairly effective and simple control. One permissible variation of this method is to use a thermostat in the air leaving the washer controlling the dry bulb temperatures at this point through regulation of the steam supply to the inside tempering coil. The wet bulb temperature of the air is controlled by means of water leaving the eliminator plates and is held at the desired point by means of adding heat to the spray water. This will control exactly the temperature and relative humidity of the leaving air. Two or more tempering coils are required for this method.

4. The fourth method is desirable where recirculation is used and consists in maintaining the temperature leaving the washer at about 40 deg. by means of a thermostat located at this point and controlling the admixture of fresh and return air through automatically operated dampers. This effectively prevents overhumidification and also danger of freezing and prevents the highest economy in cost in ventilation as no steam is required for either tempering or humidifying except after the air has passed the washer.

5. The fifth method of automatic control is to reheat the air leaving the air washer to a definite thermostatic controlled temperature and to control the relative humidity of the air by means of a hygrostat which operates either on the tempering coils to heat the air or to heat the spray water through a water heater.

STEAM REQUIREMENTS FOR AIR WASHERS AND FOR HUMIDIFICATION

Where the spray water is not heated it is necessary that the wet bulb temperature of the incoming air be above the freezing point otherwise the eliminator plates will coat with ice and stop up even if the dry bulb temperature of the leaving air is above freezing point. It is necessary to heat zero air to 48 deg. in order that the wet bulb temperature may be 35 deg. The temperature of the leaving air may then be expected to be approximately 39 deg. dry bulb and 35 deg. wet bulb with a dew point of 31 deg. The additional heat required due to humidification is that indicated by the temperature drop of 9 deg. or 162 B.t.u. per 100 cu. ft. of air, or 1 b.h.p., for every 3400 cu. ft. of air per min. These are the minimum requirements for humidication above that required for heating the air. The following Table 101 gives the heat required from various outside entering wet bulb temperatures to various dew points temperatures corresponding to a relative humidity of 70 deg.

TABLE 101. HEAT REQUIRED FROM VARIOUS OUTSIDE ENTERING WET BULB TEMPERATURES TO VARIOUS DEW POINT TEMPERATURES CORRESPONDING TO A RELATIVE HUMIDITY OF 70 DEG.

See Mark's Engineers Handbook.

WET BULB TEMPERATURE OF ENTERING AIR, DEG. FAHR.	RELATIVE HUMIDITY, PER CENT AT 70 DEG. FAHR. (AND DEW POINT, DEG. FAHR.)					
	30% (37.25)	40% (44.5)	50% (50.5)	60% (55.3)	70% (59.6)	80% (63.5)
−10	1194	1452	1653	1860	2044	2245
0	984	1246	1447	1663	1840	2039
10	750	1025	1228	1445	1621	1822
20	510	779	983	1200	1377	1581
30	300	496	700	920	1097	1300
40	.....	178	384	603	783	987
50	.....	.....	.....	220	394	619
60	.....	.....	.....	.....	.....	181

These values are for the total heat required for both heating and humidifying the air. The amount of heat required for humidfying only may be found by subtracting from the values given the heat required to raise the temperature of 1000 cu. ft. of air per min. between the limits specified. The heat required for heating the air is given by the formula

$$H = 1000\,\frac{t_2 - t_1}{55.5}$$

DUST REMOVAL

The comparative efficiency of various air cleaning devices, on the basis of dust removal can be determined by means of standardized tests operated at rated capacities and when handling air at a definite standard

with respect to quantity and quality of dirt content. The determination of the cleaning efficiency may be made according to some standard method such as that described by A. M. Goodloe, member, A. S. H. & V. E. in the February 1924, JOURNAL. The percentage of dust removal as determined by the method of testing for all commercial air cleaning devices should lie between 80 and 95 per cent and the minimum removal under such conditions should be specified and guaranteed by the manufacturer.

The efficiency of dust removal may be expressed by the following formula:

$$E = 1 - \frac{\text{Weight any sample leaving}}{\text{Weight any sample entering}}$$

In case the resistance method is used in accordance with the Anderson-Armspach method of dust determination, the formula will become

$$E = \frac{\text{Time required to give a definite resistance increment with entering sample}}{\text{Time required to give the same increment with leaving sample}}$$

or, if the same time be used in obtaining both samples, which is preferable then

$$E = 1 - \frac{\text{The resistance increment of outgoing sample}}{\text{The resistance increment of ingoing sample}}$$

RATING OF AIR WASHERS AND FILTERS

Air washers and filters are rated as follows:

1.—Capacity in cubic feet of air handled per minute.

2.—Resistance in inches of water which the washer or filter offers to the flow of air at its rated capacity.

3.—Percentage of dust removal at its rated capacity.

4.—Percentage of entrained moisture remaining in the air after passing through the washer while operated at its rated capacity.

5.—If considered as a humidifying agent, the humidfying efficiency, or the percentage of reduction in the initial wet bulb depression without external alteration of heating the circulating water.

CHAPTER XIX

APPLICATION OF REFRIGERATION IN AIR CONDITIONING

By N. A. HOLLISTER, Non-Member

THE advantages of one method of cooling air over another and the general factors governing the proportioning and design of air conditioning units are of interest to all whose work may bring them in contact with systems using refrigeration. It is the purpose of this chapter to give those not familiar with this important branch of air conditioning a better understanding of how refrigeration is applied in this work.

The producing of the refrigeration for an air conditioning installation is a problem for the engineer, and is the same as any other refrigerating problem with a varying load. The method of treatment of the air, and its distribution is a separate study involving the entire subject of air conditioning.

The remaining problem, then, in connection with the use of refrigeration in air conditioning is the actual application of refrigeration in a unit or apparatus for cooling the air.

The transfer of heat in air conditioning apparatus is usually accomplished by one of three methods:

1. Passing air through cold water or cold brine sprays
2. Passing air directly over cold coils
3. Combination of the above two methods

COLD SPRAYS VS. COLD COILS

A liquid spray which absorbs the heat from the air and transfers it to cooling coils is more frequently used than cooling coils in direct contact with the air, for the following reasons:

1: Fewer coils required, therefore lower first cost, less space and weight
2. Low power for driving compressor
3. Ease of keeping unit clean
4. Ease of controlling effect on air
5. Securing of air cleaning
6. Humidity control in winter

LESS COIL REQUIRED

Water is generally used for spraying when the lowest liquid temperature is not too close to freezing. For lower temperature calcium or brine solutions of varying strengths, according to the requirements, are used. A liquid spray has the following marked advantages:

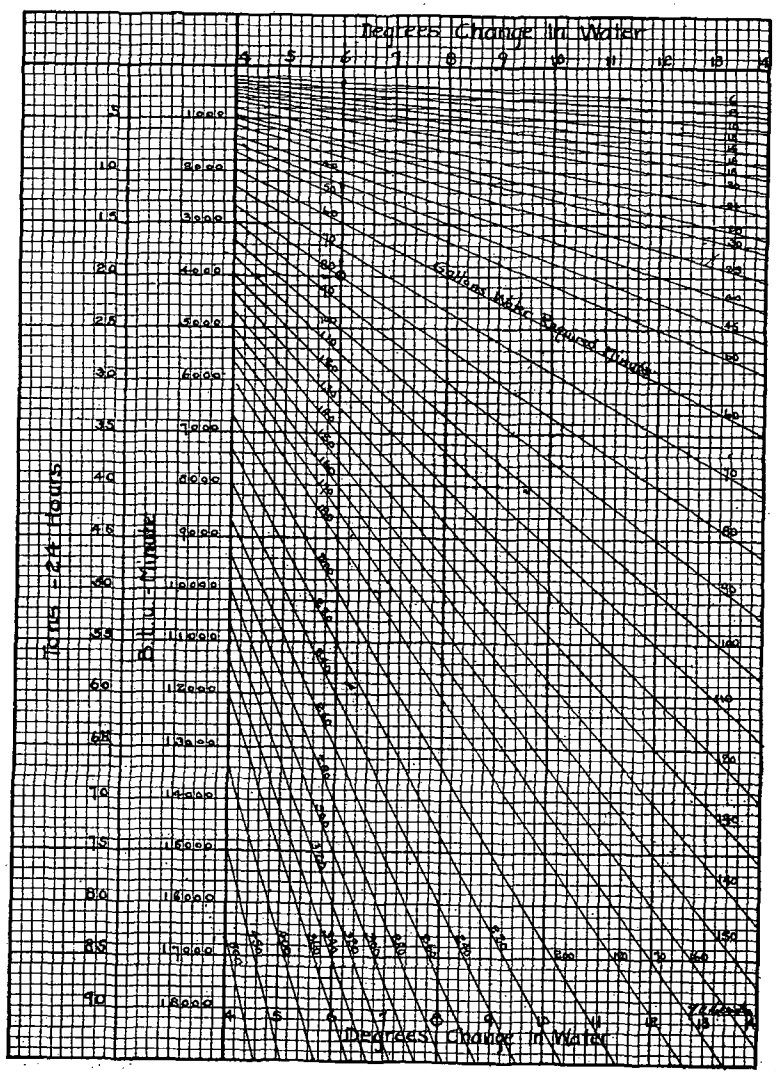


FIG. 77. GALLONS WATER REQUIRED PER MINUTE

1. Cheap method of securing an enormous radiating surface for heat transfer from the air
2. Continuous cleaning radiating surface
3. Elimination of all frosting of the coils with the *accompanying lowering of heat transfer from* coil surface
4. High heat transfer from liquid to coil surface

With the comparatively small temperature differences encountered in such work, as 40 deg. water and 55 deg. air, the need of considerable heat absorbing surface is apparent. When water is sprayed the heat transfer must take place on the surface of the drops and the square feet of surface will depend upon how finely the water is divided. Ten gallons of water sprayed and divided into spheres of 0.25 in. diameter gives about 380 sq. ft. of drop surface. If divided into drops of 0.10 in. diameter spheres, the surface increases to about 1000 sq. ft. The water is divided into almost invisible drops and the square feet of radiating surface secured will make a heat transference which would require a large and expensive coil.

With water flowing over the cooling coils the rate of heat transfer is many times that secured with air passing over the coils even when the coils are dry and not frosted. With the correct design and proportioning 40, 50, or even 60 B.t.u. per hour per sq. ft. per deg. difference may be obtained in practical commercial units as compared to the 2 B.t.u. or 6 B.t.u. from dry coils to air. The high transmission from water to coil, frosting disadvantages and other factors all combine to necessitate much less water-to-coil surface than coil-to-air surface with an accompanying saving of cost, space, and weight.

LOW POWER FOR DRIVING COMPRESSOR

Many air conditioning installations are operated 24 hours per day and on every installation the power used for operation is important. The higher the ammonia temperature, the lower the power used by the compressor.

CLEANING UNIT

When using the coil-to-air bunker room designs in order to get contact between the coils and air, the coils must be close together, arranged in some staggered form or with deflectors and baffles. Such arrangements make it almost impossible to allow for proper cleaning.

Dirt collects on the wet surfaces as on the wet eliminator or scrubber plate surfaces in the dehumidifying unit but in the bunker room there is no flow of water to clean the surface. Fungus slime frequently collects which, together with rust and dirt and matter carried in by the air, makes cleaning desirable, if not an absolute necessity.

With the spray method the flowing water keeps all surfaces cleaner and the draining of the tanks gives a ready means of carrying away all matter collected.

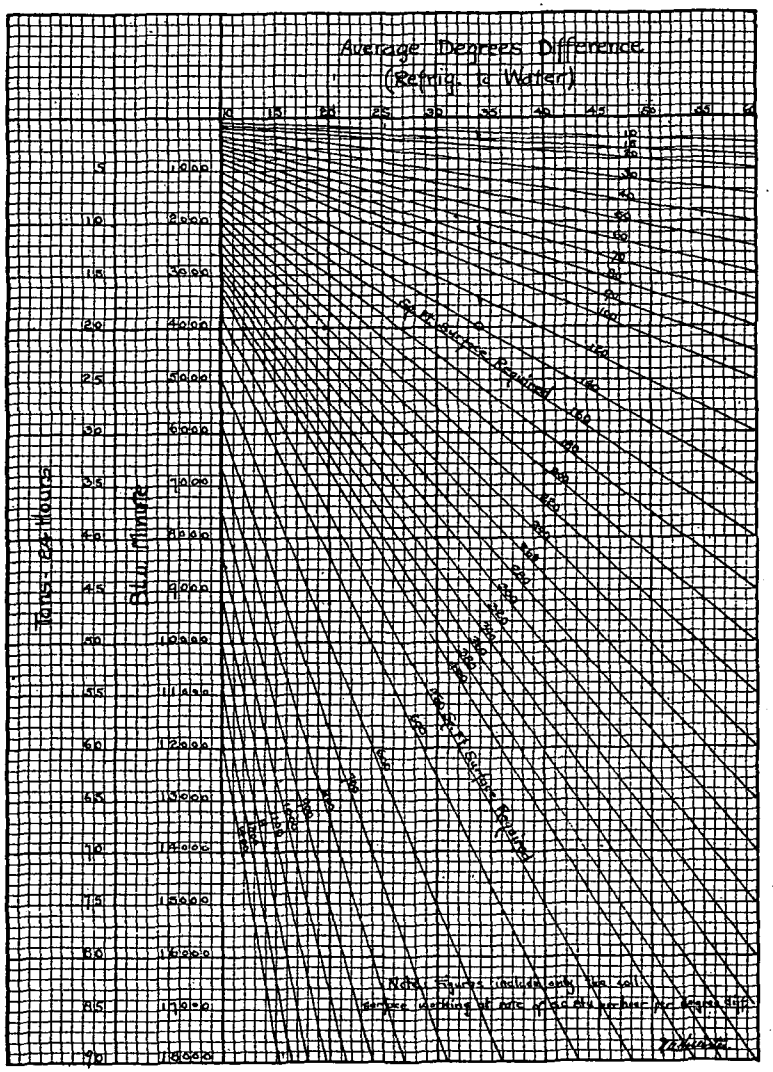


FIG. 78. SQUARE FEET WET COIL SURFACE

CONTROLLING EFFECT ON AIR

The control of outgoing air conditions, whether by hand or automatic devices is more rapidly changed in the spraying method than in the coil-to-air method. If an operator is cooling the air with coils covered with frost (and they are practically always covered with frost and ice) and he desires to remove the cooling effect he may shut off the refrigerant but the bunker room will continue to treat the air until the frost and ice are melted which may take quite a while. The alternative method of changing the air temperature is to use more space and increase the cost by providing a by-pass duct around the bunker room.

By using a small tank capacity in relation to the volume being pumped it is possible quickly to cool or heat the water and thus have quick effect on the air.

Cleaning of Air

Where dirt or gases carried by the outdoor air which would harm a product or be undesirable for persons, the coil-to-air bunker room does no cleaning and may even add unsatisfactory bacteria due to the unit not being easily kept clean. The spray unit is in itself an efficient air cleaning apparatus.

Humidifying of Air

When refrigeration is used in air conditioning work, whether primarily for lowering the dry bulb or for lowering the humidity the resulting moisture in the air is seldom as low as in the outdoor air during our many winter months. For many uses too low a humidity is as undesirable as too high a humidity and many times a constant humidity is desired all year to control yearly manufacturing conditions. The coil-to-air method offers no humidifying whatever while the spray type unit changes from a dehumidifier to a humidifier as soon as the water is not cooled. By air re-circulation or by heating the water or by both, even an excessive humidity may be readily produced by the spray type unit and the humidity controlled all year.

Coil and Spray Combined

Without study it might appear that placing the coils in the spray chamber would be the practical solution. It is seldom that this is advisable.

On light duty units, that is, where not much refrigeration is being used in comparison with the air being handled and in some small units coils may be placed in the spray chamber thus doing away with the lower coil chamber, tank, and troughs, but more coil surface and a large spray chamber must be used.

Unless the resistance of the unit is to be increased the spray chamber must be increased to allow for the space occupied by the coil in the air path. If much refrigeration is being used it will be found that the horizontal projected area of the coil is considerable.

Only a small fraction of the water sprayed hits or comes in contact with the coil surface. Some of the water is therefore not cooled during each cycle and to maintain a certain average water temperature some of the water must be cooled considerably lower. As it is not advisable to

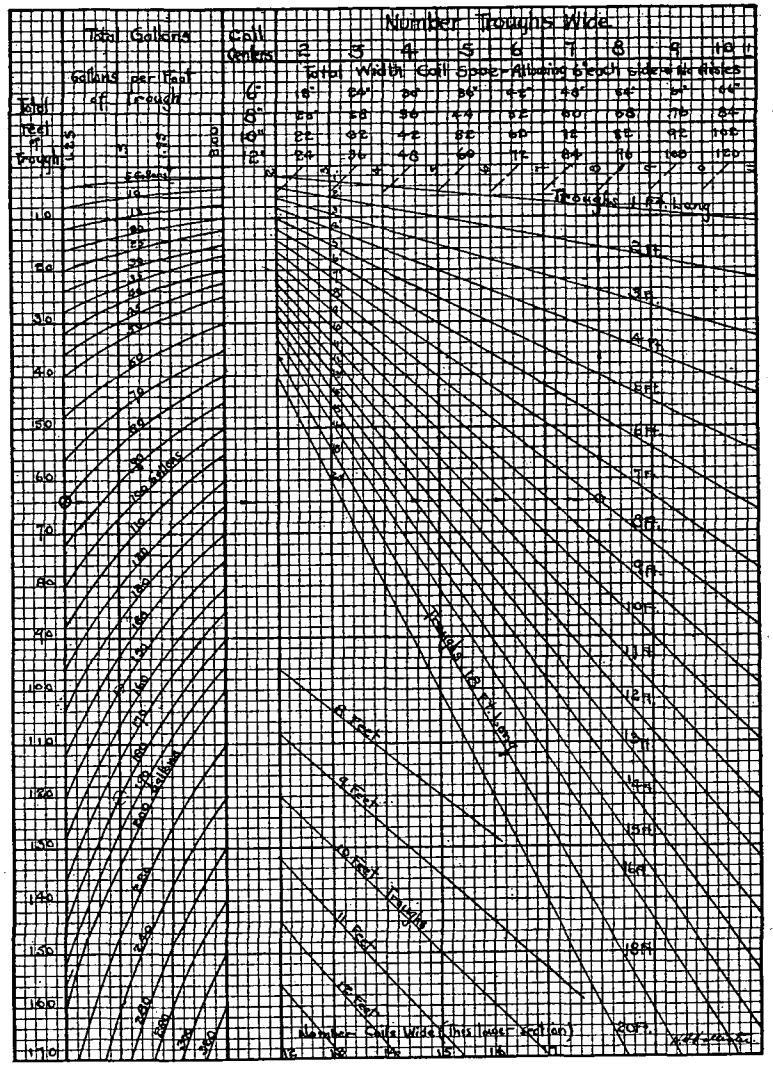


FIG. 79. TROUGHS

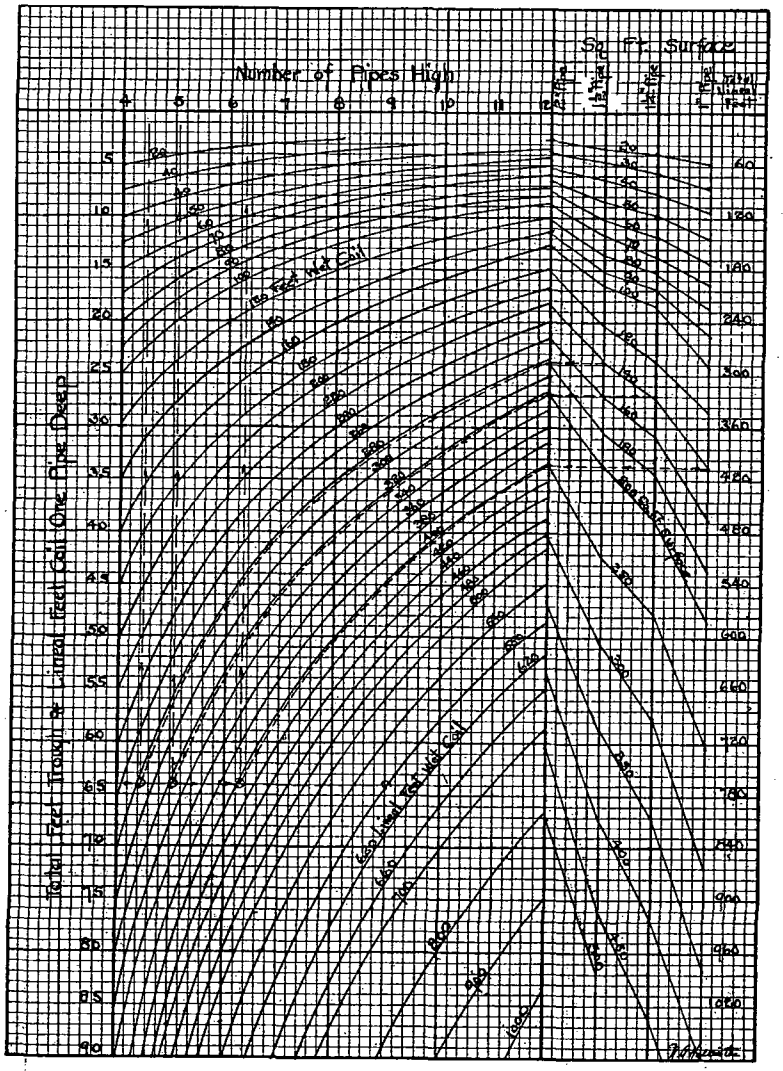


FIG. 80. SIZE OF PIPES AND NUMBER OF PIPES HIGH

CUBIC INCHES OF AMMONIA VAPOR TO BE CIRCULATED TO PRODUCE ONE TON OF REFRIGERATION IN TWENTY-FOUR HOURS

Condenser Pressure Gage	Condenser Pressure Abs.	95	110	125	140	155	170	185	200	215	230	245
		109.7	124.7	139.7	154.7	169.7	184.7	199.7	214.7	229.7	244.7	259.7
Temperature of Liquid		61°F.	68°	74.4°	80.3°	85.8°	91°	95.8°	100.3°	104.8°	108.7°	112.8°
Suction Pressure Gage	Suction Pressure Abs.	Temp. of Suction	Ammonia Vapor in Cubic Feet per Minute									
5"V.	12.2#	−33.6°F	14,880	15,100	15,310	15,525	15,750	15,975	16,175	16,375	16,575	16,775	16,975
4"	12.7	−32.3°	14,320	14,550	14,750	14,950	15,170	15,375	15,560	15,750	15,940	16,120	16,310
3"	13.2	−30.9°	13,820	14,040	14,240	14,440	14,630	14,825	15,010	15,190	15,375	15,560	15,740
2"	13.7	−29.6°	13,340	13,540	13,720	13,920	14,110	14,300	14,480	14,660	14,840	15,010	15,190
1"	14.2	−28.4°	12,885	13,075	13,250	13,445	13,640	13,820	13,990	14,150	14,320	14,490	14,660
0#	14.7	−27.1°	12,460	12,650	12,840	13,020	13,200	13,375	13,540	13,700	13,860	14,025	14,190
1#	15.7	−24.8°	11,700	11,855	12,020	12,210	12,380	12,545	12,720	12,875	13,010	13,150	13,305
2	16.7	−22.6°	11,005	11,160	11,340	11,500	11,660	11,810	11,950	12,100	12,240	12,400	12,540
3	17.7	−20.4°	10,410	10,575	10,710	10,850	11,020	11,175	11,310	11,450	11,590	11,730	11,860
4	18.7	−18.4°	9885	10,020	10,180	10,310	10,450	10,595	10,720	10,850	10,990	11,110	11,225
5	19.7	−16.5°	9400	9540	9690	9820	9960	10,090	10,210	10,340	10,450	10,580	10,700
8	22.7	−11.0°	8200	8310	8425	8550	8675	8790	8895	9000	9100	9200	9305
10	24.7	−7.7°	7550	7670	7770	7880	7990	8090	8190	8290	8390	8480	8580
12	26.7	−4.7°	7010	7110	7210	7320	7420	7520	7610	7700	7795	7880	7980
15	29.7	−0.3°	6320	6420	6510	6610	6695	6790	6860	6940	7025	7110	7190
20	34.7	+6.1°	5445	5530	5605	5690	5750	5825	5905	5990	6040	6110	6190
25	39.7	+11.9°	4780	4850	4910	4990	5050	5110	5190	5240	5300	5380	5420
30	44.7	+17.0°	4250	4310	4380	4440	4500	4560	4620	4680	4725	4790	4840
35	49.7	+21.8°	3850	3910	3970	4020	4070	4120	4170	4220	4270	4320	4370
40	54.7	+26.2°	3510	3560	3610	3655	3705	3760	3810	3855	3905	3940	3980
45	59.7	+30.3°	3220	3280	3320	3360	3410	3450	3500	3540	3590	3630	3680
50	64.7	+34.1°	2980	3020	3070	3110	3150	3190	3225	3275	3310	3350	3390

operate too close to the freezing point, either brine must be sprayed or a low temperature cannot be carried without submerged coil surface as well as extra coils in the spray chamber.

When the sprayed water hits the cooling coil it does not have a tendency to stick to the coil. The result is that a lower total volume of water will be flowing over the total coil surface and less total cooling will be secured per foot of surface used.

If the cost of a larger spray chamber, extra coil surface in the spray chamber, and the submerged coils required and the other factors are favorable, the coils may be used in the upper spray chamber with satisfactory results in some installations.

For some duties a return bend arrangement may be used passing the air through the upper chamber and then down and back through the lower coil chamber. The coils are covered by a film of running water at a lower temperature than the air and as some air will come in contact with the cold water and other cooled surfaces a limited amount of extra cooling may be secured.

There is one important point which is a problem for the refrigerating engineer, but which has sometimes been overlooked. This is the matter of control of the refrigeration. Almost all air conditioning installations, whether with automatic or hand control, give a varying refrigerating load. Systems have been operated using many tons of refrigeration and this load has suddenly been removed owing to changing requirements. Meanwhile the ammonia compressor may be operating, and freezing of the system with accompanying damages results if carried far enough. Ammonia lines in a plant cannot be tapped and valves turned on and off quite as readily as in a steam line. The refrigerating engineer should be fully advised regarding the varying of the air conditioning refrigerating load.

With the accompanying charts no one should have difficulty in checking a layout or making preliminary approximate estimates of the part of an air conditioning unit using refrigeration. It is impossible to give here all the factors governing the use of refrigeration and the allowance to make for different conditions such as coils that are dirty or oily on the inside, coils with poor outside surfaces, the element of time in changing conditions of air treatment, structural considerations and particularly the action of the water when it is sprayed in the coil chamber in contact with the air. It is not suggested by the author that those unfamiliar with the details of such work use these charts except as a source of general information as to the factors governing the design of such equipment.

Estimates as shown by the dotted lines on the charts are made as follows:

1. Total heat load—4,000 B.t.u. per minute
   20 tons refrigeration
2. Design and conditions allow 6 deg. rise in water temperature
3. Average water temperature 44 deg.
4. Average ammonia temperature 10 deg.
5. Difference ammonia and water 34 deg.
6. Gallons handled per ft. of trough 1¼
7. Standard unit available allows 8 ft. long troughs

Fig. 77 shows that 80 gallons water per minute are required.

Fig. 78 shows that 140 square feet of cooling coil surface are required when working at the rate of 50 B.t.u. per hour per square foot per degree difference.

Fig. 79 shows 64 lineal feet trough required.

Also shows 8 troughs and coils wide and space required as follows:

6 in. coil centers require space 54 in. wide
8 in. coil centers require space 68 in. wide
10 in. coil centers require space 82 in. wide
12 in. coil centers require space 96 in. wide

From Figs. 78 and 79 it was found that 140 sq. ft. of surface and 64 lineal feet of troughs were required. Fig. 80 shows the following:

Pipe diameter	1½ in.	1¼ in.	1 in.
Lineal Feet	225	283	404
Pipes High	5	6	7

Pipes High have been increased to eliminate fractions and in designing a unit the lineal feet of coil required would have to be increased in proportion. Allowance must be made for dirty coils, uneven water distribution, quick control of temperatures and other factors, all of which might double the coil surface shown mathematically by the charts.

The heat transfer which may be obtained in the upper chamber and the maximum rise in the water temperature, and therefore the use of Fig. 77, will vary with each change in nozzle, pump pressure, time element, pounds of water used per pound of air, water to air temperature differences, and other such factors as might be expected, but once the volume of water and the temperature through which it must be cooled are determined, the design of that part of the apparatus using refrigeration will be a comparatively simple problem to those familiar with such work.

CHAPTER XX

DESIGN AND CONSTRUCTION OF AIR DUCTS

By F. R. STILL, Member

THE successful operation of a mechanical or plenum heating installation, an exhaust system or a dust collecting plant is largely dependent upon the correct design of the duct system. Materials, proportions, friction, location and innumerable other items are factors in the correct operation of a duct system.

In the design of ducts and flues for the mechanical circulation of air, or by gravity, losses due to friction are the basis for figuring and these losses must be kept within the available pressure difference. This pressure difference in mechanical ventilation is that derived from the fan while in gravity ventilation it is the asperating effect due to the temperature and height of the column of heated air.

When attempting the design of a duct system the general rules to remember are:

1. The air should be conveyed as directly as possible at reasonable velocities to obtain the result desired with greatest economy of power, material and space.
2. Sharp elbows and bends are to be avoided.
3. All ducts or flues shall have sides as nearly equal in size as possible. (In no case shall the ratio between long and short sides be greater than 10 to 1.)

The piping systems for various operations must be of different design as the principal consideration for industrial work is for heating while in public buildings the air required for ventilation greatly exceeds the volume needed for heating. For instance, the ducts for a school, theatre or other public buildings, where freedom from noise and elimination of drafts is essential and where branch ducts serve individual rooms, is a much different problem in design than that involved in proportioning ducts intended for heating a factory, where a main duct of decreasing dimensions extends lengthwise of the building and gives a uniform distribution of air. For public buildings air velocities must, therefore, be kept low between 900 and 1200 ft. per minute while in industrial buildings they can range from 1500 to 2000 ft. per minute or even more with no other disadvantage than expensive operation.

Standard velocities of air in public buildings are as follows:

1. Through the outside air intakes 1,000 ft. per min.
2. Through connections to and from heater 1,000 to 1,200 ft. per min.
3. Through the main discharge duct from 900 to 1,200 ft. per min.
4. In branch ducts 700 to 900 and vertical flues 400 to 600 ft. per min.
5. In registers or grilles 200 to 400 ft. per min. depending upon the size and location.
6. If diffusers of proper design are used, 25 per cent higher air velocities may be permitted.

TABLE 102. CORRESPONDING PRESSURES AND VELOCITIES OF DRY AIR AT 70 DEG. AND 29.92 IN. BAROMETER

INCHES OF WATER	OUNCES PER SQ. IN.	VELOCITY FT. PER MIN.	INCHES OF WATER	OUNCES PER SQ. IN.	VELOCITY FT. PER MIN.
0.05	0.0289	896	4.77	2.750	8745
0.10	0.577	1266	5.00	2.884	8943
0.20	0.1154	1791	5.20	3.000	9134
0.25	0.1443	2003	5.50	3.172	9392
0.30	0.1730	2193	6.00	3.460	9810
0.40	0.2308	2533	6.07	3.500	9864
0.43	0.2500	2637	6.50	3.749	10210
0.50	0.2884	2832	6.94	4.000	10545
0.60	0.3460	3102	7.00	4.037	10595
0.70	0.4037	3351	7.50	4.326	10968
0.75	0.4326	3468	7.80	4.500	11187
0.80	0.4614	3582	8.00	4.614	11328
0.87	0.5000	3729	8.67	5.000	11792
0.90	0.5190	3800	9.00	5.190	12015
1.00	0.5768	4005	9.54	5.500	12367
1.25	0.7209	4478	10.00	5.768	12665
1.30	0.7500	4566	10.40	6.000	12915
1.50	0.8650	4905	11.00	6.344	13282
1.73	1.0000	5273	11.27	6.500	13445
1.75	1.0092	5298	12.00	6.921	13875
2.00	1.1535	5664	12.14	7.000	13950
2.17	1.2500	5895	13.00	7.497	14440
2.25	1.2975	6007	13.87	8.000	14913
2.50	1.4418	6332	14.00	8.074	14985
2.60	1.5000	6457	15.00	8.650	15510
2.75	1.5860	6641	15.61	9.000	15820
3.00	1.7300	6937	16.00	9.227	16020
3.03	1.7500	6976	17.00	9.805	16513
3.25	1.8740	7220	17.34	10.000	16675
3.47	2.0000	7457	18.00	10.380	16990
3.50	2.0185	7492	19.00	10.960	17456
3.75	2.1630	7756	19.07	11.000	17488
3.90	2.2500	7910	20.00	11.535	17910
4.00	2.3070	8010	20.81	12.000	18265
4.25	2.4510	8256	22.54	13.000	19012
4.34	2.5000	8337	24.28	14.000	19730
4.50	2.5950	8496	26.01	15.000	20420
4.75	2.7395	8729	27.74	16.000	21090

TABLE 103. CORRESPONDING VELOCITY FOR DRY AIR AT VARIOUS PRESSURES AND TEMPERATURES AND 29.92 IN. BAROMETER

PRESSURE		50°	60°	70°	100°	150°	300°	500°	550°
Inches	Ounces								
0.25	0.1443	1965	1986	2003	2059	2149	2399	2696	2895
0.5	0.2884	2778	2808	2832	2911	3038	3391	3812	4095
0.75	0.4326	3402	3439	3468	3565	3720	4153	4668	5020
1.00	0.5768	3929	3971	4005	4117	4296	4796	5390	5795
1.25	0.7209	4393	4440	4478	4602	4804	5362	6027	6470
1.50	0.8650	4812	4864	4905	5042	5262	5874	6602	7100
1.75	1.0092	5197	5254	5298	5446	5683	6344	7131	7655
2.00	1.1535	5556	5616	5664	5822	6076	6783	7624	8195
2.25	1.2975	5892	5956	6007	6174	6443	7193	8085	8690

It is customary in proportioning ducts for heating and ventilating work to follow either of two methods:

1. Arbitrarily select sizes from assumed velocities, depending upon velocity of air at fan outlet.
2. Determining the velocity which will give an assumed resistance within fan capacity at noiseless operating speed.

By decreasing the velocity in main duct as air is delivered through branch outlets: (1) uniform air delivery through outlets is accomplished, (2) friction in smaller pipes is reduced, (3) portion of velocity head is converted into static pressure.

The two greatest losses in duct systems are dynamic losses and friction losses. The former are chiefly caused by changes in direction or in velocity of air flow and are expressed in pressure in inches of water gage as per Table 103.

Friction losses due to friction of air against sides of ducts, vary directly as the length of the pipe, directly as the square of the velocity and inversely as the diameter. Friction is commonly expressed as equivalent pressure in inches water gage or in terms of velocity heads, (the ratio of friction loss to the theoretical pressure corresponding to the velocity in the duct). One velocity head is the pressure corresponding to the velocity of air in the duct.

For smooth round pipes the friction loss is:

$$F = \frac{L}{50\,D}\left(\frac{V}{4005}\right)^2$$

where

F = loss of pressure in inches of water
V = velocity in feet per minute
L = length of pipe
D = diameter of pipe in feet; $\frac{L}{D}$ = length of pipe in diameters.

If a factor of safety is thought desirable the length 45 may be used though experiments show that the friction loss is equal to one velocity head in a length varying from 40 to 60 diameters depending upon the smoothness of the duct. The engineer's judgment and experience should prevail in this matter. For example correction should be made for pipes with rough or uneven surfaces and in the case of brick or concrete ducts the friction loss should be increased 25 per cent or more.

A formula for rectangular ducts is derived in a similar manner but it will be found very convenient to use the accompanying chart Fig. 81.

Other losses of pressure are at the entrance to the duct, through heater, air washer, etc. In ordinary practice it is usual to keep the sum of the piping losses $\frac{1}{8}$ to $\frac{1}{2}$ and the loss through heater at less than $\frac{1}{2}$ of the static pressure. The remainder is then available for producing velocity.

The ideal duct system will take all factors into consideration and proportion air velocities so that the resistance will be practically equal in all ducts regardless of length.

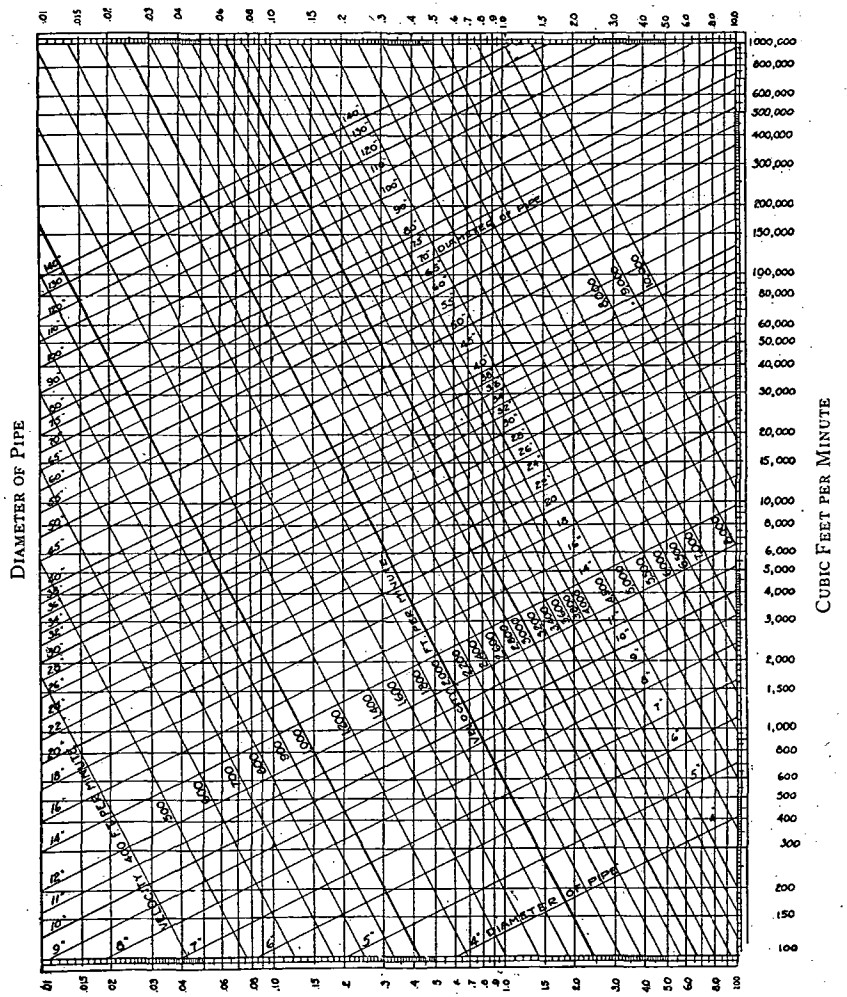


FIG. 81. FRICTION CHART

HOW TO USE THE FRICTION CHART

While this chart can be used to determine the friction of air which is flowing through ducts, it can also be used for determining the size of a pipe to handle a specified volume or the velocity that will be necessary. For example:

1. Assume that a volume of 20,000 cu. ft. per min. is to be discharged through a 36 in. duct. The volume is given on the right hand margin; follow along the horizontal line opposite 20,000 cu. ft. per min. until it intersects with the diagonal line sloping upward to the right which is marked 36 in. diameter of pipe. The velocity will be found to be 2,800 ft. per min., this being the other diagonal line sloping downward to the right. At this point of intersection is a vertical line giving the friction, which is indicated at the bottom of the chart as being 0.4 in. water gage per hundred feet of length. Thus if the duct is only 40 ft. long, the friction will amount to $\frac{40 \times 0.4}{100} = 0.16$ in. W. G.
2. The friction of elbows varies with the radius; an elbow having a radius in the throat that is half the diameter of the pipe, will present a frictional resistance that is equivalent to a straight pipe that is 30 times its diameter. For instance a 36 in. diameter elbow having a radius of 18 in. in the throat would present as much friction as $\frac{30 \times 36}{12} = 90$ ft. of straight 36 in. pipe.

   If the radius in the throat is equal to the diameter then the friction would only be equal to 10 diameters. If the radius is twice the diameter, the friction is only 4.3 diameters.

   The friction of a rectangular pipe for a given velocity (not for volume) can be converted to an equivalent round pipe as follows: $D = \frac{4\,W\,H}{2\,W + 2\,H}$, in which W is the width, H is the height and D is the diameter, all in inches.

   To find an equivalent diameter for a given volume and the same friction as a rectangular duct, proceed as follows:

$$D = \frac{W}{0.79 \sqrt[5]{\left(\frac{W}{H}\right)^3 + \left(\frac{W}{H}\right)^3}}$$

SOME GENERAL INSTALLATION AND CONSTRUCTION HINTS

1. Ducts should be not less than 6 x 6 in. in size and made of galvanized iron or steel.
2. Angular turns should be made with elbows having a radius not less than the width or diameter of the duct.
3. Offsets should be at an angle of 30 to 45 deg.
4. Branch ducts should make curved connection with main duct and should have accessible dampers.

GAGES OF GALVANIZED IRON OR STEEL TO BE USED FOR DUCTS, FOR OUTSIDE AIR INTAKE

Heating and Ventilating

ROUND DUCTS, DIAM., IN.	GAGE	RECTANGULAR DUCTS WIDTH, IN.	GAGE
6 to 19	26	4 to 18	26
20 to 29	24	19 to 30	24
30 to 39	22	31 to 60	22
40 to 49	20	61 to 118	20
50 and above	18	118 and above	18

5. Rectangular ducts should have metal strap or rod supports and when over 36 in. in width should be stiffened with angle iron at 4 ft. intervals.
6. Longitudinal seams and transverse joints should be flat and smooth inside; slip joints should be in direction of air flow.
7. Access doors to ducts should be hinged and fire dampers in supply and vent ducts should be of ⅛ in. steel plate, held by fusible link for release at 160 deg. fahr.
8. Air intake should be screened with 1 in. mesh or less and protected from weather.
9. Final exit for exhaust ducts should be protected from weather and placed so as not to contaminate air supply.
10. Underground ducts should be waterproofed, drained and provided with means of access for inspection and cleaning.

MEASUREMENT OF AIR FLOW

The quantity, velocity and pressure of air discharged by a fan or flowing through a pipe may be determined by various methods. An anemometer is used where accuracy is not required and where air velocities not over 600 ft. per min. are to be measured, as at registers. For the greatest measure of reliability the anemometer shall have been newly calibrated, and correction shall be made for the error as shown by the calibration.

The standard method for measuring air velocity and pressure shall be the pitot tube as described in the A. S. H. & V. E. Standard Code for the Testing of Centrifugal and Disc Fans (TRANS., A. S. H. & V. E., Vol. 29, 1923, p. 407.) Installation tests for determination of fan capacity and efficiency shall be under laboratory conditions, in accordance with this Code.

CHAPTER XXI

EXHAUST AND COLLECTING SYSTEMS

PNEUMATIC exhaust and collecting systems may be classified in various ways. They may be classified by the economic purpose to be accomplished by the industries served, or by the type of system used.

Classifying exhaust systems by industries served, they fall in subdivisions such as, metal working, woodworking, leather and shoe manufacturing, rubber industry, flint grinding, pottery works, pulverizing works, celluloid manufacturing, printing establishments, felt hatting and fur manufacturing, textile mills, grain and cereal industry, etc.

TYPES OF SYSTEMS

The type of exhaust system to be used is determined by the industry served, kind of material handled, and the work to be accomplished. There are two general arrangements; the central and the group systems. In the central system a single or double fan is located near the center of the shop with a piping system radiating to the various machines to be served. In the group system, which is sometimes employed where the machines to be served are widely scattered, small individual exhaust fans are located at the center of the machine groups.

The group arrangement has the advantage of flexibility. It is, however, more difficult to balance than the central, and also the large number of small diameter trunk lines required show a much higher friction loss per foot of length than with the central system where one large main pipe serves a considerable number of machines.

Exhaust systems are also characterized by the means employed to collect the dust or other material handled. The dust or refuse may be collected and controlled by enclosing hoods, open hoods, inward air leakage or general room exhaustion.

With another class of machinery it is not feasible to closely hood the machines and in these cases open hoods over or adjacent to the machines are provided to collect as much of dust and fumes arising as possible. In this class come such machines as rubber mills, package filling machinery, sand blast, crushers, forges, pickling tanks, melting furnaces, and the unloading points of various types of conveyors.

The open hoods should be placed as close to the source of dust or fumes as possible with due regard to the movements of the operator.

When the hood has to be placed at some distance above the machine it should be large enough to encompass an area of considerable extent as diffusion is usually quite rapid.

Material for this section was prepared especially for THE GUIDE by H. M. Nichols, Boston, Mass.

Consideration must also be given to the natural movement of the fumes. For those that are lighter than air the hood should be over or above the machine and where a heavy vapor or dust-laden air at ordinary temperature is to be removed, horizontal or floor connections are required. If it is attempted to remove heavy dust such as lead oxides by an overhead hood the conditions may be worse than if no exhaust were used at all, owing to the rising air current carrying the dust up through the breathing zones. The principle to keep in mind in all cases is to take advantage of the natural tendency of the material to move upward or downward.

In another class of operation the main object is to prevent the escape of dust into the surrounding atmosphere, the removal of some dust from the machine or enclosure being merely incidental. The dust creating apparatus is enclosed within a housing which is made as tight as practicable, and sufficient suction is applied to the enclosure to maintain an inward air leakage, thus preventing escape of the dust. While the exhaust system is only required to handle the air which leaks in through the crevices and openings in the enclosure, yet in many installations leakages are very high and great care is required to obtain satisfactory results with a system of this kind. The inward leakage principle is utilized for controlling dust in the operating of tumbling barrels, grinding, screening, elevating and similar processes.

Certain dust and fume producing operations are best carried on by isolating the process in a separate compartment or room and then applying general ventilation to this space. The compartment or room in which the work is performed should be as small as is consistent with convenience in handling the work. The ventilating system should be designed so that a strong current of clean air is drawn across the operator, and away from him toward the work, where the dust is picked up and carried from the room.

IMPORTANT REQUIREMENTS OF AN EFFICIENT EXHAUST AND COLLECTING SYSTEM

It is impracticable to enumerate all of the requirements for an efficient exhaust and collecting system, however, among the more important there are the following:

1. Fans, collectors, hoods, and ducts should be of adequate size.
2. Air volume and velocities should be adequate for the work to be accomplished.
3. The exhaust hoods should not interfere with the operation of the machine or access to its working parts.
4. The system should not increase the fire hazard.
5. The system should not increase the dust explosion hazard.
6. Where power is expensive, should do the required work with a minimum power consumption.
7. In cold climates, should not remove any more air than necessary from the building.
8. Where power is comparatively cheap, first cost should be low, even if the power required to operate is slightly higher.

In designing an exhaust system certain quantities must be chosen arbitrarily by the engineer, and the success of the installation depends to a large degree upon his experience and the skill with which he chooses these arbitrary quantities. It is quite possible for an inexperienced designer to lay out a system which may figure out properly, but the general results are likely to be unsatisfactory.

The first step in designing systems employing hoods to trap the material is to determine the number and size connections for each individual machine. At this point the designer's past experience is of great value, as, while it is possible to set certain general standards, yet in actual practice the sizes are considerably affected by the local conditions which the layout man finds in the field, and he bases the pipe sizes and hoods on his judgment, being guided by his experience and the general practice.

The size of hoods and connections are determined by the size and type of machines or apparatus to be handled by the exhaust system, by the kind of material worked, by the duty of the machines and other local conditions. It is impracticable to lay down any general rules for determining size connections for the various types of machines and Tables 104 to 106, giving sizes as used in some of the common industries are only intended to serve as a general guide. Under certain favorable conditions smaller connections may be supplied.

Open bottom exhaust hoods of the canopy type, where it is impractical to enclose completely the point of origin of the dust or fumes, should extend over the machine or operation at least 6 in. in every direction if the hood is not elevated more than 2 ft. For each additional 2 ft. of elevation, the size of the hood should be increased 6 in. in all directions.

In systems employing inward air leakages the area of connections must be proportional to total leakage area in the enclosing housing.

Tumbling barrels have connections ranging from 4 to 8 in., bucket conveyors 6 to 12 in., and screening machines 6 to 10 in.

In general room exhaust large connections should be provided so that the air may be handled at low velocity and with a minimum power consumption.

After having determined on the proportions of the exhaust system as regards hoods and connections it is then necessary to choose the air velocity or suction at the hood connections, suction at the hood connections being a measure of the air velocity at that point.

AIR VELOCITY

The air velocity required is dependent upon the specific gravity of the material, the fineness of the particles, and their physical characteristics. Certain materials such as grease wools, silk waste, salt, and other hydroscopic substances are difficult to handle due to the tendency to deposit in the conveyor pipes.

While the velocity in the system should be sufficiently high to insure the removal of the material it should be kept as low as practicable since any higher velocity requires the use of unnecessary power. With a fixed system or orifice the power increases as the cube of the increase in velocity.

TABLE 104. SIZE OF CONNECTIONS FOR WOOD-WORKING MACHINERY

TYPE OF MACHINE	DIAMETER OF CONNECTIONS IN INCHES
Circular Saws, 12-in. diam.	4
Circular Saws, 12-24-in. diam.	5
Circular Saws, 24-40-in. diam.	6
Band Saws, Blade under 2 in. wide	4
Band Saws, Blade 2-3 in. wide	5
Band Saws, Blade 3-4 in. wide	6
Band Saws, Blade 4-5 in. wide	7
Band Saws, Blade 5-6 in. wide	8
Small Mortisers	6
Single End Tenoners	6
Double End Tenoners	7
Double End, Double Head Tenoners	10
Planers, Matchers, Moulders, Stickers, Jointers, etc.—	
With Knives, 6-10 in.	5–6
With Knives, 10-20 in.	6–8
With Knives, 20-30 in.	6–10
Shapers, Light Work	4–5
Shapers, Heavy Work	8
Belt Sander, Belt less than 6 in. wide	5
Belt Sander, Belt 6-10 in. wide	6
Belt Sander, Belt 10-14 in. wide	7
Drum Sander, 24 in.	5
Drum Sander, 30 in.	6
Drum Sander, 36 in.	7
Drum Sander, 48 in.	8
Drum Sander, over 48 in.	10
Disc Sander, 24 in. diam.	5
Disc Sander, 26-36 in. diam.	6
Disc Sander, 36-48 in. diam.	7
Arm Sander	4

TABLE 105. SIZE OF CONNECTIONS FOR GRINDING AND BUFFING WHEELS

DIAMETER OF WHEELS	MAX. GRINDING SURFACE SQ. IN.	MIN. DIAM. OF BRANCH PIPES IN INCHES
Grinding—		
6 in. or less, not over 1 in. thick	19	3
7 in. to 9 in., inclusive, not over 1½ in. thick	43	3½
10 in. to 16 in., " " " 2 in. "	101	4
17 in. to 19 in., " " " 3 in. "	180	4½
20 in. to 24 in., " " " 4 in. "	302	5
25 in. to 30 in., " " " 5 in. "	472	6
Buffing—		
6 in. or less, not over 1 in. thick	19	3½
7 in. to 12 in., inclusive, not over 1½ in. thick	57	4
13 in. to 16 in., " " " 2 in. "	101	4½
17 in. to 20 in., " " " 3 in. "	189	5
21 in. to 27 in., " " " 4 in. "	338	6
27 in. to 33 in., " " " 5 in. "	518	7

TABLE 106. SUCTIONS REQUIRED AT HOODS FOR CONNECTIONS OF USUAL PROPORTIONS

WORK	STATIC SUCTION IN IN. OF WATER
Exhausting from Grinding and Buffing Wheels	1–2
Exhausting from tumbling barrels	1–2
Exhausting from wood-working machinery—light duty	1–2
Exhausting from wood-working machinery—heavy duty	2–4
Shoe Machinery Exhaust	2–3
Exhausting from rubber manufacturing processes	1–2
Flint grinding exhaust	1–2
Exhausting from pottery processes	1–2
Lead dust and fume exhaust	1–4
Fur and Felt Machinery Exhaust	2–3
Exhausting from textile machinery	1–3
Exhausting from elevating and crushing machinery	1–2
Conveying bulky and heavy materials	3–5

Velocities commonly employed are: 2,500 to 3,000 ft. per min. for light dusts, cotton, shavings and sawdust from dry wood, and similar substances. Heavy dusts, wool, shavings and sawdust from wet wood, rags, waste paper and similar materials 3,000 to 4,000 ft. per min. Lead dust, hog waste, pulp chips, etc., 4,000 to 6,000 ft. per min.

In choosing the pipe sizes consideration must be given to the way and manner in which the machines will be operated, as in case a considerable number of machines, all discharging into one main, should be shut off at the same time, the velocity in the main might easily be lowered to the point where it would not be sufficient to carry the material from the machines still in operation, and thus result in clogging the pipes. Accordingly, it is sometimes desirable to use velocities higher than the minimum to allow a factor of safety to cover this contingency.

The resistance of a round pipe to the flow of air is inversely proportional to the fifth power of the diameter of the pipe. Therefore, handling a given quantity of air through a larger pipe at a lower velocity decreases the frictional resistance very materially and correspondingly decreases the horse-power required at the fan, and thus it is very desirable to keep the air velocities throughout the system as low as possible, consistent with the major requirement that the material must be taken away as fast as made, without clogging the pipes, under the varying operating conditions met with from day to day in the plant.

The static suction required at the hood connections varies from 1 to 5 in. of water. The suction required depends upon many factors such as the relative size of the hoods and connections, kind and quantity of material handled, as well as its physical condition. In some states codes have been issued specifying suctions to be maintained for the more common dusts.

A suction standard should always be considered in conjunction with the shape of hood, and size connection, as these factors together determine the volume of air exhausted and its velocity which in turn are a measure of the effectiveness of the exhaust system.

The cubic feet of air of standard density taken into the system at each connection is given by the formula:

$$Q = 4000\, A\, f \sqrt{i}$$

where

Q = Cubic feet of air per minute;
A = Area of connection in square feet;
f = Orifice or restriction coefficient;
i = Static suction measured in inches of water.

The orifice coefficient f is dependent upon the shape and construction of the hood and will range from 60 to 90 per cent. An average value is 70 per cent.

Knowing the suction at each hood and the diameter of each connection, the volume of air passing up each branch can be taken from the accompanying Table 107. The sum of all these volumes gives the total volume to be handled by the exhaust fan.

TABLE 107. CUBIC FEET OF AIR HANDLED PER MINUTE THROUGH AVERAGE COLLECTING HOODS

Based on Coefficient of Orifice of 0.71 with 10 Per Cent Added for Leakage

DIAMETER OF CONNECTION PIPE IN.	MAINTAINED SUCTION—IN. WATER GAGE						
	1	1½	2	2½	3	4	5
1½	38	47	54	61	67	76	86
2	68	84	97	108	118	136	153
2½	107	131	161	168	185	214	238
3	153	188	217	243	266	306	343
3½	209	256	296	330	362	418	466
4	273	334	386	431	473	546	609
4½	345	423	488	546	598	690	775
5	427	523	605	676	741	854	955
6	614	751	867	970	1062	1228	1373
7	835	1023	1181	1322	1448	1670	1870
8	1092	1337	1546	1727	1892	2184	2440
9	1381	1694	1953	2184	2387	2762	3091
10	1705	2090	2409	2695	2959	3410	3806

Common practice is to provide a main suction pipe having an area 20 to 25 per cent in excess of the sum of the areas of the branches entering it between the point in question and the dead end of the main. Similarly the discharge pipe leading from the fan outlet to collector is frequently made the same diameter as the large end of the main suction pipe. The reason for this increase in size is that a considerable power saving results from the lower air velocity. However, there is no technical reason why mains should be a certain percentage greater area than the sum of the connections, and still lower power consumption can be obtained by using larger branches and mains of equal area. While the rule

of thumb method of determining size of mains works very well in many cases, yet it is always desirable to figure the mains and branches of the proper size to give the velocity which has been found best suited to the work to be done.

In certain special cases where explosive or poisonous dusts such as aluminum buffings, grain dust, powdered sugar, or lead dust are handled, increasing the size of the mains unduly would introduce a serious hazard.

An exhaust system to be effective must remove a certain amount of air from each hood or other connection, and in addition must maintain sufficient velocity throughout the piping system to convey the dust or refuse material to the separator. Any system which is mechanically well constructed and handles the requisite air at the connections and maintains sufficiently high velocities, is an effective system from the standpoint of the work done. However, to keep the operating cost low it is advantageous to do the work with as low velocities as the characteristics of the material will permit. The skilled designer will keep both of these requirements in mind and produce a system which is both effective and economical of power.

The maintained resistance of the exhaust system is composed of three factors: (1) Loss through the hoods; (2) Collector drop; and (3) Friction drop in the pipes.

A. Suction at the various hoods must be chosen from experience. Loss through the hoods can be calculated by an experienced engineer but may be taken very roughly at one-half the suction.

B. Collector drop in inches of water is given by the following formula:

$$\text{Drop} = C\left(\frac{V}{1000}\right)^2$$

where

C = a constant which depends upon the type of collector and is found to range from 0.25 to 0.75;
V = velocity in feet per minute of air entering the collector.

C. Friction drop in the pipes must be computed for each section where there is a change in area or in velocity. Find the velocities in each section of pipe starting with the branch furtherest from the fan. The friction drop for these sections can be determined by reference to Table 108. Total friction loss in the piping system is the friction drop in furthest branch plus the drop in the various sections of the main, plus the drop in the discharge pipe.

The total maintained resistance of the system—or static head required at the fan $= A + B + C$.

SELECTING THE FAN

Having determined the volume of air and static head required, the size of exhaust fan, speed and horse-power can be found by reference to the manufacturers performance tables or charts covering the type of exhaust fan selected.

TABLE 108. FRICTIONAL RESISTANCE OF STRAIGHT CONVEYOR PIPE

To Flow of Air Per 100 Feet of Pipe

VEL. OF AIR IN FT. PER MIN.	LOSS OF PRESSURE IN INCHES FOR GIVEN DIAMETER PIPE						
	4"	5"	6"	7"	8"	10"	12"
2000	1.92	1.53	1.28	1.09	0.962	0.770	0.640
2200	2.32	1.85	1.55	1.32	1.16	0.932	0.778
2400	2.77	2.22	1.84	1.58	1.39	1.01	0.924
2600	3.26	2.60	2.17	1.86	1.63	1.30	1.08
2800	3.76	3.01	2.52	2.15	1.89	1.51	1.26
3000	4.33	3.46	2.88	2.47	2.08	1.73	1.44
3200	4.93	3.94	3.28	2.82	2.47	1.97	1.64
3400	5.56	4.45	3.71	3.18	2.78	2.22	1.85
3600	6.23	4.98	4.15	3.56	3.12	2.49	2.08
3800	6.95	5.55	4.62	3.97	3.48	2.78	2.32
4000	7.69	6.15	5.13	4.40	3.85	3.08	2.57
4200	8.48	6.78	5.65	4.85	4.25	3.49	2.83
4400	9.26	7.41	6.18	5.30	4.63	3.71	3.09
4800	11.05	8.85	7.38	6.32	5.55	4.43	3.69
5200	13.00	10.50	8.66	7.44	6.50	5.21	4.34
5600	15.25	12.05	10.05	8.61	7.55	6.03	5.05
6000	17.30	13.85	11.52	9.89	8.66	6.92	5.76
	14"	16"	18"	20"	22"	24"	30"
2000	0.550	0.482	0.428	0.385	0.350	0.320	0.257
2200	0.655	0.582	0.578	0.465	0.423	0.388	0.310
2400	0.790	0.693	0.617	0.553	0.504	0.462	0.369
2600	0.930	0.810	0.722	0.650	0.590	0.542	0.434
2800	1.07	0.932	0.838	0.754	0.685	0.628	0.503
3000	1.24	1.08	0.961	0.865	0.788	0.722	0.577
3200	1.41	1.23	1.09	0.985	0.895	0.820	0.657
3400	1.59	1.43	1.24	1.11	1.01	0.925	0.742
3600	1.78	1.56	1.38	1.25	1.13	1.04	0.832
3800	1.99	1.74	1.54	1.39	1.26	1.16	0.926
4000	2.20	1.92	1.71	1.54	1.40	1.28	1.03
4200	2.43	2.12	1.88	1.70	1.54	1.42	1.13
4400	2.66	2.33	2.06	1.85	1.68	1.54	1.24
4800	3.17	2.77	2.46	2.22	2.02	1.85	1.48
5200	3.72	3.25	2.89	2.61	2.36	2.16	1.75
5600	4.32	3.78	3.35	3.02	2.74	2.52	2.01
6000	4.95	4.33	3.85	3.46	3.14	2.89	2.31

FRICTIONAL RESISTANCE OF ELBOWS

Elbows having a radius equal to the pipe diameter set up a resistance equivalent to a section of straight pipe approximately 10 diameters long. With a radius of 1½ times the diameter the resistance is about the same as seven diameters of straight pipe.

The usual types of ventilating fans are unsuitable for exhaust systems which are required to handle materials such as shavings, sawdust, emery dust, etc. Higher pressures are required than in ventilating work and in addition housings and blast wheel must be so constructed that the materials handled do not deposit in same. While the fans used in different exhaust systems are more or less of the same general type, modifications are frequently necessary to fit them for handling such materials as long shavings, strips of paper, cotton, pulverized coal, etc.

The most common method of separating the dust and other materials from the air is to pass the mixture through a centrifugal or "cyclone"

collector. In this type of collector the mixture of the air and material is introduced on a tangent, near the cylindrical top of the collector, and the whirling motion sets up a centrifugal action causing the comparatively heavy materials suspended in the air to be thrown against the side of the separator, from which position it spirals down to the tail piece, while the air escapes through the stack at the center of the collector.

For most systems, the nominal size and number of the collector will be the same as the diameter in inches of the main pipe leading to it. The nominal sizes of the different makes of collectors vary greatly, and it is advisable to make sure that a collector is large enough to do the work without excessive pressure drop, irrespective of nominal number or size. The larger the collector the better will be the separation, and the less will be the back pressure on the fan and power consumed.

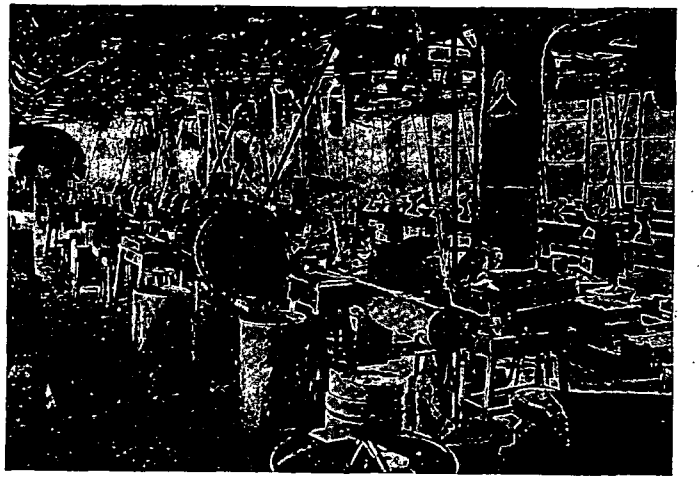


FIG. 83. EXHAUST AND CONVEYING SYSTEM HANDLES WASTE FROM WOOD-WORKING MACHINES

Special construction is sometimes required for fine dust, also some blow pipe manufacturers use a special type of collector for furnace feed, the object being to deliver the material to furnaces as uniformly as possibly.

When more than one fan delivers into a single collector a back pressure valve is required to prevent one fan blowing back through the other in case the second fan should stop for any reason.

In most plants, where wood refuse is used for fuel, it is delivered by gravity directly from the collector to the furnace. The discharge pipe leading from the bottom of the collector is divided and the junction furnished with a switch or valve so arranged that when the material comes too fast for the fires it can be diverted into a reserve bin.

The furnace feeder should be hinged where it is attached to the lower end of the discharge pipe, in order that it may be disconnected from the

furnace when the fan is shut down. Also great care must be taken to provide an absolutely tight switch. Otherwise, when discharging refuse to the storage bin, fine sawdust will sift through this valve and settle in the furnace feed pipe, and, in case the fireman has neglected to disconnect the feeder from the furnace, the flame may flash back, following this train of fine sawdust, into the collector.

Other forms of collectors or separators, are: settling chambers, cloth screen and bag collectors, bag houses, air washers and electric precipitators.

DESIGN OF HOODS

The mechanical design as regards shape and construction of the hoods is extremely important. Probably more systems fail from improper hood construction than from any other one cause.

If the material to be moved is already in motion, as are the chips thrown off from wood-working machines, the hoods should be arranged in the path of the particles so that the velocity of the particles assists the air in carrying the material to the throat of the hood.

Hoods should be arranged to draw dust and fumes away from the face of the operator. They should be placed as close as possible to the source of dust or waste material and wherever practical, the hoods should entirely enclose the dust producing operation.

Hoods are usually constructed of galvanized sheet iron or other equally substantial and durable material. The material should be heavy enough to stand the abrasive action of the dust and refuse. The hoods should be of sufficient mechanical strength to keep their shape and should be well braced and substantially supported. Galvanized iron used should never be lighter than No. 22 gage.

If acid or corrosive fumes are present heavy material painted with acid resisting paint should be used, or the hoods may be made of non-corrosive material.

The exposed edges of all sheet metal hoods should be bound with wire or band iron, not only to give the necessary stiffness, but also to prevent the operator from being cut by the raw edges of the sheets.

CONVEYOR PIPES

The conveyor pipes leading from the hoods to the fan and thence to the collector are commonly made of galvanized iron, the gage of which varies from No. 24 to 14, depending upon the diameter. The piping should be free from dents, fins and projections of all kinds on which refuse material might catch.

All permanent circular joints should be lap-jointed, riveted and soldered, and all longitudinal joints either grooved and locked or riveted and soldered. Circular laps should be in the direction of the flow, and piping installed out-of-doors should have the longitudinal laps at the bottom. Every change in pipe size should be made on a taper not by an abrupt change.

All pipes passing through roofs should be equipped with collars so arranged as to prevent water leaking into the building.

The main trunks and branch pipes should be as short and straight as possible, strongly supported, and have the dead ends capped to permit inspection and cleaning. All branch pipes should join the main at an acute angle. The junction being at the side or top and never at the bottom of the main. Branch pipes should not join the main pipes at points such that the material from one branch tends to enter the branch on opposite side of main.

Cleanout openings having suitable covers should be so placed in the main and branch pipes that every part of the system can be easily reached

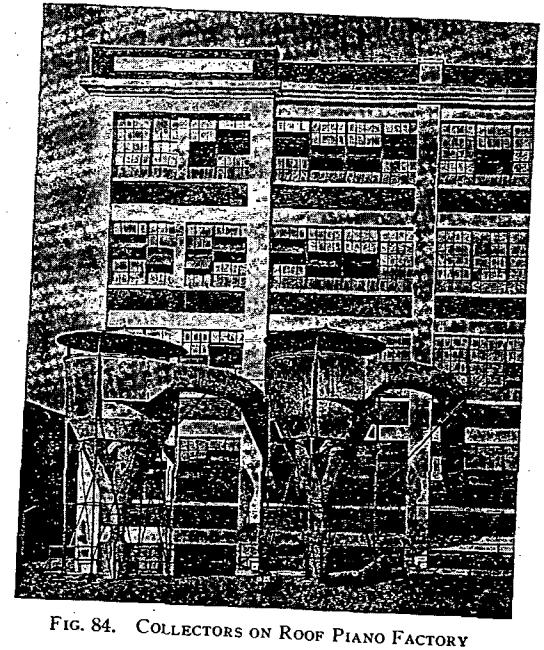


FIG. 84. COLLECTORS ON ROOF PIANO FACTORY

in case the system clogs. Either a large cleanout door should be placed in the main suction pipe near the fan inlet or a detachable section of pipe, held in place by lug bands, may be provided.

Elbows should be made at least two gages heavier than straight pipe of the same diameter, the better to enable them to withstand the additional wear caused by changing the direction of flow. They should preferably have a throat radius of at least one and one-half times the diameter of the pipe.

Every pipe should be kept open and unobstructed throughout its entire length, and no fixed screen should be placed in it, although the

use of a trap at the junction of the hood and branch pipe is permissible, provided it is not allowed to fill up completely.

The passing of pipes through fire-walls should be avoided wherever possible, and sweep-up connections should be so arranged that foreign material cannot be easily introduced into them.

Where considerable quantities of explosive dust or inflammable materials pass through the exhaust fan, the blast wheel should be constructed of brass composition, copper or other soft metal and in all cases ample clearance should be provided between blast wheels and housings.

MAINTENANCE OF SYSTEM

Because of its simplicity the exhaust system usually receives but little attention once it is installed; however, to obtain the best results, it should be inspected at suitable intervals and necessary adjustments made.

The exhaust fan should be given proper attention the same as any other high-speed machine. It should be kept in proper alignment and tightly bolted to its foundation.

Suction hoods, which have been removed to adjust the machines, should be replaced as soon as the adjustments are completed.

Never start a machine with the blast gate closed, as the slight air leakage past the blast gate may draw material into the pipe and clog it.

Disconnect furnace feeders from the furnaces when not in operation, and do not overload the system by ill-advised additions.

CHAPTER XXII

VENTILATORS AND NATURAL VENTILATION

OF the two methods of ventilating available, namely by mechanical means, and by the so-called natural forces, the later is often favored, because it is not dependent upon fans, blowers and motive power apparatus, any of which may get out of order; it requires no supervision, and it costs nothing for power to operate. It is dependent upon the operation of natural laws and is not subject to the requirements of control possible with mechanical ventilation.

Natural ventilation utilizes two separate agencies, (1) the buoyancy of the air caused by temperature difference between inside and outside of the building, and (2) the energy of the wind. The former is the same action that produces draft in a chimney. The two forces are entirely distinct and separate, and may either co-operate or oppose each other, depending upon the design of the ventilator.

A ventilator is an opening in the roof, properly protected against rain, snow and down draft; and surrounded by a hood or cowl intended to utilize the force of even the slightest breeze from any direction what-soever, in such a manner as to assist and increase ventilation. Occassionally a damper is required to prevent over-ventilation in cold, stormy weather. In any event, openings near the floor of the building which is to be ventilated are necessary to allow the ventilators to act.

Ventilators may be classified in general as, stationary and rotary, and each of these may be divided into siphoning and non-siphoning. The rotary ventilators being one which always presents the same face to the wind, and the siphoning ventilator being one which is so constructed as to use the force of the wind to siphon the air out of the ventilator, usually allowing some of the external air to pass through the head.

Engineers, architects and contractors who must make a selection should be guided by the following four general points, (1) quality of material, (2) design, (3) construction and (4) capacity (conditions should be stated otherwise a fair comparision of this item is impossible.)

What is generally desired more specificially is, the greatest amount of reliable ventilation for a given cost of equipment. The following facts affect ventilation and ventilator capacity:

1. Temperature difference between inside and outside of building.
2. Height of ventilator above air inlet openings.
3. Wind velocity.
4. Shape and design of ventilator.

Material for this section furnished especially for THE GUIDE by Frank Kelley, C. T. Palmer and Thornton Lewis.

5. Air admission below the ventilator, (resistance to flow of air *into* building).
6. Resistance to air flow *through* the building.
7. Resistance to air flow in the ventilators themselves.
8. Location of the ventilator with respect to surrounding objects.

Of the factors mentioned, only items 4 and 7 depend upon the ventilator itself; the other items depend upon circumstances wholly outside of ventilator size and design.

While ventilators may be divided into certain classes or groups and the average efficiency of one class will be higher or lower than the average efficiency of another class, this does not in any way determine the capacity of individual ventilators, as ventilators of the same class and, which from a casual observation appear to be the same, will have entirely different characteristics, due to the fact that some of the fundamentals have been overlooked or changed in one or the other.

The basic principles which should be adhered to are as follows:

1. A reasonably large head, as it gives a larger low pressure area and a better exhaust.
2. A sufficiently large area for the air leaving the ventilator head preferably larger than the cross sectional area of pipe.
3. A storm band on stationary non-siphoning ventilators sufficiently wide and so placed as to prevent the entrance of external air into the ventilator head.
4. If the ventilator is a siphoning type additional outlet air space must be provided in the head in order not to restrict the air passage from the exhaust pipe.
5. Provided a smooth, easy passage of sufficient area for the exit of exhaust air avoiding sharp turns and obstructions.
6. A flaring outlet from a rotary ventilator will give a better exhaust than a straight oultet.

The simplest form of ventilator, shown in Fig. 85, consists of an outlet pipe with a conical hood above it. The addition of a storm band, as shown in Figs. 86, 87 and 88, gives an increased protection against the entrance of rain or snow. The storm band, if placed so close to the cones as to restrict the outflow of air, interferes with ventilation. On the other hand, if the openings are made large enough to permit free egress of the inside air, the storm band increases the ventilation by utilizing the wind velocity to produce suction.

A further development of the later principle is the siphon ventilator, as illustrated in Fig. 89, in which siphons or ducts are introduced for the particular purpose of producing suction.

In the swiveling or rotary ventilators, typified by Figs. 90 and 91, a freely rotating cowl is used. A wind vane is provided for keeping the opening facing away from the direction of the wind. This type allows

free egress of the inside air (unless the outlet is made unduly small). For producing suction, it depends upon the viscous drag of the wind passing along the outside of the cowl.

In the induction or ejector type of ventilator, which is also of the swiveling or rotary type Fig. 92, the kinetic energy of the wind is used to a large extent by creating suction, due to the viscous drag both inside and outside the cowl. This device is effective for ventilation even with very low wind velocities. In some stationary ventilators of the siphon type, or of the swiveling cowl type, low wind velocities have the effect of reducing

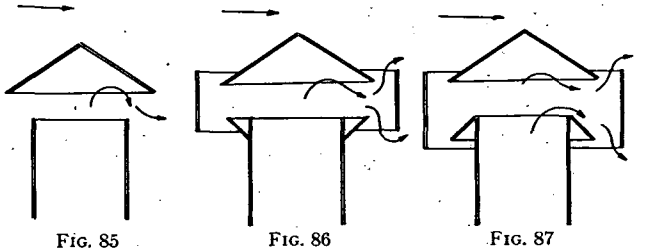


FIG. 85 FIG. 86 FIG. 87

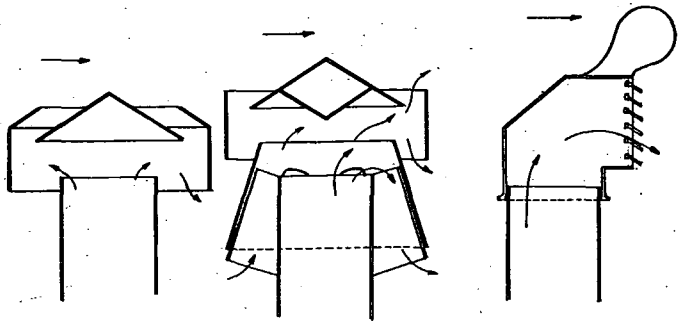


FIG. 88 FIG. 89 FIG. 90

VARIOUS STYLES OF ROOF VENTILATORS

the air discharge produced by the temperature difference, apparently because the laws of fluid flow are not the same at high and low velocities, which is an established fact. In the ejector ventilator, the funnel shape ejector tube converts the pressure of a slow wind into a higher velocity at the throat thereby maintaining suction.

All comparisons of capacity must be referred to a given dimension, namely the throat area, corresponding to the nominal size of the ventilator.

Resistance to flow of air is caused by; (1) restricted outlet openings, or (2) many turns or changes of the direction of the air flow. As regards the first item, this depends entirely upon the proportions, and not upon

the type; some of the stationary ventilators have smaller, and others have larger outlet area than some cowl ventilators of the same nominal size. Regarding the second item, the swiveling cowl ventilators offer less resistance than the stationary type, in that the direction of air flow is changed as little as possible.

Unless swiveling ventilators move very freely, the opening, at times, faces towards the wind so that ventilation produced by temperature difference is much reduced, or wholly counteracted. In that case, snow and rain may blow in. The rumbling or creaking noise caused by hard turning swivel ventilator is also very unpleasant. These troubles are, of course, eliminated in well designed ventilators, but must be kept in mind.

In Fig. 93, is shown a rotary or air-turbine ventilator, which rotates continously under the action of the wind, the motion being produced by the difference of wind pressure on the convex and concave sides of the vanes. The air-exhausting action is due to centrifugal force. This type of ventilator must be very carefully designed if it is to be leak-proof, and if the noises and impact forces, due to ice accumulating on the vanes in the winter are to be eliminated.

CAPACITIES

The variety of factors affecting capacity makes it essential for the user of ventilators to exercise great care in respect to this item of capacity.

The draft in a ventilator head, due to the velocity of the wind, is primarily caused by the low pressure area or partial vacuum on the leeward side of the ventilator head. A draft in certain designs may also be caused by the siphoning action of the wind passing through the ventilator head, but any air which is allowed to enter the head to create a siphoning action must get out and in so doing will diminish the effective area of the head for exhausting air, and it is also very likely to reduce the effectiveness of the low pressure area.

Naturally the ventilator which makes the best use of the available forces for creating a draft and which at the same time provides the freest path for the flow of exhaust through the ventilators should be the best ventilator. It does not follow, however, that a ventilator of one class is better or poorer than one of any other class. It may be good or poor not because it belongs to a certain class, but depending upon whether the proper basic principles have been observed in its design.

The theoretical velocity of the gases due to temperature difference may be obtained from the following well-known formula:

$$V = \sqrt{2gH} = \sqrt{2gH\left(\frac{T^1}{T^0} - 1\right)}$$

in which

V = Velocity in feet per second
g = Gravity 32.2
H = Effective height of ventilator
T^1 = Temperature absolute of air in ventilator
T^0 = Temperature absolute of air outside

This gives the theoretical velocity which will be reduced in the practical case by the resistance in the pipe and the ventilator head. It is impossible to state an exact ratio between the velocity obtainable and the theoretical as every case will be different, but a reasonable assumption would be 50 per cent providing there is free admission of fresh air into the room or space ventilated.

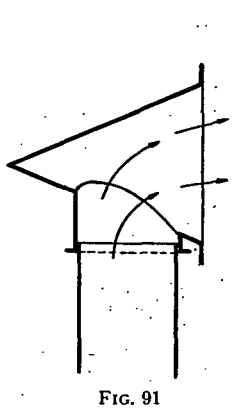


FIG. 91

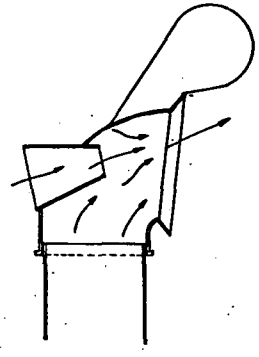


FIG. 92

ROTARY VENTILATORS

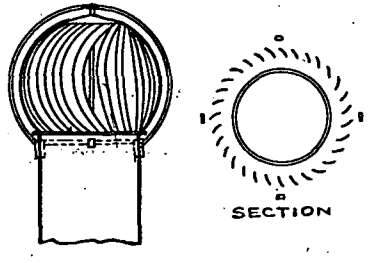


FIG. 93

AIR-TURBINE VENTILATOR

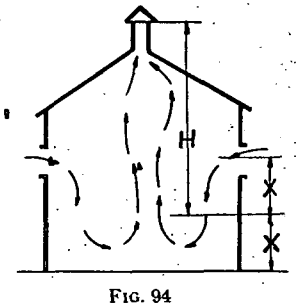


FIG. 94

DETERMINING THE EFFECTIVE HEIGHT

Many exaggerated claims have been made in the marketing of ventilators and it was only recently that very careful tests were made by the U. S. Bureau of Standards (TRANS. A. S. H. V. E., Vol. 27, 1921, p. 67. See also TRANS., Vol. 28, 1922, p. 189 and Vol. 29, 1923, p. 39) and by other reliable investigators, with the result that ventilator capacities are now quite accurately known.

Conservative figures for the best types of ventilators now on the market,

under conditions of unrestricted flow of air to the ventilator, are given by the equation:

$$Q = A \times \left[\frac{36 \times \sqrt{H \times (t_i - t_o)}}{6 + V} + 20. \times V \right]$$

where

Q = cubic feet of air exhausted per hour through a ventilator having a free area at the throat of A square inches, mounted on a roof at a height of H feet from the center of the ventilator outlet to the floor, and with a wind velocity of V miles per hour, and average temperature t_i inside t_o outside.

The height H has been given as the height above the floor; strictly speaking, it is the height of the column of warm air in the building, which is approximately equal to the height above the location of the air inlet to the building. This location is usually near the floor. If, however, the inlet is much higher, as shown for instance in Fig. 94, the height H is indeterminate, but may, in general, be taken as halfway between the center of the air inlet and the floor.

Highest class ventilators, for instance those of the ejector type, will, under favorable conditions, discharge continuously 25 per cent more air than these conservative figures indicate. Capacities are lower, on the other hand, if ventilators of lower efficiency are used, or if the flow of air into or through the building is restricted, or if the ventilator is not exposed to the free sweep of the wind. Tests occasionally show considerably higher discharge rates over short periods of time. These abnormally high results are produced by the action of the wind upon certain openings of the building; they are not due to the ventilator itself, and cannot be depended upon for continuous ventilation if the direction of the wind changes. In the smaller sizes of ventilators (12 in. or less in throat diameter) the air discharge per square inch of cross-sectional area is reduced, on account of the frictional resistance and, in the rotary types, on account of reduction of free area by the supports, bearings, etc.

Example.—What is the capacity of an 18 in. ventilator, located 35 ft. above the floor, with 6 miles per hour wind velocity, 50 deg. fahr. outside temperature, 68 deg. fahr. inside temperature?

Answer.—$A = 0.7854 \times (18)^2 = 255$ sq. in.

$$Q = 255. \times \left[\frac{36. \times \sqrt{35 \times (68 - 50)}}{6 + 6} + 20 \times 6 \right] = 50{,}000 \text{ cu. ft. per hr.,}$$

average capacity under these conditions.

VENTILATION REQUIREMENTS

The air supply per person and per hour, or the number of the renewals of air contents per hour is given in Chapter I, p. 21. (See also Chapter XIV, p. 194.)

To obtain effective, uniform ventilation and avoid local drafts, the ventilators should not be placed more than 30 ft. apart; 20 ft. apart is a good average. It is best, although not absolutely necessary, to locate the

ventilator at the ridge of the roof, unless the building exceeds 40 ft. in width, in which case two rows of smaller ventilators should be used. Where the building to be ventilated is surrounded by higher buildings which obstruct air currents, it is desirable to extend the ventilators above the buildings by mounting them on stacks.

Example.—A foundry building is 40 ft. wide, 200 ft. long, with an average height of 40 ft.; the ventilators are to be mounted at the ridge of the roof, at a height of 55 ft. above the floor. What number and size of ventilators are required?

Answer.—In this case, ventilation is especially necessary in summer. The air in the building should not be over 10 deg. fahr. warmer than the outside air. The wind velocity may be as low as 4 miles per hour. Spacing the ventilators, tentatively, 25 ft. apart, 8 ventilators would be required. Under average conditions, 10 air renewals per hour are sufficient. If the foundry is small and cramped, and pouring takes place over a large section of the floor space, 15 or more air renewals per hour may be needed. On the basis of 10 renewals per hour, the capacity of each ventilator must be:

$$Q = \frac{10 \times (200 \text{ ft.} \times 40 \text{ ft.} \times 40 \text{ ft.})}{8} = 400{,}000 \text{ cu. ft. per hour}$$

The discharge per square inch of throat area under these conditions is;

$$\left[\frac{36 \times \sqrt{55 \times 10 \text{ deg.}}}{6 + 4 \text{ mi./hr.}} + 20 \times 4 \text{ mi./hr.} \right] = 165. \text{ cu. ft. of air per hr.}$$

The required throat area per ventilator is

$$\frac{400{,}000}{165.} = 2420. \text{ sq. in.}$$

if there is no resistance and no wind pressure.

The diameter is $\sqrt{\frac{2420.}{.7854}} = 55.5$ inches. Standard sizes are 54 in. and 60 in. Either eight—54 in. or else seven—60 in. ventilators could be used, spaced respectively 25 ft. or 28 ft. apart.

The foregoing is based on the use of high class ventilators. If ventilators of lower efficiency are used, or if the air flow into the building is restricted (as in winter) larger ventilators may be required.

CONTROL OF VENTILATION

The ideal ventilator would be one which utilized to the very best advantage even the very lowest wind velocities; attained full capacity at a wind velocity of 4 or 5 miles per hour; and then automatically controlled the air flow so that the discharge remained constant at all higher wind velocities. Such an ideal ventilator does not exist.

The best types now on the market do, however, fulfill very well the first two requirements; for the last one, hand regulation is depended upon. For this purpose either a butterfly damper is provided in the throat of the ventilator, or, in some of the rotary types, louvres are sometimes arranged at the discharge opening of the ventilator. The damper or louvres may be operated by chains from the floor of the building, or the butterfly damper electrically controlled by push button. The louvres with their operating device have the disadvantage of restrict-

ing the free area of discharge, even when open wide. In some designs, this results in a serious reduction of capacity. Ice can interfere with their operation. The dampers may be made to close automatically in case of fire, by use of a weight and fusible link arrangement. The dampers should be so located that ice cannot freeze them tight so that adjustment is impossible.

Regulation may also be accomplished, just as effectively, by restricting the flow of air into the building (closing the windows or doors), although this is quite inconvenient in many cases.

APPLICATION OF VENTILATORS

The use of ventilators on factory and mill buildings is too well known to require comment. For pickling rooms, etc., where noxious fumes are produced, they are practically indispensable.

Ventilators for houses are becoming quite common, especially for the ventilation of bathrooms, which has been much neglected in the past. A frequent use for ventilators is on the top of chimneys, to prevent down drafts and to increase the updraft by means of wind action.

For use on houses, several requirements must be kept in mind. Good appearance and noiseless operation are very important. The motion of the ventilator, if of the revolving type, must not shake the building or cause knocks or thumps; and the construction must be such that in the winter the movable part does not freeze to the fixed portion of the ventilator and thus stop the rotation.

On account of the increasing danger of carbon monoxide posioning, it is becoming regular practice to equip garages with ventilators to carry off the waste gases coming from motor exhausts.

Another application of ventilators is found in connection with power ventilating systems on the outlet or discharge opening.

A very important application for ventilators is on schools, where recirculation of air is used. The duty required, necessitates careful selection. Down draft must positively be eliminated.

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CATALOG DATA SECTION

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(Pages 509–521)

and

INDEX TO ADVERTISERS

(Pages 522–524)

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Main Office

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Territorial Offices in the Principal Cities of the United States
Also Throughout Canada and London, England

Humidifying, Dehumidifying, Cleansing, Cooling, Humidity Control

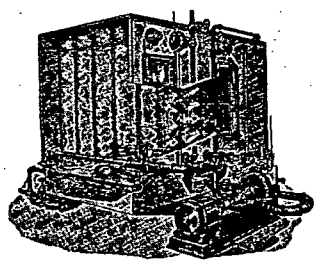
Modern Ventilation

Modern Ventilation practice demands the removal of dust and foreign matter from incoming air whether it be for insuring comfort or providing healthful conditions for audience, student or employee and applies to efficiency and accuracy in many manufacturing processes.

Of more importance, however, is the maintenance of the proper relative humidity by the addition or removal of moisture from the air according to season or local conditions.

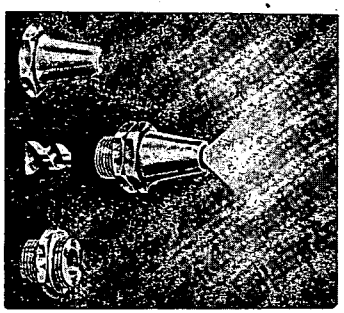
The design, manufacture and in some cases the installation of air conditioning apparatus in many types of buildings is our sole undertaking and during fifteen years of research and practice we have furnished hundreds of equipments with remarkable results.

In Schools, Auditoriums, Theatres, Ball Rooms, Dining Rooms, Cafes, Court Rooms and all spaces where people gather in large numbers our type of equipment has become essential.



Webster Humidifier

Showing circulating pump and spiral spray nozzles by the operation of which air is cleansed, baffles for elimination of free moisture, and automatic devices for the control of temperature and relative humidity



Webster Spiral Spray Nozzle Used in All Atmospheric Installations

Also used by meat packers throughout the United States, Canada and South America for spraying brine in meat coolers.

Humidifiers have been furnished for producing and maintaining the proper relative humidity.

Dehumidifiers have been installed in Industrial Plants where excessive humidity must be removed, for drying or process work. This being accomplished either by evaporation of the spray water or the use of artesian well water.

In many cases it is found necessary to resort to refrigeration and in this type of equipment we have excelled.

Equipment for Maintaining Artificial Atmospheric Conditions in Industrial Plants

The addition of the proper percentage of humidity to make up deficiency.

The removal of excessive humidity when high moisture content in the air prevents proper drying or carrying out of certain processes.

Maintaining either high or low temperatures where local conditions or specific materials demand such treatment.

The maintenance of uniform humidity conditions within 2 per cent of that for which control is set.

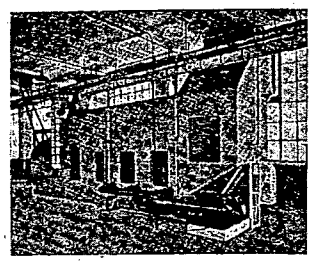
The maintenance of working space at the Comfort Zone to insure efficiency of employees.

The cleansing and cooling of air for the Ventilation of Turbo-Alternators, equipment commonly known as Generator Coolers.

Webster Air Washers

Type A Apparatus, designed primarily for air washing in connection with ventilating systems in public buildings, where a moderate cooling effect by evaporation is desired.

Type B Apparatus, designed for air washing in public buildings and industrial plants, where the greatest possible cooling effect by evaporation is desired.



The Webster Dehumidifier

Used for cleansing and cooling the air in a large Candy manufacturing plant. The spray water is cooled by refrigeration through the coil shown on the right

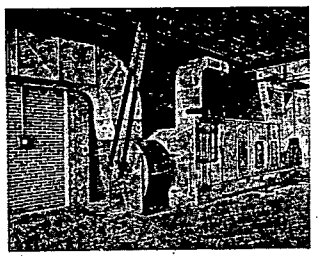
Webster System of Humidity Control

May be applied to the various types of Webster Air Washers, Humidifiers and Dehumidifiers. Perfect in principle and accurate in operation—the chief controlling thermostat subject to water, a medium with four times the specific heat of air.

Service

Each Air Conditioning problem is a separate study and it has been found impossible to set forth in catalogue or bulletin form such information as would apply to any specific case except in a general way.

We have such catalogues and bulletins as would give the prospective purchaser a general idea as to what the apparatus would consist but we find that in the end a personal interview is desirable.

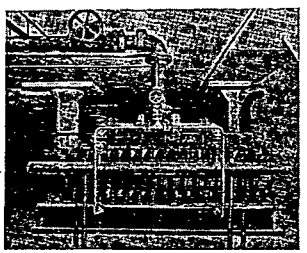


Webster Dehumidifier

During course of erection and before insulation was applied. Description of the plant in which this apparatus is giving very effective results will be sent in pamphlet form on application.

We gladly render service to those interested, in the form of recommendations and quotations, no charge being made except for actual equipment furnished.

We will not undertake a contract where we cannot accomplish just the results the



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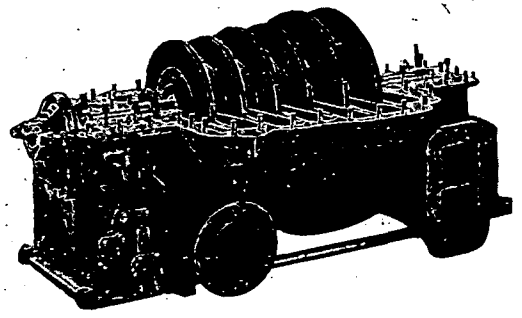
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The Carrier Centrifugal Refrigerating System is an innovation in the production of cold. The refrigerant is a harmless, inoffensive, stable liquid at normal temperatures and pressures. The compressor is a simple multistage fan or turbine, the only contact of moving parts is at the end bearings; no valves. The entire system operates at pressures considerably below atmospheric so that outward leakage is impossible. Complete equipment, compressor, evaporator and condenser occupy less than 25% of the space and have less than 25% of the weight for the same tonnage capacity in other systems. These machines are used in our own dehumidifying and cooling installations and will be found adaptable to many other uses. They are particularly to be recommend for marine service where complete safety below decks is necessary and where the great saving in weight and space is an important consideration recommended by leading engineers. *Write for details.*



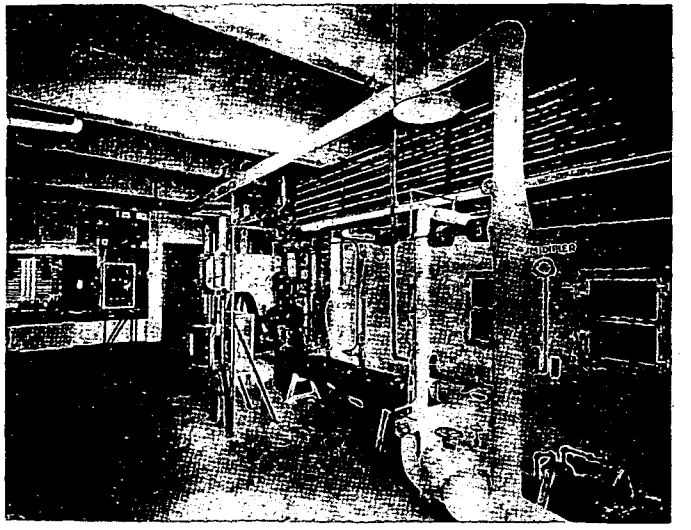
A 75 ton Carrier Centrifugal Refrigeration Compressor with the upper half of shell removed. Note the extreme simplicity of design and the fact that the only contact of moving parts are the lubricated end bearings.

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Automatically Controlled Air Conditioning Systems: Cooling—Humidifying—Dehumidifying — Heating — Ventilating — Drying — Ross Paper Conditioning — Fleisher Bakery Systems



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Whether the cure for such difficulties involves the creation of high or low temperatures and high or low humidities in any combination, this organization offers a broad experience in the careful design of dependable equipment united with the highest type of engineering and contracting service.

In addition to the treatment of industrial departments requiring humidifying or dehumidifying, the cooling of theatres, moving picture houses, cafes, and other places of assembly are fields in which we have specialized with marked success.

Having had extensive experience in practically all fields where this type of equipment is employed, our sales engineers will be glad to cooperate with those requesting their service.

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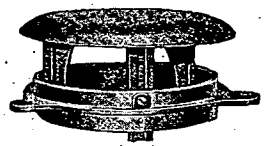
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for Auditoriums of Theatres, Churches, Schools

Kauffman Mushroom Diffusers are made for every condition requiring uniform distribution and exhausting of air for ventilation, for Theatres, School Auditoriums, Churches, Assembly Rooms, etc.

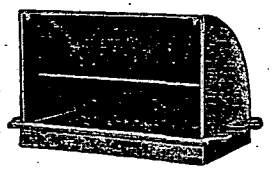


KAUFFMAN MUSHROOM DIFFUSER

Once regulated they require no further adjustment, and are locked in position and cannot be tampered with. They are rigid in construction, being made of cast iron throughout; made in two pieces, the floor flange and the cap. The cap is held in position by means of set screws which cannot be tampered with, nor jarred loose. The cap can be raised or lowered in any position to admit any volume of air desired. The raised collar on the floor piece prevents dirt or water entering the air duct. When wide open it will deliver full area of connecting pipe. We recommend a velocity not exceeding 300 ft. per min.

MADE IN 5 SIZES

Size	Area in Inches	Weight Lbs.	C. F. M. at 200	Price
4" Diam.	12.566	2.5	27	$0.70
5" "	14.635	3.	42	0.85
6" "	28.274	4.5	60	1.10
8" "	50.265	8.00	105	1.50
10" "	78.54	11.00	165	2.00



KAUFFMAN AISLE AIR DIFFUSER

Kauffman Aisle Air Diffusers are designed to be placed under the aisle seats only, to throw fresh air out into the aisles in one direction, but can be used for downward ventilation in the same manner.

This diffuser has a damper which is locked in any position desired and requires no further adjustment after once set, and cannot be tampered with.

Its large opening makes it possible to use a relatively small number of diffusers to obtain the desired volume of air.

They are rigid in construction, being made of cast iron throughout; made in 2 pieces, floor flange and cap, with damper held in position by means of set screw.

By using **Kauffman Aisle Diffusers** a big saving in construction of ducts and floor openings can be made because the air can be thrown into the aisles with no possibility of the air being felt.

MADE IN 2 SIZES

Size	Long	Wide	High	Weight Lbs.	Area Sq. Ft.	C.F.M. at 200	Price
Small	8"	4½"	4½"	7½	.25	75	$2.75
Large	8"	6"	6"	12	.333	100	3.25

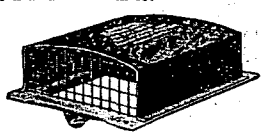
KAUFFMAN TUNNEL TYPE DIFFUSER

Kauffman Tunnel Type Diffusers are the latest development in the art of air diffusers. They give 2-way delivery of the air under seats and permit keeping the duct work at a minimum cost.

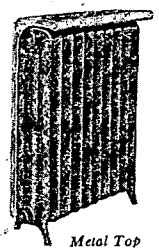
This diffuser is equipped with a damper that cannot be tampered with after it is once set.

Dirt from the shoes cannot be deposited on these diffusers and they can be placed on either concrete or wood floors. They are being adopted by the leading theatre architects of the country.

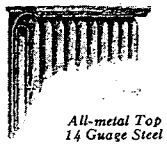
SIZE 8" Wide x 9" Long x 3½" High.



KAUFFMAN RADIATOR SHIELDS AND ENCLOSURES



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All-metal Top 14 Guage Steel



Glass Top

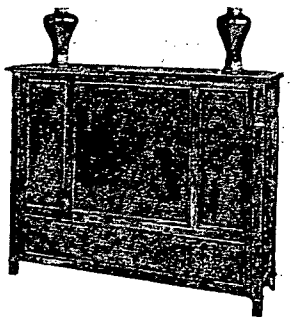
Kauffman Radiator Shields are made in five different types, Metal, All-metal with heavy steel top, Marble, Glass or Decorative Marble Top.

Kauffman Radiator Shields are made of black sheets, electrically welded to steel brackets. No bolts or screws are used in connection with the construction of these shields.

All shields are equipped with either a Stationary or Movable Dust Catcher.

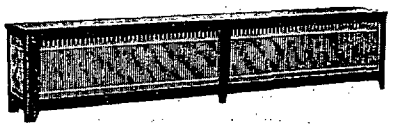
The brackets prevent the air from circulating off the side of the radiator and discoloring the walls. The fastening of the shields to the radiator is very simple and can be done in five minutes by any man with a screw driver.

Kauffman Radiator Shields are painted in either gold or aluminum bronze, or any flat colors, baked on with six coats of enamel, or any photographic wood imitations with six coats of varnish and are everlasting in finish.



Kauffman Consola Radiator Enclosures are made in a number of period designs, and are made to harmonize with the decorative and furniture schemes in the individual rooms in which they are to be used.

Kauffman Consola Radiator Enclosures are made with steel tops, marble tops or glass tops, and those shown herewith are only a few of the numerous designs that we manufacture.



Knowles Mushroom Ventilator Co.

202-204 FRANKLIN STREET, NEW YORK

Knowles Air Diffusers

for Auditoriums of
THEATRES, CHURCHES, SCHOOLS

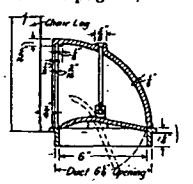
Notch Type Mushrooms

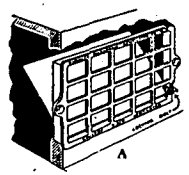
Are adjustable by merely raising and lowering the cap in recessed notches, and locking. They cannot be tampered with and are made with lugs for either wood or concrete floors. No set screws. Three outer bearings make them rigid.



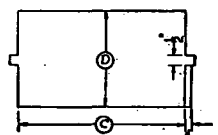
Size	C. F. M. at 300 Vel.	Area, Sq. Ft.	Weight, Lbs.
4" diam.	27	0.087	2.75
5" "	42	0.136	3.50
6" "	60	0.196	4.25
7" "	81	0.267	5.75
8" "	105	0.349	8.00
10" "	165	0.545	11.75

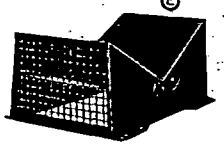
Specification Data—For concrete floors furnish and place 6 in. cast iron mushroom air diffusers with recessed notches for permanent adjustment of mushroom caps at any desired opening: to have center screw locking feature, and L shaped lugs as manufactured by Knowles Mushroom Ventilator Co. Provide for each opening No. 20 galvanized iron sleeve extending through concrete floor; to be set when floor slab is laid. (See booklet page 6.)





Riser Concrete. Plan





Standard Aisle Hood Air Deflectors

Are used to throw the fresh air out into the aisles in one direction. They provide the engineer with an inexpensive method of introducing a large volume of air wherever needed without causing annoying drafts. A curved damper reduces friction loss.

	Long	Wide	High	Lbs.	C. F. M. at 300 Vel.	Area Sq. Ft.
Small Size.....	8"	4½"	4½"	9½	75	0.25
Large Size.....	8"	6"	6"	13	100	0.333

May also be made in any size to suit conditions.

Gallery Riser Ventilator

For the intake or exhaust of warm or cool air in the balconies of auditoriums adjustable to any opening and locked.

SIZE	A	B	C	D	E	AREA SQ. FT.	CFM V 300	LBS WT.
6	7⅝	4⅝	7⅛	4⅛	¼	.196	60	2
8	9⅝	6⅜	10¼	6⅜	¼	.349	105	4
10	11⅝	7⅝	12⅛	8⅛	⅜	.545	165	6½
12	16⅜	10⅜	17	11⅜	½	.785	235	9½

Camelback Air Diffusers

Give a two-way air delivery, at ends as shown and are particularly desirable in keeping duct work at a minimum. They are furnished with or without dampers. Nos. 1 and 3 have no dampers while Nos. 2 and 4 have two regulating dampers.

Nos. 1 and 3—Size 14" long, 7" wide, 6" high at ends.
Nos. 2 and 4—Size 14" long, 7" wide, 5" high at ends.
(See Booklet for Capacities)

All are of substantial construction being made of heavy cast iron. Other KNOWLES Products are Single Damper, Double Damper and Lever Lock Mushroom Ventilator.

Send for NEW BOOKLET containing complete engineering data.

MIDWEST AIR FILTERS

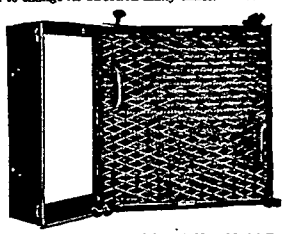
INCORPORATED
100 EAST 45TH STREET
GRAND CENTRAL TERMINAL BLDG.
NEW YORK, N. Y. U. S. A.

MIDWEST CANADA LIMITED
83 Craig Street, W.
Montreal, Canada

MIDWEST PACIFIC, Inc.
Monadnock Bldg.
San Francisco, Calif.

Branches In Principal Cities

PRINCIPLE—Midwest Air Filters operate on the baffle-impingement principle. Each filter cell (See Fig. 1) contains a series of specially perforated and shaped filter sheets of steel, so designed that dusty air in passing through the cell is forced to change its direction many times. These sheets are



Midwest Filter Unit (cell and frame) New Model Type U-S

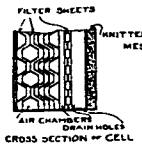


Fig. 1

coated with a viscous sticky fluid, "Viscosine." Dust particles are impinged against the sticky surfaces of the filter sheets at each change of direction of the air stream, where they are caught and held.

At the back of each cell a secondary filtering effect is provided, consisting of a series of knitted mats of flat copper wire, also coated with Viscosine. Fine particles of dust which may pass by the filter sheets, are impinged and caught here.

Openings in the filter sheets, and the spaces between them are so large as to prevent clogging, and provide for ample dust capacity. Cleaning is easily accomplished, since there is no obstruction to the free flow of washing water through the cell.

SPECIAL FEATURES—Each filter unit consists of a frame and a cell, all of which are completely interchangeable.

Each frame is provided with a continuous flange in the rear, against which the filter cells are forced by thumb screws set in removable plate clips which fit into slits at the four corners of the frame. Thus air-tight joints are provided between all cells and frames. (See Fig. 2).

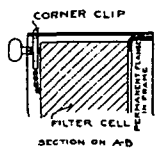


Fig. 2

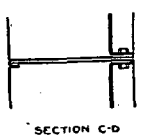


Fig. 3

Each frame is further provided with projecting turned-over lips, at one side and at the bottom. These lips grip and interlock with the adjoining side and top of adjacent frames. The frames themselves are bolted together at the rear. In this way, a double air seal is formed on all frames, and an absolutely air-tight installation assured. (See Fig. 3).

INSTALLATION—An installation consists of the proper number of units assembled in an angle iron frame. Any limitations of space are easily and economically met.

OPERATION AND MAINTENANCE—There being no moving parts, practically no operating supervision is required. Maintenance consists in periodical cleaning and recharging of cells in Viscosine.

Cleaning is systematically carried out by removing the cell next to the one last cleaned, and replacing at once by a clean, charged reserve cell. The dirty cell is washed in hot water and soda in a special tank provided with the installation. It is then drained and allowed to dry. When dry it is dipped in Viscosine and set aside to drain, when it serves as the next reserve cell.

The entire filter being constantly covered with Viscosine, does not corrode or rust. An installation is practically everlasting.

DATA AND SPECIFICATIONS

Size of unit (overall)—20 x 20 x 6½ in.
Size of Cell—19½ x 19½ x 4 in.
Net Weight of Cell—28 lb.
Weight of Unit—40 lb.
Capacity per Cell—At ⅜ in. operating resistance, 800 cu. ft. per min.
Efficiency—Maximum dust content in cleaned air, under normal operating conditions will not exceed 0.05 grain of dust per 1000 cu. ft.
Resistance—Maintained at ⅜ in. water gauge by routine cleaning.
Cleaning—Depends on dust conditions. In average installation, each cell is cleaned once every six to eight weeks. Time required—3 to 5 minutes per cell.
Viscosine Consumption—One gallon per unit per year.

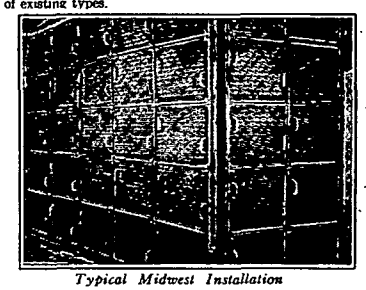
APPLICATIONS

General Ventilation—Art Galleries, Museums, Libraries, Banks, Office Buildings, Churches, Auditoriums, Theatres, Telephone Exchanges, Hotels, Hospitals, Department Stores, Restaurants, Clubs, Schools and other buildings.

Industrial Plants—Protection of equipment against dust damage—such as turbo and hydro-electric generators, mill motors, air compressors, internal combustion engines, etc.—Improving working conditions; Saving heat by recirculation of cleaned air; Improving quality of products; Recovery of valuable dusts and many other special purposes.

Other Types and Humidifiers—Special types of Midwest Air Filters are provided for various purposes. These include Midwest Window Ventilators, self-contained units with fan, motor and filter for individual offices and smaller rooms. Midwest Range Filters, another special type, are used in hotels, restaurants, clubs, etc., to collect grease from kitchen ranges before it enters the flues.

Wherever required, we can furnish a unique and simple, automatically controlled humidifier free from the weaknesses of existing types.



Typical Midwest Installation

Reed Air Filter Co.

Incorporated

Factory and General Offices
202 Central Avenue : LOUISVILLE, KY.

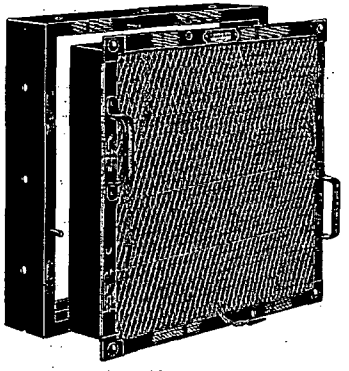
NEW YORK OFFICE
50 CHURCH STREET

Reed Air filters

BRANCH OFFICES
IN PRINCIPAL CITIES

The Reed System of Air Filtration provides a simple, economical and efficient method of supplying clean air for ventilation and industrial processes.

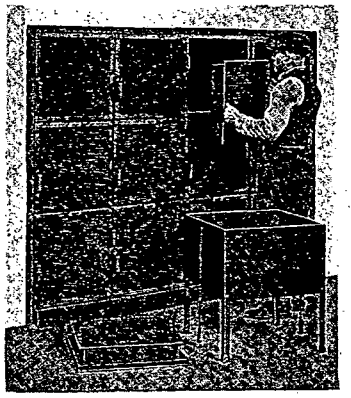
The Reed Air Filter—all metal—operates on the same fundamental principle as the human nostril. Air in passing through the filter impinges upon the filter media coated with "Adhesine," a viscous liquid having a strong affinity for dust, dirt and soot. As the successive layers of dirt are deposited and bound on the filter medium, additional "Adhesine" is supplied by capillary action, being withdrawn from the minute drops or reservoirs of the liquid held at the intersections of the media and in this way binding and keeping the entire system moist for considerable periods. The filter media are progressively packed—the density being least in the front section for the removal of the bulkier dirt and greatest in the rear section to effect the final cleaning. This patented feature keeps resistance at a minimum and prolongs the periods between cleanings.



A Reed Air Filter Unit

Specifications

Size	20"x20"x4"
Capacity (Normal Rat.)	800 C. F. M.
Resistance	0.1875" W. G.
Efficiency	97%
Velocity (recommended)	365 C. F. M.
Weight	25 lb.



Removing Cell for Cleaning

CLEANING AND CHARGING

When dirty, the cells are dipped in the cleaning tank, recharged with "Adhesine" and again put back into service.

FLEXIBILITY

The Reed Filter unit, consisting of a filter cell and its frame, forms a complete filtering unit in itself, but is so designed to be quickly and easily attached to other units, allowing expansion to meet almost any requirements as to capacity and available space.

Our Engineering and Research Department will gladly furnish data and sketches without cost or obligation to you.

Reed Bulletins

106—Description of Reed System.
107—Tests, Data, Specifications.
108—General Ventilation.
109—Ventilating Electrical Machinery.
110—Air Compressors.
111—Drying Operation and Bacteria Control.

Spray Engineering Company

60 High Street
BOSTON, MASSACHUSETTS

SPRACO AIR FILTERS

Spraco Air Filters are adaptable to any system of ventilation where clean air is desired. The filters are made in standard size units which can be installed in various arrangements to fit the space available.

Some of the main advantages of **Spraco Air Filters** are:—

1. Highest cleaning efficiency, due to use of filter media comprised of foraminous metal sheets producing the largest amount of dust collecting surface in a given space.
2. Minimum resistance to air flow consistent with large cleansing capacity.
3. Progressive Filtration—filter media arranged from coarse to fine in direction of air flow.
4. All metal construction—will stand up indefinitely.
5. Foolproof—no auxiliary apparatus or moving parts, such as motors, pumps, etc.
6. Minimum operation and maintenance cost. Requires the services of unskilled labor only.
7. No shut downs—can be cleaned while in operation.
8. Can be adapted to almost any available space.
9. Simple and inexpensive to install.
10. Charging and cleaning tanks each accommodate four filter cells on drain cover at one time—no loose trays.



Inserting Clean Cell

Engineering Service

The Spray Engineering Company maintains a corps of engineers experienced in all phases of air conditioning, including the filtering, washing, cooling, humidifying, and dehumidifying of air for all classes of work. These engineers are available for consultation regarding the best solution of such problems.

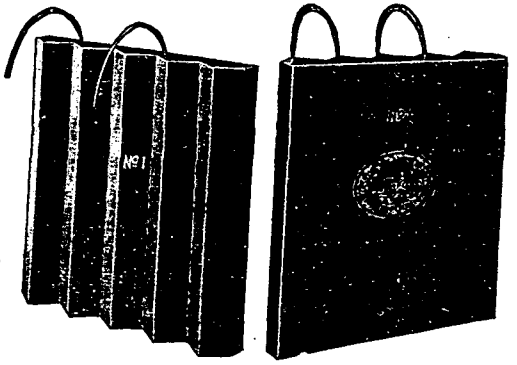
Specifications

Size of Unit	20" x 20" x 4"
Normal Capacity per Unit	800 C. F. M.
Resistance (Clean)	17" w. g.
Resistance (¾ lb. dirt per cell)	25" w. g.
Cleaning Efficiency	98%
Weight of Cell—30 lb. Weight of Frame—15 lb.	45 lb.

Savo Manufacturing Company

111 West Monroe Street
CHICAGO

SAVO AIR MOISTENERS are coal savers. They convert the dry, vitiated indoor air into a moist, wholesome, healthful atmosphere that nature requires and good health demands. Operate automatically. Fill with water and hang on the back of radiator, out of sight. Produce from 40 to 50 humidity.



Style No. 1
Height, 14 in. Width, 12½ in. For 6 to 20 coil radiators.

For Steam and Hot Water Radiators.

These two for radiators 36 in. or 38 in. high.

Style No. 1 (pictured here).

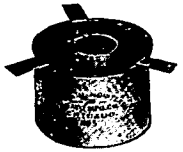
Style No. 2—14 in. high, 8 in. wide, 3 corrugations.

These two for low radiators.

Style No. 3—9 in. high, 12½ in. wide, 5 corrugations.

Style No. 4—9 in. high, 5 in. wide, 2 corrugations.

Styles No. 1 and No. 3 have 2½ in. and 3 in. center corrugations.

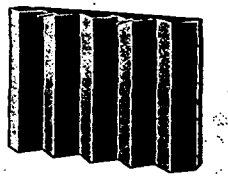


Sets in hot air pipe under floor register

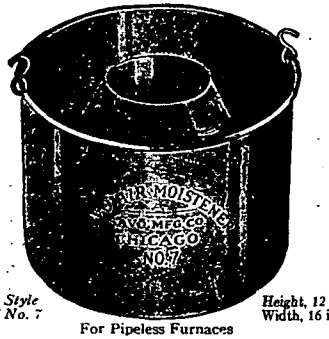
Style No. 5
Height, 6 inches
Width, 8 inches

Style No. 5 for furnace heat. The hot air passing up through the center cone and around the whole outside of the moistener, heats the water in the moistener, producing a rapid evaporation.

Style No. 6 for side wall registers. The two small hooks or wires are put through the top holes in the side wall register plate and the corrugated side of the moistener hangs down in front of the register.



Style No. 6
For Side Wall Registers
Height, 9 inches
Width, 12¼ inches



Style No. 7
For Pipeless Furnaces
Height, 12 in.
Width, 16 in.

Style No. 7 is for pipeless furnaces. Hangs underneath and attached to floor registers by two small hooks where the diameter of the opening below is from 18 in. to 36 in. Filled by using a small funnel.

All styles of SAVO AIR MOISTENERS are made of No. 1 Grade Galvanized Iron, beautifully finished in aluminum or gold bronze.

Write for catalog

"X" LIQUID

REPAIRS LEAKS IN STEAM AND HOT WATER HEATING SYSTEMS, HIGH AND LOW PRESSURE BOILERS

Made by

"X" LABORATORIES, 25 West 45th St., New York

Factories: Boston and Toronto

"X" LIQUID is a pure colloidal solution which repairs leaks quickly and permanently in High and Low Pressure Boilers and Hot Water Heating Systems below the water line. Just pour it in. "X" Liquid circulates freely with the water in the system. Trickling out through leaks, "X" becomes a solid by contact with the air. This solid is turned into a metallic-like seal by heat in the water. "X" contracts and expands with the metal.

"X" seals numerous hair cracks, porous castings, leaky bolt heads and all leaks inside the system which otherwise would be impossible to get at.

"X" is in practically world-wide use. "X" was used by the Government to repair the cracked steel water jacket of the Navy Seaplane N. C. 4 when that ship was forced down in Portugal on its Trans-Atlantic flight.

"X" Liquid was carried by the Army Aeroplane T-2 on its Ocean-to-Ocean non-stop flight. On the Round the World Flight, "X" was procured for each aeroplane by order of the Flight Engineer.

"X" Increases Thermal Efficiency

"X" Liquid increases boiler efficiency because it prevents rust and the deposits of lime and silica which quickly coat the inside of pipes and boilers, reducing heat conductivity. Boilers can be kept permanently free from corrosion by occasional addition of "X" Liquid to the water.

An "X" repair is a permanent repair, and will stand over 600 lb. pressure.

"X" Boiler Liquid
Sold by all Jobbers

SIZES AND PRICES

Quart Cans	$6.00 Each
Half Gallon Cans	$10.00 Each



ABENDROTH BROTHERS

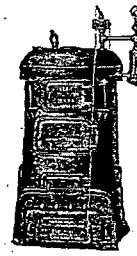
Estab. 1840 **Port Chester, N. Y.**

YORK ABENDROTH HEATERS

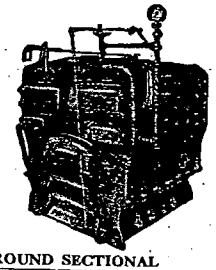
for Steam-Water-Vapor

"The genius of modern heating engineers and the skill of master craftsmen."

Rated conservatively according to accepted standards, and built on the soundest principles of heater construction.



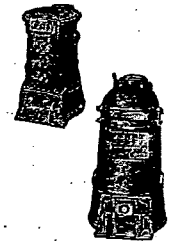
Long Fire Travel.
Perfect Circulation.
Low Water Line.
Fuel Economy.
Fine Castings.



TANK HEATERS

For Every Requirement

40 to 1,800 Gal. Capacities.
Tested to 250 lb. pressure.



No.	Tank Capacity in Gallons
012	40-50
110	150
201	100
212	125
112	125
12	200
120	250
601	350
1611	600
2011	800
2211	1000
2511	1400
2811	1800

YORK ROUND SECTIONAL

Number	Rating	Diameter Fire Pot at Grate	Water Line	Tappings Each Flow and Return
16 Y S 3	225	16	38¾	2-2
19 Y S 3	350	19	39¾	2-2½
20 Y S 3	450	20	42¾	2-2½
22 Y S 3	550	22	45	2-3
25 Y S 3	700	25	47¾	2-3
28 Y S 3	900	28	49	2-4
16 Y W 3	450	16	.....	2-2
19 Y W 3	575	19	.....	2-2½
20 Y W 3	740	20	.....	2-2½
22 Y W 3	900	22	.....	2-3
25 Y W 3	1150	25	.....	2-3
28 Y W 3	1485	28	.....	2-4
16 Y S 4	300	16	43¼	2-2
19 Y S 4	375	19	44¾	2-2½
20 Y S 4	475	20	48	2-2½
22 Y S 4	575	22	50	2-3
25 Y S 4	750	25	53¾	2-3
28 Y S 4	965	28	54½	2-4
16 Y W 4	500	16	.....	2-2
19 Y W 4	620	19	.....	2-2½
20 Y W 4	780	20	.....	2-2½
22 Y W 4	950	22	.....	2-3
25 Y W 4	1240	25	.....	2-3
28 Y W 4	1590	28	.....	2-4
16 Y S 5	325	16	47½	2-2
19 Y S 5	400	19	49¾	2-2½
20 Y S 5	500	20	53¼	2-2½
22 Y S 5	600	22	55	2-3
25 Y S 5	800	25	59¾	2-3
28 Y S 5	1025	28	60	2-4
16 Y W 5	540	16	.....	2-2
19 Y W 5	660	19	.....	2-2½
20 Y W 5	825	20	.....	2-2½
22 Y W 5	990	22	.....	2-3
25 Y W 5	1320	25	.....	2-3
28 Y W 5	1690	28	.....	2-4

YORK SQUARE SECTIONAL

	Number	Rating	Grate Dimensions	Tapping Each Flow and Return
Series 200 and 300 Steam	204	700	20x23	2-4
	205	900	20x30	2-4
	206	1,100	20x37	2-4
	207	1,300	20x44	2-4
	208	1,500	20x51	2-4
	305	1,450	30x30	2-4
	306	1,800	30x37	2-4
	307	2,150	30x44	2-4
	308	2,500	30x51	3-4
	309	2,850	30x58	3-4
	310	3,200	30x65	3-4
Series 200 and 300 Water	204	1,150	20x23	2-4
	205	1,475	20x30	2-4
	206	1,800	20x37	2-4
	207	2,150	20x44	2-4
	208	2,475	20x51	2-4
	305	2,400	30x30	2-4
	306	3,000	30x37	2-4
	307	3,550	30x44	2-4
	308	4,125	30x51	3-4
	309	4,700	30x58	3-4
	310	5,280	30x65	3-4
Series 400 Steam	405	2,900	40x34	2-5
	406	3,625	40x42½	2-5
	407	4,350	40x51	2-5
	408	5,075	40x59½	3-5
	409	5,800	40x68	3-5
	410	6,525	40x76½	4-5
	411	7,250	40x85	4-5
	412	7,975	40x93½	4-5
Series 400 Water	405	4,800	40x34	2-5
	406	6,000	40x42½	2-5
	407	7,200	40x51	2-5
	408	8,400	40x59½	3-5
	409	9,600	40x68	3-5
	410	10,800	40x76½	4-5
	411	12,000	40x85	4-5
	412	13,200	40x93½	4-5

AMERICAN RADIATOR COMPANY

General Executive Office

40 West 40th St. :-: NEW YORK, N. Y.

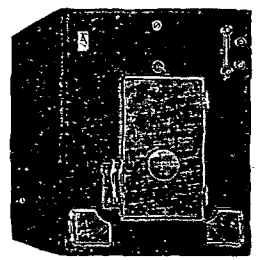
Western Executive Office
816 South Michigan Ave.
CHICAGO, ILL.

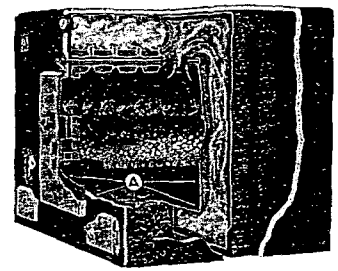
General Sales Department
1807 Elmwood Ave.
BUFFALO, N. Y.

Ideal Boilers, American Radiators, Heating and Vacuum Cleaning Equipment

The series of boilers and other heating equipment represented by the illustrations on these pages is the best and most complete ever offered by any company. It covers a large type, heating, and price range, and includes the latest and most scientific developments and refinements in heating apparatus.

A complete line of beautifully illustrated catalogs with valuable data for Engineers covers the equipment shown here. It will be appreciated if Heating Engineers whose files are incomplete in this respect will kindly have their names forwarded to our nearest Sales Branch so that they may receive the latest technical catalogs as published.



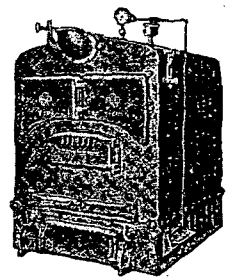


THE IDEAL TYPE "A" HEAT MACHINE

For Hard Coal, Coke, Oil or Gas

Steam Capacity: 450 to 6000 sq. ft.
Water Capacity: 750 to 9600 sq. ft.

The Ideal Type "A" Heat Machine is a powerful, dependable heat generator that uses, on the average, one-third less fuel than the usual boiler. Its cleanliness and fuel economy are made possible by its exclusive features. Among these are: Dial control of automatic heat regulator, Lock-Safe Fire Door, Water-Surrounded Ashpit (A), Tapered, Revertible Flue, and asbestos-lined Ideal Metal Jacket. Complete data and information are contained in the new Type "A" Heat Machine Catalogue.



The Ideal Water Tube Boiler

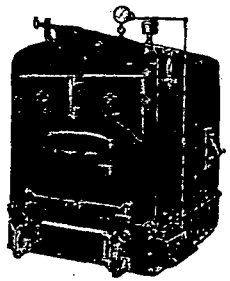
THE IDEAL WATER TUBE BOILER

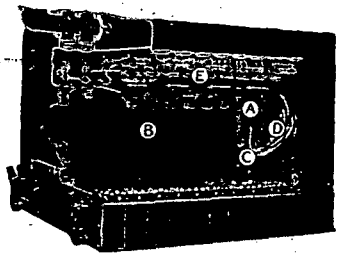
Burns all kinds of fuel

Steam Capacity: 600 to 17,750 sq. ft.
Water Capacity: 975 to 28,500 sq. ft.

The Ideal Water Tube Boiler is justly one of the most popular boilers made by this company. Its carefully balanced design, long double flue travel, and the iron-to-iron gas-tight junctions of its machine-ground section surfaces effect rapid and efficient heat transmission. The boiler is fully described in the Ideal Water Tube Boiler Catalogue.

A book, "Ideal Boilers for Oil Burning," contains valuable material on the use of oil with the Ideal Water Tube Boiler and Type "A" Heat Machine.





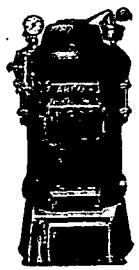
THE IDEAL SMOKELESS BOILER

Burns Soft Coal Smokelessly

Steam Capacity: 2,000 to 17,750 sq. ft.
Water Capacity: 3,250 to 28,500 sq. ft.

The Ideal Smokeless Boiler has established a new standard in smokeless combustion By means of the Ideal Smoke Oxidizer (A), which is a permanent, indestructible part of the boiler, air is distributed in fine streams at a high velocity over the glowing coals across the rear of the fire bed (C) and mixed with the soot making volatile matter. The mixture, ignited, bursts into flame in the rear gas chamber (D). The soot making carbon particles are completely burned, the valuable, heat bearing gases being made available for practical heating service. The completeness of combustion attained not only eliminates smoke but insures permanent economy.

The Ideal Smokeless Boiler catalogue describes in detail the unique construction of the boiler.



The Arco Round Boiler

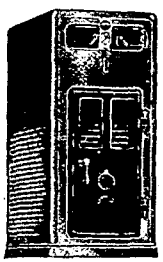
THE ARCO ROUND BOILER

Burns all kinds of Fuel

Steam Capacity: 350 to 1700 sq. ft.
Water Capacity: 600 to 2825 sq. ft.

The Arco Round Boiler is the most popular Boiler of its kind. Its exclusive Third Nipple construction produces continuous, rapid water circulation. Its flue areas are carefully proportioned and designed. The broad, high steam dome of the Steam Boiler provides a large disengaging surface and steam storage space. Dry steam at the outlet is the result. Doors, plate work, and hinge pins are of a heavy, substantial character.

Detailed information is to be found in the Ideal Arco Round Boiler catalogue.



The Ideal Arcola Parlor Heater

THE IDEAL ARCOLA PARLOR HEATER

Burns all kinds of Fuel

Water Ratings: 375 to 750 sq. ft.

The Ideal Arcola Parlor Heater brings to the small home, store, or office, with or without cellar, the convenience, healthfulness, and economy of hot water heating. Combustion is perfectly controlled by a new automatic heat control device. Its features include a water-surrounded ash-pit, Lock-Safe Door with glow panels, large combustion chamber, and well designed fire travel. It is handsome in appearance and clean in operation.



The Ideal Arcola Heater

THE IDEAL ARCOLA HEATER

Water Capacity: 200 to 600 sq. ft.

The Ideal Arcola Heater is similar in principle to the Ideal Arcola Parlor Heater, but differs chiefly in not having the enameled cover and automatic damper regulator. Although this ingenious little combination boiler-radiator is not regularly supplied with an automatic heat regulating device, such a device may easily be added at any time.

A catalogue describing both the Ideal Arcola Heater and Ideal Arcola Parlor Heater will be sent on request.



The Ideal Vecto Heater

THE IDEAL VECTO HEATER

(For homes up to 8,000 cu. ft. content)

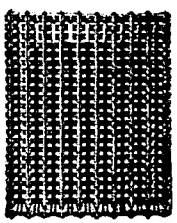
The Ideal Vecto Heater is the most highly perfected warm air heater yet developed, for small homes and other buildings. It draws in, heats, and circulates large volumes of air at moderate temperatures, spreading an even warmth throughout the home; and because of its effective design and construction it requires no more fuel than the old-fashioned one-room heater. Its efficiency is due chiefly to its very extensive ribbed heating surface.



Corto—The Radiator Classic

CORTO—THE RADIATOR CLASSIC

The beautiful, compact Corto Radiator now costs but a small amount more than regular radiation, and is being more and more widely specified. It occupies 30 per cent less space than regular radiation. Here is the ideal radiator for the ideal home.

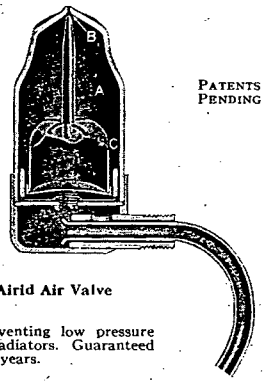


Vento Heaters

VENTO HEATERS

Vento Cast-Iron Hot Blast Heaters are now the standard here and abroad for heating mechanically circulated air. They are made in 40, 50, and 60 inch sizes in the Narrow Pattern; and in 30, 40, 50, 60, and 72 inch sizes in the Regular Pattern.

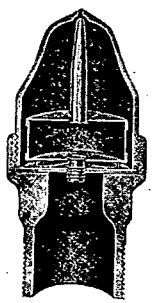
Two books, "Ventilation by Vento Heaters" and "Engineers' Data on Vento Heaters" give all needed information.



PATENTS PENDING

Airid Air Valve

For venting low pressure steam radiators. Guaranteed for five years.

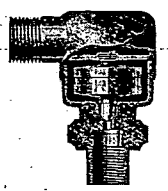


PATENT PENDING

No. 815

Ideal Quick Vent

All metal. Very sensitive. For venting mains, long runs of pipe, indirect stacks, drop risers, etc.

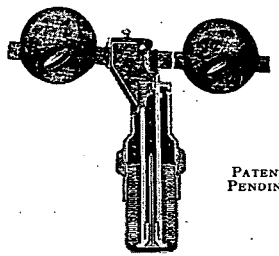


PATENT PENDING

No. 817

Vento Vent

For use on Vento Heaters and Blast Coils.

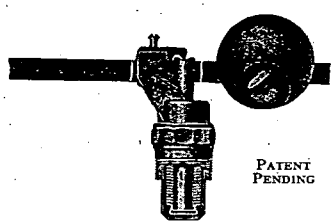


PATENTS PENDING

No. 800

Arco Water Regulator

For damper control on hot water heating boilers. Adjustable for temperature between 100° and 220°. All metal.
Length of Bulb 2⅞ inches. Connection, 2 inches.

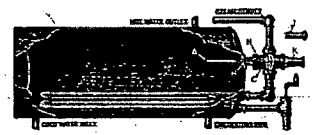


PATENT PENDING

No. 801

Arco Junior Water Regulator

For damper control on Hot Water Supply Boilers. Temperature range 130°–180°. Length of Bulb, 2 inches. Connection, 1½ inches.



PATENT PENDING

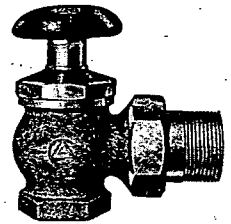
No. 825

Arco Tank Regulator

For temperature control of liquids heated by steam. (Also made in flexible tube type No. 826).
Range 140° to 180° F. For use on steam pressures up to 15 lbs.

Send for complete catalog of Ideal Heating Specialties

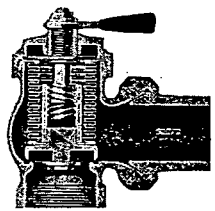
PACKLESS VALVES



No. 988

Arco Packless Valves—Quick Opening

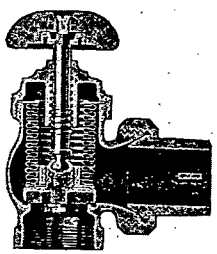
Leakless feature consists of special moulded ring with metallic core held under compression by a spring. Requires no repacking. Opens or closes with one turn. Does not stick or bind. Furnished with either round or lever composition handle.
No. 988 Angle. No. 955 R. H. Corner. No. 960 L. H. Corner. No. 970 Globe. No. 968 Fractional Type with indicator and graduated dial.



No. 878

Ideal Super-Packless Valves—Bellows Type Quick Opening

Made similar to No. 850 (below) but quick opening. Opens or closes with ⅛ turn of the handle. Equipped with either round or lever composition handle.
No. 878 Angle. No. 879 R. H. Corner. No. 880 L. H. Corner. No. 870 Globe. No. 868 Fractional Type with indicator and graduated dial.

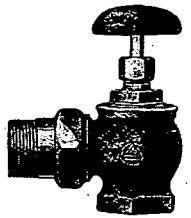


No. 850

Ideal Packless Valves—Bellows Type

Metallic bellows surrounds the stem and working parts, which prevents passage of steam, water or air around the stem opening. Equipped with round composition handle.
No. 850 Angle. No. 851 R. H. Corner. No. 852 L. H. Corner. No. 860 Globe.

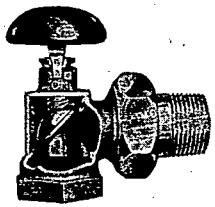
PACKED VALVES



No. 72

Detroit Steam Valves

Metal well distributed—strong and heavy where strength is needed. Regularly equipped with composition handle, black hard rubber finish.
No. 72 Angle. No. 32 R. H. Corner. No. 37 L. H. Corner. No. 57 Globe. No. 373 Gate.



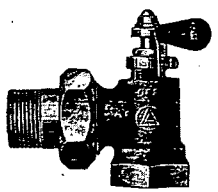
No. 101

Detroit Hot Water Valve

The No. 101 Hot Water Valve will not stick or turn hard. The narrow edge of the plate presents a small area of contact so that corrosion is easily broken away. Concave plate gives true elbow shape when valve is open, reducing friction of water flow. Made in Angle pattern only.

Detroit Equalizing Hot Water Valves

Made similar to No. 101 (above) but equipped with a movable stop collar which provides means for graduating the flow. With these valves hot water jobs can be perfectly balanced after installation.

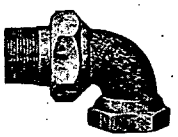


No. 105

No. 105 with composition lever handle. No. 104 with composition round handle. Angle pattern only.

Detroit Union Elbows

Made with the same care and inspection as Detroit Valves. Strong and heavy where strength is needed. No. 132.



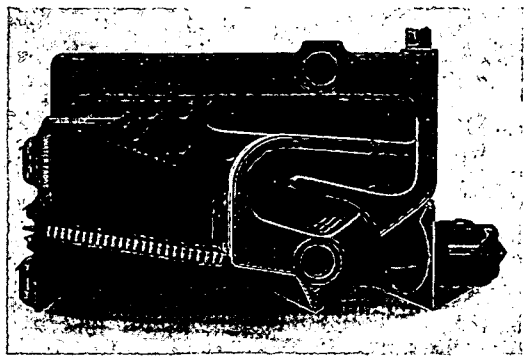
No. 132

Bernhard Boiler Mfg. Co.

3161 East 61st Street

Cleveland - Ohio

BERNHARD TRIPLE COMBUSTION BOILERS



Smokeless Boiler with the Lowest Water Line

The Con

The [redacted] from each Grate Bar being entirely taken care of in the Section directly above it, the same Ratio of GRATE Surface, FIRE Surface and FLUE Area is always maintained. Note how Gases Expand at three different points.

Boiler No.	Steam Rating	Water Rating	Grate Surface Sq. Ft.	Flue Area Through Sections Sq. In.	Lbs. Steam per Hour	B.t.u. per Hour	Height Water Line	Flow Openings
20- 5	600	1000	2.50	42	150	145,500	42"	2-3"
20- 6	800	1300	3.33	56	200	194,000	42"	2-3"
20- 7	1000	1650	4.17	70	250	242,500	42"	2-3"
20- 8	1200	2000	5.00	84	300	291,000	42"	2-3"
20- 9	1400	2350	5.84	98	350	339,500	42"	3-3"
30- 6	1600	2600	5.00	80	400	388,000	42"	2-4"
30- 7	2000	3250	6.25	100	500	485,000	42"	2-4"
30- 8	2400	3900	7.50	120	600	582,000	42"	2-4"
30- 9	2800	4550	8.75	140	700	679,000	42"	2-4"
30-10	3200	5200	10.00	160	800	776,000	42"	3-4"
30-11	3600	5850	11.25	180	900	873,000	42"	3-4"
30-12	4000	6500	12.50	200	1000	970,000	42"	3-4"
40- 8	4200	6720	10.00	160	1050	1,018,500	46"	2-5"
40- 9	4900	7840	11.66	185	1225	1,188,250	46"	2-5"
40-10	5600	8960	13.33	210	1400	1,358,000	46"	2-5"
40-11	6300	10080	15.00	235	1575	1,527,750	46"	2-5"
40-12	7000	11200	16.66	260	1750	1,697,500	46"	3-5"
40-13	7700	12320	18.33	285	1925	1,867,250	46"	3-5"
40-14	8400	13440	20.00	310	2100	2,037,000	46"	3-5"
40-15	9100	14560	21.66	335	2275	2,206,750	46"	3-5"
40-16	9800	15680	23.33	360	2450	2,376,500	46"	3-5"
40-17	10500	16800	25.00	385	2625	2,546,250	46"	4-5"
40-18	11200	17920	26.66	410	2800	2,716,000	46"	4-5"
40-19	11900	19040	28.33	435	2975	2,885,750	46"	4-5"
40-20	12600	20160	30.00	460	3150	3,055,500	46"	4-5"
40-21	13300	21280	31.66	485	3325	3,225,250	46"	4-5"
40-22	14000	22400	33.33	510	3500	3,395,000	46"	4-5"
*to	700	1120	1.67	25	175	169,750	...	...
40-32	21000	33600	50.00	760	5250	5,092,500	46"	6-5"

*Add per Section.

The Bigelow Company

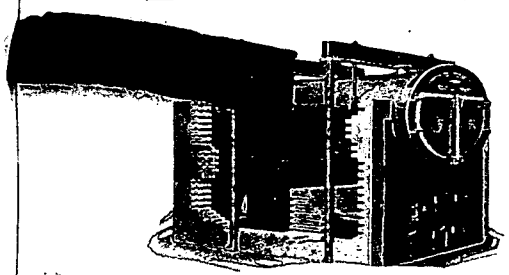
Main Office and Works

NEW HAVEN : CONNECTICUT

NEW YORK, N. Y.
85 LIBERTY STREET

BOSTON, MASS.
141 MILK STREET

Manufacturers of Bigelow Hornsby Water Tube Boilers, Bigelow H. R. T., Bigelow Two-Pass, Bigelow Manning and Bigelow Upright Fire Tube Boilers.

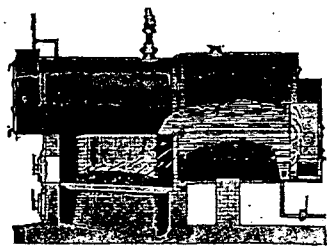


Bigelow H. R. T. Boiler

Investigation of the Bigelow H. R. T. boiler will convince you of its true value. Economical service has been the big feature of Bigelow products during a period of boiler building extending over 50 years. With a shop containing the most modern approved equipment for boiler construction a product is assured representing the highest quality in workmanship.

For Central Power Stations and large industrial plants the Bigelow Hornsby water tube boiler is unexcelled. High continuous economy, large overload capacity, large furnace volume and straight tubes are a few of the features contained in this type of boiler. The Hornsby is built in units of 375 H. P. to 3,000 H. P.

The Bigelow Two-Pass Boiler is the latest development of this company. After careful investigation of the existing types of steel heating boilers an effort was made to eliminate the objectionable features of many; the result being the Two-Pass Boiler. This boiler will meet heating and power requirements especially where space limitations prevail. Elimination of staybolts and special brick shapes in furnace reduces maintenance to a minimum. Large furnace volume; long gas travel, uniform velocity of gas over heating surface and low exit temperature assures maximum efficiency.



Bigelow Two-Pass Boiler

The Brownell Company

Dayton, Ohio

SALES REPRESENTATIVES IN ALL SECTIONS OF THE COUNTRY

Steel Heating and Power Boilers, Feed Water Heaters, Tanks, Breechings, Stacks, Boiler Castings, Steel Plate Construction and Steam Engines.

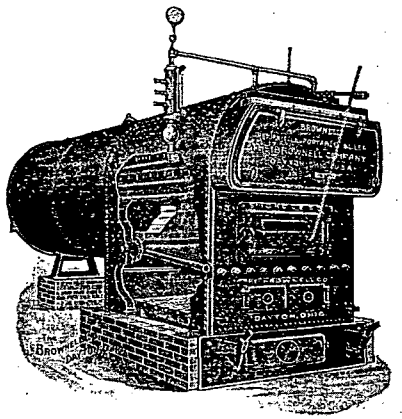
Since 1855, when **The Brownell Co.** was established, this company has been manufacturing a complete line of High Grade Boilers and other equipment.

The **Brownell** Smokeless Firebox Boiler is designed and constructed to burn any kind of fuel economically and without smoke. **Brownell** Firebox Boilers are mechanically correct and insure long life. **Brownell** Heating Boilers have generous and properly designed fireboxes, permitting complete combustion and high efficiency.

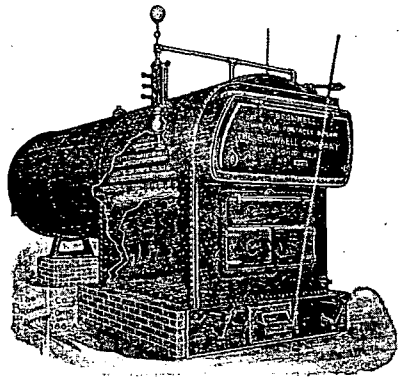
Brownell ratings are very conservative, only the parts of boiler below the normal water level and coming in actual contact with the hot gases being considered as effective heating surface.

Brownell Boilers will carry the number of square feet of direct radiating surface or equivalent given in opposite tables if sufficient radiation is installed to heat the building to the required temperature.

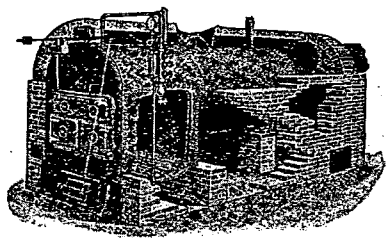
Brownell Firebox Heating Boilers are regularly built according to the *A. S. M. E.* Code for 15 lb. working pressure but will be furnished for pressures up to 100 lb. at an increased cost.



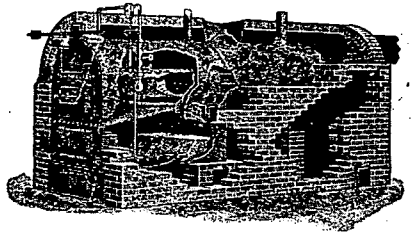
Brownell Return Flue Portable—Smokeless Type—Bulletin B-6A



Brownell Return Flue Portable—Direct Draft Type—Bulletin B-6A



Brownell Brick-set Firebox Boiler—Direct Draft Type
Bulletin B-6



Brownell Brick-set Firebox Boiler—Smokeless Type
Bulletin B-6

BROWNELL DIRECT DRAFT PORTABLE BOILERS

Boiler No.	407	408	409	410	411	412	413	414	415	416	417	418	419	420	421	422	423	424
Capacity—Steam, Sq. Ft.	2500	2900	3500	4000	4500	5000	5500	6000	7000	8000	9500	11000	13000	15000	17500	20000	25000	28000
Capacity—Water, Sq. Ft.	4100	4800	5800	6600	7400	8300	9100	9900	11600	13200	15700	18200	21500	24800	28500	32000	40000	45000
Approximate Weight	6900	7400	8300	9000	9800	10600	13200	14100	15900	17300	19600	21000	23000	24800	27100	29000	35000	38000
Diam. of Boiler, In.	48	48	48	54	54	54	60	60	60	60	66	66	72	72	78	78	84	84
Length Boiler Overall, Ft., In.	8–6	9–6	10–6	10–0	11–0	12–0	12–6	13–6	14–0	15–6	15–8	17–8	15–10	17–4	17–10	19–10	20–0	22–0
Heating Surface, Sq. Ft.	293	333	373	427	487	537	614	670	698	781	936	1061	1224	1356	1539	1796	2227	2478
Size of Steam, In.	6	6	6	6	6	6	7	7	7	7	8	8	8	8	8	8	10	10
Size of Return, In.	4	4	4	4	4	4	5	5	5	5	6	6	6	6	6	6	6	6
Height of Water Line, In.	69	69	69	76	76	76	78	78	78	78	87	87	92	92	92	92	98	98
Height, Floor to Top of Shell, In.	84	84	84	91	91	91	95	95	95	95	108	108	109	109	110	110	116	116
Space Required to Open Rear Doors, In.	25	25	25	28	28	28	30	30	30	30	35	35	37	37	40	40	43	43
Diam. Breeching, In.	22	22	22	24	24	24	26	26	28	28	30	32	34	34	36	36	40	40
Diam. Stack, In.	20	20	20	22	22	22	24	24	26	26	28	30	32	32	34	34	38	38
Min. Height Stack, Ft.	50	50	55	55	55	60	60	60	65	65	65	70	70	70	80	90	90	100
Diam. Breeching, 2 Boilers, In.	30	30	30	34	34	34	38	38	40	40	44	46	50	50	52	52	56	56
Diam. Stack, 2 Boilers, In.	28	28	28	31	31	31	34	34	36	36	40	42	46	46	48	48	54	54
Minimum Height Stack, 2 Boilers, Ft.	60	60	65	65	65	70	70	70	75	75	75	80	80	80	90	100	100	100

BROWNELL SMOKELESS PORTABLE BOILERS

Boiler No.	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324
Capacity—Steam, Sq. Ft.	3000	3500	4000	4500	5000	5500	6000	6500	7500	8500	10000	12000	14000	16000	18000	20000	25000	30000
Capacity—Water, Sq. Ft.	5000	5800	6600	7400	8300	9100	9900	10700	12400	14000	16500	19800	23100	26400	29700	33000	40000	48000
Approximate Weight	7800	8600	9300	10400	11100	11900	14300	15300	16900	17800	20000	21900	24000	25500	27900	28000	35000	41000
Diam. of Boiler, In.	48	48	48	54	54	54	60	60	60	60	66	66	72	72	78	78	84	84
Length Boiler Overall, Ft., In.	8–7	9–10	10–10	10–7	11–7	12–7	12–7	13–7	15–1	16–1	15–9	17–9	16–6	17–8	17–8	18–8	20–1	24–1
Heating Surface, Sq. Ft.	307	381	405	472	526	579	631	687	766	822	922	1062	1255	1370	1529	1601	2090	2655
Size of Steam, In.	6	6	6	6	6	6	7	7	7	7	8	8	8	8	8	8	10	10
Size of Return, In.	4	4	4	4	4	4	5	5	5	5	6	6	6	6	6	6	6	6
Height of Water Line, In.	69	69	69	76	76	76	78	78	78	78	87	87	92	92	92	92	103	103
Height, Floor to Top of Shell, In.	84	84	84	92	92	92	95	95	95	95	108	108	109	109	110	110	118	118
Space Required to Open Rear Doors, In.	25	25	25	28	28	28	30	30	30	30	35	35	37	37	42	42	44	44
Diam. Breeching, In.	22	22	22	24	24	24	26	26	28	28	30	32	34	34	36	36	40	40
Diam. Stack, In.	20	20	20	22	22	22	24	24	26	26	28	30	32	32	34	34	38	38
Min. Height Stack, Ft.	50	55	55	55	55	60	60	60	65	65	65	70	70	70	80	90	90	100
Diam. Breeching, 2 Boilers, In.	30	30	30	34	34	34	38	38	40	40	44	46	50	50	52	52	56	56
Diam. Stack, 2 Boilers, In.	28	28	28	31	31	31	34	34	36	36	40	42	46	46	48	48	54	54
Min. Height Stack, 2 Boilers, Ft.	60	65	65	65	65	70	70	70	75	75	75	80	80	80	90	100	100	110

BROWNELL DIRECT DRAFT BRICK-SET BOILERS

Boiler No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Capacity—Steam, Sq. Ft.	900	1050	1200	1400	1700	2000	2000	2600	3000	3500	4000	4500	5500	6500	7500	8700	10000	11000	12000	14000
Capacity—Water, Sq. Ft.	1500	1700	2000	2300	2800	3300	3300	4300	5000	5800	6600	7400	9100	10700	12400	14400	16500	18200	19800	23100
Approx. Shipping Weight	2800	3000	3200	3600	4200	4800	5200	5600	6000	7000	7800	8600	9700	11000	13500	14800	16000	17400	18600	20400
Diam. of Boiler, In.	30	30	30	36	36	36	42	42	42	48	48	48	54	54	60	60	66	66	72	72
Length Boiler, Ft., In.	6–6	7–6	8–6	7–6	9–0	10–6	8–6	10–0	11–6	10–6	12–0	13–6	14–0	16–6	15–6	18–0	16–0	18–0	16–0	18–0
Heating Surface, Sq. Ft.	113	128	143	193	231	268	269	317	364	390	444	499	573	683	755	887	971	1097	1183	1343
Size of Steam, In.	3	3	4	4	4	4	6	6	6	6	7	7	7	7	7	7	8	8	8	8
Size of Return, In.	2½	2½	3	3	3	3	4	4	4	4	4	5	5	5	5	5	6	6	6	6
Height of Water Line, In.	53	53	53	59	59	59	61	61	61	65	65	65	67	67	75	75	80	80	85	85
Height Floor to Top of Brick Work, In.	70	70	70	77	77	77	83	83	83	90	90	90	96	96	108	108	114	114	120	120
Diam. Breeching, In.	12	14	16	16	18	18	20	20	22	22	24	24	28	28	32	32	32	32	36	36
Diam. Stack, In.	12	12	14	14	16	16	18	18	20	20	22	22	26	26	30	30	30	30	34	34
Min. Height Stack, Ft.	40	40	40	40	40	45	45	45	45	45	50	50	50	50	55	55	60	60	60	60
Diam. Breeching, 2 Boilers, In.							26	28	30	30	34	36	38	38	40	40	40	42	44	46
Diam. Stack, 2 Boilers, In.							24	26	28	28	30	32	34	34	36	36	36	38	40	42
Min. Height Stack, 2 Boilers, Ft.							50	50	50	50	50	50	55	60	60	70	70	70	70	70

BROWNELL SMOKELESS BRICK-SET BOILERS

Boiler No.	107	108	109	110	111	112	113	114	115	116	117	118	119	120
Capacity—Steam, Sq. Ft.	2600	3100	3600	4000	4700	5500	6500	7500	8500	10000	11500	13000	14000	16000
Capacity—Water, Sq. Ft.	4300	5100	5900	6600	7800	9100	10700	12400	14000	16500	19000	21500	23100	26400
Approximate Shipping Weight	6100	6700	7200	8400	9100	9800	12300	13600	16000	17400	19400	21000	22400	24300
Diam. of Boiler, In.	42	42	42	48	48	48	54	54	60	60	66	66	72	72
Length Boiler Overall, Ft., In.	9–10	11–4	12–11	12–4	13–10	15–4	15–10	18–4	17–10	20–4	18–4	20–4	18–4	20–4
Heating Surface, Sq. Ft.	309	359	409	448	506	563	643	756	851	987	1074	1204	1303	1468
Size of Steam, In.	6	6	6	6	6	7	7	7	7	7	8	8	8	8
Size of Return, In.	4	4	4	4	4	5	5	5	5	5	6	6	6	6
Height of Water Line, In.	61	61	61	65	65	65	67	67	75	75	80	80	86	86
Height Floor to Top of Brick Work, In.	82	82	82	89	89	89	95	95	107	107	113	113	119	119
Space Required to Open Rear Doors, In.	22	22	22	25	25	25	28	28	30	30	35	35	37	37
Diam. Breeching, In.	22	22	24	24	27	27	30	30	34	34	36	36	38	38
Diam. Stack, In.	20	20	22	22	24	24	28	28	32	32	34	34	36	36
Min. Height of Stack, Ft.	50	50	50	50	55	55	60	60	60	60	70	70	70	70
Diam. Breeching, 2 Boilers, In.	28	30	34	34	36	36	38	40	42	42	44	46	48	50
Diam. Stack, 2 Boilers, In.	26	28	30	30	32	32	34	36	38	38	40	42	44	46
Min. Height Stack, 2 Boilers, Ft.	60	60	60	60	60	60	70	70	70	75	75	80	80	80

THE BRYANT HEATER & MFG. COMPANY

Factory, 952 E. 72nd St. — **CLEVELAND, OHIO**

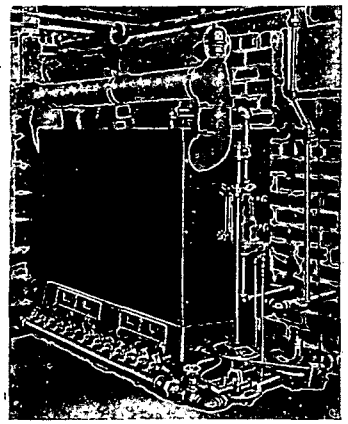
TUBULAR TRADE MARK

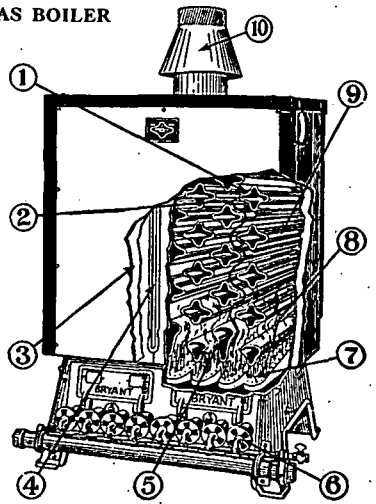
Branches in Principal Cities

BALTIMORE, MD., 1116 Lexington Bldg.
BIRMINGHAM, ALA., American Trust Bldg.
BOSTON, MASS., 126 High St.
BROOKLYN, N. Y. 353 Atlantic Ave.
BUFFALO, N. Y., 610 Erie County Bank Bldg.
CANTON, OHIO 415 Daily News Bldg.
CHICAGO, ILL., 218 South Wabash Ave.
CINCINNATI, OHIO, 421 Union Trust Bldg.
CLEVELAND, OHIO, Sales Service 1454 East 17th St.
DENVER, COLO., 1425 Sixteenth St.
DETROIT, MICH., 7644 Woodward Ave.
KANSAS CITY, MO., 207 Davidson Bldg.
MUSKOGEE, OKLA., 110 S. Fourth St.
PHILADELPHIA, PA., Bourse Bldg.
PITTSBURGH, PA., East End Trust Bldg.
ROCHESTER, N. Y., 112 S. Clinton St.
SAINT LOUIS, MO., 840 Planters Bldg.
SAN FRANCISCO, CAL., 710 Polk St.
TOLEDO, OHIO, 405 Nicholas Bldg.
WICHITA, KANS., 302 Orpheum Bldg.

Bryant Gas Boiler for Hot Water, Steam or Vapor Heating
Bryant Hot Water Storage Systems **Bryant Hot Water Steam Generators**

BRYANT GAS BOILER





General Description of Boiler

Sectional design with an individual burner for each section. Automatic regulating and control devices.

Cast iron construction with heavy base which serves as foundation.

Liberally proportioned tubes—staggered for long gas travel. Tubes are easily accessible for cleaning.

Large steam liberating space, which insures a steady water line.

Bryant Engineers

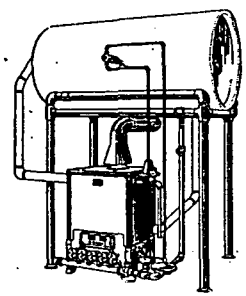
Bryant representatives travel the entire country in an endeavor to give whole-hearted co-operation and service. Complete information can be secured from any of the offices listed above.

1—Water Tubes of original and exclusive design; of large area, with thin walls which quickly transmit the heat to the water. The pitch of these tubes facilitates natural circulation.
2—Staggered Tubes afford long gas travel.
3—Metal jacketed cover, with Asbestos Cell insulation, effectively retards radiation of heat into basement. Plastic asbestos may be used if desired, however.
4—Tubes, easily accessible for cleaning. This is unnecessary, except under unusual gas conditions.
5—Special Shape of Lower Tubes prevents reflection and aids heat in quickly reaching water tubes above.
6—Large Adjustable Mixers, equipped with sturdy and convenient T-handle valves.
7—Scientifically Designed Burners with drilled ports. Fuel supplied by Venturi mixing tubes. Both may be easily removed.
8—An individual Burner for each Section. Correct proportioning of gas consumption to heating surface; 1800 sq. in. of heating surface per boiler horse power.
9—Baffle Plates, on end castings, direct hot gases against water tubes.
10—Draft Hood regulates draft and eliminates hazard from accidently stopped flue.
Iron Sections, assembled with cast iron nipples and secured by tie rods, give water-tight connections that are not affected by expansion, contraction, or gases.

Ratings and Dimensions of Bryant Gas Boilers

Steam Boiler No.	Rating	Water Boiler No.	Rating	Dimensions, Inches A	B	C	D	E	F	G	H	J	K	L
3-S-2	200	3-C-2	320	47	5	15⅝	28½	29	29¾	22	12⅛	2	18	13⅞
4-S-2	265	4-C-2	425	47	5	18⅜	31⅝	29	29⅝	22	12⅛	2	18	13⅞
5-S-2	335	5-C-2	535	47	5	21⅛	34⅞	29	29¾	22	12⅛	2	18	13⅞
3-S-3	400	3-C-3	640	65	5	17⅛	30½	37	46	36	15⅛	3	26⅞	21⅛
4-S-3	560	4-C-3	895	66	6	20¼	33¼	37	46	36	15⅛	3	26⅞	21⅛
5-S-3	720	5-C-3	1150	66	6	23⅛	37⅛	37	46	36	15⅛	3	26⅞	21⅛
6 S-3	880	6-C-3	1410	66	6	26⅛	41¼	37	46	36	15⅛	3	26⅞	21⅛
7-S-3	1040	7-C-3	1665	67	7	29⅝	44¼	37	46	36	15⅛	3	26⅞	21⅛
8-S-3	1200	8-C-3	1920	67	7	33	47⅛	37	46	36	15⅛	3	26⅞	21⅛
9-S-4	1500	9-C-4	2400	66½	8	40⅛	54⅝	37	47¼	37	15¾	4	26⅞	21⅛
11-S-4	1880	11-C-4	3010	67	8	47⅜	63⅜	37¼	47¼	37	15¾	4	26⅞	21⅛
13-S-4	2260	13-C-4	3620	67	8	54⅛	70⅞	37¼	47¼	37	15¾	4	26⅞	21⅛
15-S-4	2640	15-C-4	4220	67½	9	61⅞	77⅛	37¼	47¼	37	15¾	4	26⅞	21⅛
17-S-4	3020	17-C-4	4830	67½	9	69⅛	86	37⅜	47¾	37	15¾	4	26⅞	21⅛
19-S-4	3400	19-C-4	5440	67½	9	76⅜	93¼	37⅜	47¾	37	15¾	4	26⅞	21⅛
21-S-4	3780	21-C-4	6050	67½	9	83⅝	100½	37⅜	47¾	37	15¾	4	26⅞	21⅛
23-S-4	4160	23-C-4	6660	68	10	90⅞	107¾	37⅜	47¾	37	15¾	4	26⅞	21⅛
25-S-4	4540	25-C-4	7260	68	10	98⅛	115	37⅜	47¾	37	15¾	4	26⅞	21⅛
27-S-4	2920	27-C-4	7870	68½	11	105⅜	122¼	37⅜	47¾	37	15¾	4	26⅞	21⅛
29-S-4	5300	29-C-4	8480	68½	11	112⅝	129½	37⅜	47¾	37	15¾	4	26⅞	21⅛
31-S-4	5680	31-C-4	9090	68½	11	119⅞	136¾	37⅜	47¾	37	15¾	4	26⅞	21⅛
33-S-4	6060	33-C-4	9700	68½	11	127⅛	144	37⅜	47¾	37	15¾	4	26⅞	21⅛
35-S-4	6440	35-C-4	10,300	68½	11	134⅜	151¼	37⅜	47¾	37	15¾	4	26⅞	21⅛
37-S-4	6820	37-C-4	10,910	69	12	141⅝	158½	37⅜	47¾	37	15¾	4	26⅞	21⅛
39-S-4	7200	39-C-4	11,520	69	12	148⅞	165¾	37⅜	47¾	37	15¾	4	26⅞	21⅛
41-S-4	7580	41-C-4	12,330	69	12	156⅛	173	37⅜	47¾	37	15¾	4	26⅞	21⅛

BRYANT HOT WATER STORAGE SYSTEMS

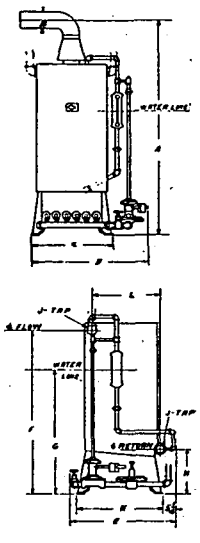


General Description of Hot Water Storage System

Designed and built for supplying large quantities of hot water at an instant's notice. Boiler is automatically controlled to maintain a full tank of hot water at all times. Ample capacity for peak loads or sustained heavy demand.

Capacities of Bryant Hot Water Storage Systems

Boiler H.P.	Available B.t.u. Per Hour	Boiler No.	Capacity, in gallons per hour raised 60°	100°	140°
1.3	45,000	3-A-2	94	54	39
1.8	60,500	4-A-2	126	72	52
2.2	75,500	5-A-2	157	90	65
2.7	90,500	3-A-3	185	110	80
3.6	120,500	4-A-3	240	145	105
4.5	151,000	5-A-3	300	180	130
5.4	181,000	6-A-3	360	215	155
6.3	211,000	7-A-3	420	250	180
7.2	241,500	8-A-3	480	290	205
9	305,000	9-A-4	610	370	260
11	372,000	11-A-4	735	450	320
13	439,000	13-A-4	880	530	380
15	506,000	15-A-4	1020	610	435
17	573,000	17-A-4	1150	690	485
19	640,000	19-A-4	1280	770	550
21	707,000	21-A-4	1410	850	605
23	774,000	23-A-4	1540	930	660
25	840,000	25-A-4	1680	1010	720
27	908,000	27-A-4	1820	1090	775
29	975,000	29-A-4	1940	1170	835
31	1,041,000	31-A-4	2080	1250	890
33	1,109,000	33-A-4	2220	1330	950
35	1,176,000	35-A-4	2350	1410	1005
37	1,242,000	37-A-4	2480	1490	1060
39	1,310,000	39-A-4	2620	1570	1120
41	1,377,000	41-A-4	2750	1650	1180



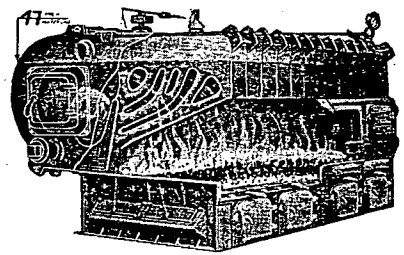
Continental Heater Corporation

Dunkirk, N. Y.

MANUFACTURERS OF CAST IRON BOILERS AND RADIATORS

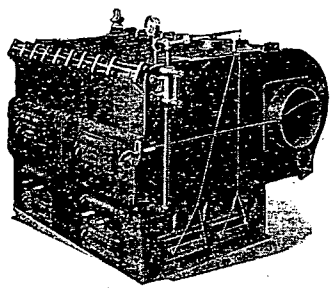
Continental Low Water Line Boilers

Smokeless and Regular Types



Interior View

Many engineers, architects and heating contractors will recognize the Continental as the boiler which during the past 12 years has helped them solve low head room problems. The extremely low water line eliminates the necessity for pits and prevents water line troubles by providing ample space between the water line and low point of the main.

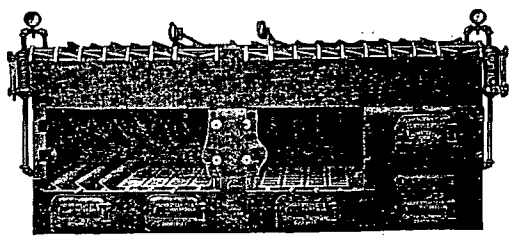


No. 410S—Single Series (Regular)

Free and rapid circulation throughout the boiler makes for efficiency and prevents priming. By reason of its design the boiler is a rapid steamer.

The Continental does justice to the engineers layout and the heating contractors installation. It pleases the owner by its ease of operation and fuel economy.

Continental Double Series Boiler

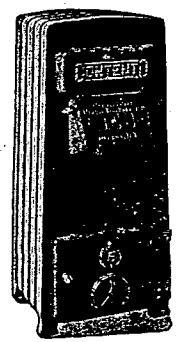


Double Series Boiler

The Continental Double Series Boiler has two separate fire boxes, either or both of which may be used. They may be of equal size, or one larger than the other. Only one part of the boiler need be used during mild weather.

30-in. double series 2600 sq. ft. to 8200 sq. ft. steam capacity. 40-in. double series 5500 sq. ft. to 22,300 sq. ft. steam capacity.

CONTENTO BOILERS



Contento

The Contento can be used either on the same floor with the radiators or in the basement.

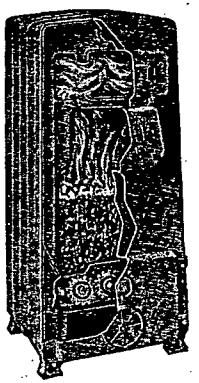
The forward and back fire travel utilizes the gases instead of allowing them to be wasted up the chimney.

Contento Number	Water Rating Sq. Ft.	Steam Rating Sq. Ft.
4	400	240
5	535	320
6	670	400
7	825	500

Height, 45 in., two 2 in. flow tappings, two 2 in. return tappings.

Steam boilers have 2 in. top outlet.

Shipped in one piece crated.



Inside View

CONTINENTAL LOW WATER LINE BOILER DATA

(Ratings have never been changed)

Smokeless Boiler Number	Regular Series Boiler Number	Steam Rating	Water Rating	Grate Area	Flow and Return 2 Each Inches	Front Length of Boiler Inches	Extreme Overall Depth Inches	Chimney Area Inches	Chimney Height Feet
20 Series Water Line 38 Inches—Height of Flow 43 Inches									
....	25	700	1,150	3.88	3	35	39½	8x12	40
....	26	900	1,500	4.85	3	42	39½	12x12	40
....	27	1,100	1,850	5.82	3	49	39½	12x12	40
....	28	1,300	2,200	6.80	3	56	39½	12x12	40
30 Series Water Line 43 Inches—Height of Flow 48 Inches									
530	35	1,200	2,000	5.83	4	35	54½	12x12	40
630	36	1,600	2,650	7.29	4	42	54½	12x12	40
730	37	2,000	3,300	8.75	4	49	54½	12x12	40
830	38	2,400	4,000	10.21	4	56	54½	12x12	40
930	39	2,800	4,650	11.67	4	63	54½	12x16	40
1030	310	3,200	5,300	13.13	4	70	54½	12x16	45
1130	311	3,600	6,000	14.59	4	77	54½	12x16	45
1230	312	4,000	6,650	16.05	4	84	54½	16x16	45
40 Series Water Line 47 Inches—Height of Flow 54 Inches									
640	46	2,500	4,150	9.72	5	42	79	12x16	50
740	47	3,200	5,300	11.66	5	49	79	12x16	50
840	48	3,900	6,450	13.60	5	56	79	16x16	50
940	49	4,600	7,600	15.54	5	63	79	16x20	55
1040	410	5,300	8,750	17.48	5	70	79	16x20	55
1140	411	6,000	9,900	19.43	5	77	79	20x20	55
1240	412	6,700	11,100	21.35	*5	84	79	20x20	60
1340	413	7,400	12,250	23.32	*5	91	79	24x24	65
1440	414	8,100	13,400	25.27	*5	98	79	24x24	65
1540	415	8,800	14,550	27.22	*5	105	79	24x28	65
1640	416	9,500	15,700	29.17	**5	112	79	28x28	70
1740	417	10,200	16,850	31.12	**5	119	79	28x28	70
1840	418	10,900	18,000	33.07	**5	126	79	28x32	70

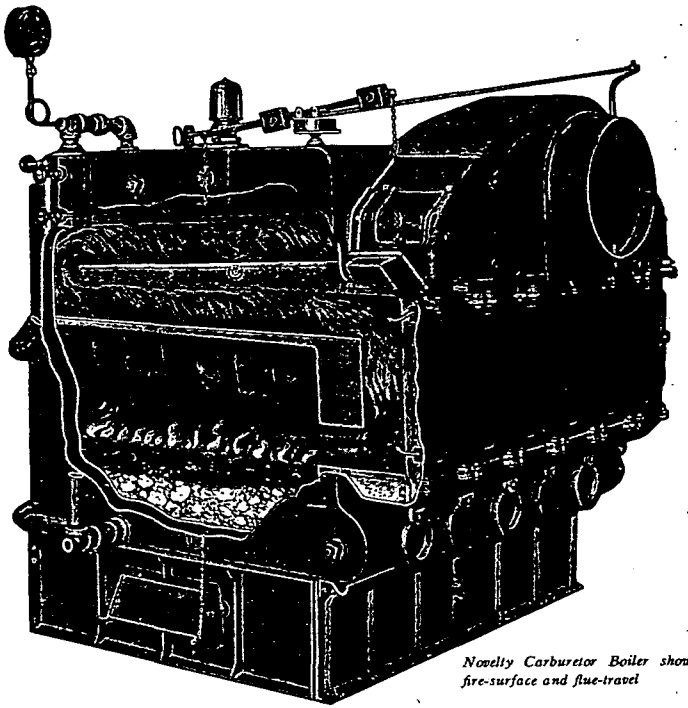
*One additional 5-in. flow. **Two additional 5-in. flows. Double series boilers 2,600 to 22,300 sq. ft.

Abram Cox Stove Company

PHILADELPHIA CHICAGO NEW YORK BOSTON

MANUFACTURERS OF

NOVELTY Round and Sectional Boilers for steam, water and vapor heating; NOVELTY Coal Tank Heaters and Laundry Stoves; NOVELTY Pipe and Pipeless Furnaces for warm air heating; NOVELTY Coal Ranges; NOVELTY FORTUNE Combination Coal-and-Gas Ranges; FORTUNE Gas Ranges and Gas Water Heaters.



Novelty Carburetor Boiler showing fire-surface and flue-travel

BOILER RATINGS ABANDONED ENTIRELY!

Owing to the confusion that has arisen from time to time due to the continual changing of cast iron boiler ratings without any material change in capacities by some manufacturers, the Abram Cox Stove Company has abandoned ratings entirely. In place of them, we offer the Novelty Boiler Selection-Plan which states the actual amount of **net** equivalent column radiation that each boiler will carry under seven different conditions found on jobs.

These amounts are based on the grate area, the size and height of the flue, the rate of combustion, the rate of evaporation, the kind of fuel that is burned, and the coal carrying capacity.

This method of selection, you will readily see, takes into consideration the conditions found on your own job; so you, knowing these conditions, can select a boiler to care for them instead of spending valuable time in an effort to figure out this information on boilers that are rated on laboratory tests when the factors that are taken into consideration are ideal and seldom found in actual installations.

TAKES ALL FACTORS INTO CONSIDERATION

The Novelty Boiler Selection-Plan is not an entirely new idea. In the past, many engineers have based their selection of the boiler on either the grate area, the coal carrying capacity, the rate of combustion, or the rate of evaporation, because they could not depend upon ratings. The Novelty Plan takes all of these factors into consideration so that the correct size boiler can be selected for any job in accordance with the conditions found there.

Due to the fact that we give the **net** equivalent column radiation that each boiler will carry under seven different conditions found on jobs, and much other data, important to engineers, such as that on chimney flues, dimensions and measurements, etc., it is impossible for us to give here complete information of the many sizes of Novelty Boilers.

The Novelty Boiler Selection-Plan, however, along with this engineering data is given in the Novelty Boiler Handbook where it is fully explained. Thousands of Engineers, Architects, and Heating Contractors are using it today. We have received hundreds of letters from users complimenting us upon the Plan.

Below is printed an exact reproduction of the Selection-Plan for the No. 7-40 Novelty Carburetor Boiler, which is illustrated on the opposite page. After you have examined the plan carefully, we are sure you will say that the publishing of the net equivalent column radiation that a boiler will carry under conditions found on the job is just the thing that you have been wishing the manufacturer would do. A copy of the Novelty Handbook will be mailed you upon request.

NOVELTY Boiler Selection-Plan (Carburetor Boilers)

	Novelty Boiler—No. 7-40 Grate Area 15.28 sq. ft.						
1—Rate of combustion in lbs. of coal per square foot grate per hour	5.0	5.5	6.0	6.5	7.0	7.5	8.0
2—Evaporation pounds of water per pound of HARD coal*	8.8	9.2	9.5	9.6	9.7	9.6	9.5
3—Coal, pounds per hour	76	84	92	99	107	115	122
4—Steam, pounds per hour	669	773	874	950	1038	1104	1159
5—Total condensing load in terms of direct column radiation sq. ft.	2676	3092	3496	3800	4152	4416	4636
6—Net direct steam radiation or equivalent sq. ft.	2141	2474	2797	3040	3322	3533	3709
7—Net direct water radiation or equivalent sq. ft.	3426	3958	4475	4864	5315	5653	5934
8—Draft required/Over fire	0.025	0.03	0.035	0.04	0.045	0.05	0.055
in inches of water/Smoke-hood	0.185	0.23	0.265	0.31	0.36	0.415	0.47
9—Chimney/Size inches	12 x 16	16 x 16	16 x 16	16 x 20	16 x 20	20 x 20	20 x 24
Chimney/Height feet	40	40	50	55	65	70	75

*Item 2 includes the smaller sizes of coal such as pea and No. 1 buckwheat.

For soft coal, take 95 per cent of items 2-4-5-6-7.

See notes on chimney sizes, pages 38 to 44.

Chimney sizes and height (item 9) applies to tight, straight, individual flues lined or unlined and not influenced by surrounding objects.

Item 8 indicates measurement with draft gauge over fire and on boiler side of damper in smoke-hood.

Fitzgibbons Boiler Co., Inc.

ESTABLISHED 1886

GENERAL OFFICES: **47 West 42nd Street, New York City**

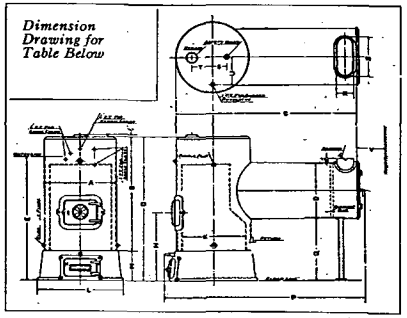
Works: OSWEGO, N. Y.

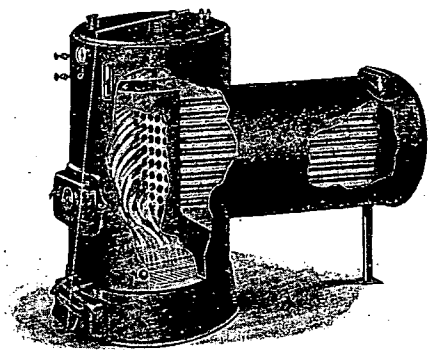
Products: Fitzgibbons-**Ontario** (small-sized) steel boilers for steam or hot water heating.

Fitzgibbons **Compac** (intermediate sized) steel boilers for steam or hot water heating.

Fitzgibbons (large sized) steel boilers for steam or hot water heating.

Reputation and Performance: For the past forty years Fitzgibbons Boilers have been known and recognized for their economy in coal consumption, quick steaming ability, and high evaporative power. Equally well-known have been their performance records for low cost operation and absence of maintenance cost.





Fitzgibbons-Ontario Steel Boiler

Fitzgibbons-Ontario Small Sized Steel Boilers: These boilers embody all the economical and efficient features of the larger sized Fitzgibbons boilers and are made in 16 sizes ranging from 400 sq. ft. to 3200 sq. ft., steam rating or from 700 sq. ft. to 5100 sq. ft. water rating. The smallest size is 4 ft. 7 in. high, 5 ft. long and 2 ft. 2 in. wide, and is particularly suited for use in small residences where space is limited.

FITZGIBBONS-ONTARIO STEEL BOILERS—Ratings and Specifications

Number of Boiler	H-8	H-12	H-16	H-20	H-22	H-24	H-28	H-30	H-32	H-36	H-38	H-44	H-50	H-52	H-58	H-64
Steam Rating	400	600	800	1000	1100	1200	1400	1500	1600	1800	1900	2200	2500	2600	2900	3200
Hot Water Rating	700	1000	1300	1600	1750	1900	2200	2400	2600	2900	3000	3500	4000	4200	4600	5100
A-Diam. Vert. Shell	26″	29″	29″	29″	33″	33″	33″	36″	36″	36″	40″	40″	40″	43″	43″	43″
B-Height Bare Boiler	3′-8½″	4′-1″	4′-1″	4′-1″	4′-1″	4′-1″	4′-1″	4′-4″	4′-4″	4′-4″	4′-8″	4′-8″	4′-8″	5′	5′	5′
C-Length Bare Boiler	4′-2″	5′	6′	7′	5′-5″	6′-5″	7′-5″	5′-9″	6′-9″	7′-9″	6′-7″	7′-7″	8′-7″	7′-4″	8′-4″	9′-4″
D-Diam. Hor. Shell	18″	21″	21″	21″	23″	23″	23″	27″	27″	27″	31″	31″	31″	33″	33″	33″
E-Floor to Water Line	3′-9″	4′-4″	4′-4″	4′-4″	4′-4″	4′-4″	4′-4″	4′-7″	4′-7″	4′-7″	4′-11″	4′-11″	4′-11″	5′-2″	5′-2″	5′-2″
K-Diameter Fire Box	21″	24″	24″	24″	28″	28″	28″	31″	31″	31″	34″	34″	34″	37″	37″	37″
L-Diam. Cast Iron Base	30″	33½″	33½″	33½″	37½″	37½″	37½″	40½″	40½″	40½″	42¼″	42¼″	42¼″	45¾″	45¾″	45¾″
M-Height Cast Iron Base	10½″	13″	13″	13″	13″	13″	13″	13″	13″	13″	13″	13″	13″	13″	13″	13″
N-Floor to Center Fire Door	26½″	31″	31″	31″	31″	31″	31″	31″	31″	31″	31″	31″	31″	31″	31″	31″
O-Height	4′-7″	5′-2″	5′-2″	5′-2″	5′-2″	5′-2″	5′-2″	5′-5″	5′-5″	5′-5″	5′-9″	5′-9″	5′-9″	6′-1″	6′-1″	6′-1″
P-Length Overall	5′	5′-10″	6′-10″	7′-10″	6′-3″	7′-3″	8′-3″	6′-7″	7′-7″	8′-7″	7′-5″	8′-5″	9′-5″	8′-2″	9′-2″	10′-2″
Q-Height Cast Iron Stand	25¼″	28¾″	28¾″	28¾″	27¾″	27¾″	27¾″	28″	28″	28″	28″	28″	28″	28″	28″	28″
R-Width Smoke Uptake	5½″	6½″	6½″	6½″	7½″	7½″	7½″	8½″	8½″	8½″	9½″	9½″	9½″	10″	10″	10″
S-Length Smoke Uptake	12½″	15½″	15½″	15½″	17½″	17½″	17½″	20½″	20½″	20½″	22″	22″	22″	25″	25″	25″
T-Location Supply Outlet	8″	8½″	8½″	8½″	10½″	10½″	10½″	11¼″	11¼″	11¼″	13″	13″	13″	12½″	12¼″	12¼″
U-Location Damper Reg	10″	12″	12″	12″	13″	13″	13″	15″	15″	15″	15″	15″	15″	17″	17″	17″
V-Suggested Behind Boiler	18″	23″	33″	45″	23″	32″	44″	24″	31″	43″	23″	35″	47″	28″	40″	52″
Supply Outlet	3″	4″	4″	4″	4½″	4½″	4½″	5″	5″	5″	5″	5″	5″	6″	6″	6″
Return	3″	4″	4″	4″	4½″	4½″	4½″	5″	5″	5″	5″	5″	5″	6″	6″	6″
Safety Valve	¾″	1″	1″	1″	1¼″	1¼″	1½″	1½″	1½″	1½″	2″	2″	2″	2″	2″	2″
Diameter Smoke Pipe	8″	10″	10″	10″	12″	12″	12″	14″	14″	14″	16″	16″	16″	18″	18″	18″
Approx. Sq. Ft. Covering	36	46	52	58	54	60	66	64	72	80	78	86	94	92	102	110
Approx. Shipping Weight	1750	1950	2000	2050	2250	2300	2350	2850	2900	2950	3300	3550	3800	3900	4200	4500

Ratings are based on two pounds pressure for steam and 180 deg. fahr. for water and give actual number of square feet direct cast iron radiator surface or equivalent when sufficient radiation is installed to heat the building to 70 deg. fahr.

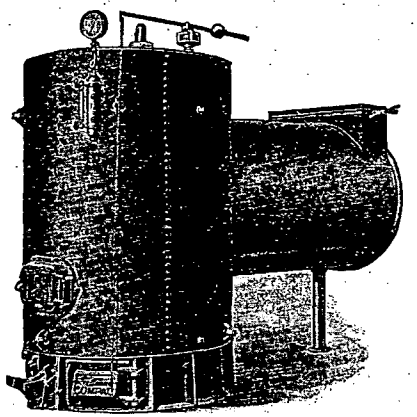
Fitzgibbons Compac Intermediate Sized Steel Boilers: These boilers embody all the economical and efficient qualities of the large Fitzgibbons Boilers and are made in 12 sizes ranging from 3300 to 8500 sq. ft. steam rating, or from 5300 to 13,600 sq. ft. water rating. The smallest size is 7 ft. 1 in. high, 8 ft. 1 in. long and 4 ft. wide. A most compact boiler, and one specially adapted to smaller apartment houses where space is limited.

Construction: Both the **Ontario** and the **Compac** boilers are built completely of steel without a single cast-iron part holding water. Tested under pressure before shipment, and ready for immediate installation upon arrival at job. No assembling of parts at the building; no packed joints, unions, bolts, etc.

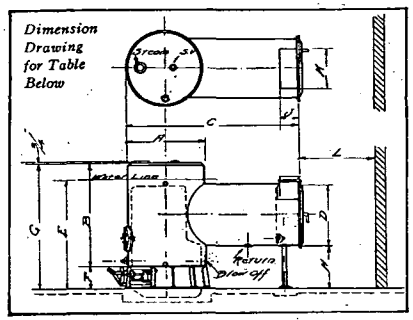
Fuel Economy: The fire-box is so deep, the combustion chamber with its gas diverting arch so large, and the heating surface so ample, that the direct fire and major portion of flue surface is exposed to the hottest gases, utilizing all the heat available from the fuel. This results in a saving of upwards of 20 per cent in amount of fuel required in comparison with other types of heating boilers.

Burn Coal, Oil or Gas: A feature of these smaller sized boilers is that any kind or size of coal can be used. The fuel saving results whether egg, stove, chestnut, pea or buckwheat size of coal, or oil or gas is used as fuel.

Ratings are Net: Each rating is the amount of equivalent cast-iron radiation that the boiler will heat to keep rooms at 70 deg. fahr. (outside temperature zero) with the heating system properly designed to maintain 70 deg. room temperature with two pounds steam pressure, or water in boiler at 180 deg. fahr. for hot water heating.



Fitzgibbons Compac Steel Boiler



FITZGIBBONS COMPAC STEEL BOILERS—Ratings and Specifications

No. of Boiler	Steam Rating Sq. Ft.	Hot Water Rating Sq. Ft.	Diam. Vert. Shell A	Height Bare Boiler B	Length Bare Boiler C	Diam. Hor. Shell D	Water Line E	Cast Iron Base F	Over-all Height G	Height of Stand H	Smoke Uptake J x K	Space to Draw Tubes L	Approx. Sq. Ft. Covering	Approx. Weight in Lbs.
H-66	3300	5300	4′-0″	5′-10″	8′-1″	3′-4″	6′-0″	15″	7′-1″	2′-7″	13½″x25″	2′-9″	118	5500
H-76	3800	6100	4′-0″	5′-10″	9′-1″	3′-4″	6′-0″	15″	7′-1″	2′-7″	13½″x26″	3′-9″	128	5850
H-86	4300	6900	4′-0″	5′-10″	10′-1″	3′-4″	6′-0″	15″	7′-1″	2′-7″	13½″x26″	4′-9″	138	6200
H-88	4400	7100	4′-4″	5′-11″	8′-7″	3′-6″	6′-0″	15″	7′-2″	2′-5″	14″ x27″	2′-8″	132	6300
H-98	4900	7900	4′-4″	5′-11″	9′-7″	3′-6″	6′-0″	15″	7′-2″	2′-5″	14″ x27″	3′-8″	143	6650
H-108	5400	8700	4′-4″	5′-11″	10′-7″	3′-6″	6′-0″	15″	7′-2″	2′-5″	14″ x27″	4′-8″	154	7000
H-120	6000	9600	4′-9″	6′-7″	9′-9″	4′-0″	6′-7″	15″	7′-10″	2′-7″	14″ x37″	3′-8″	167	9000
H-132	6600	10600	4′-9″	6′-7″	10′-9″	4′-0″	6′-7″	15″	7′-10″	2′-7″	14″ x37″	4′-8″	180	9500
H-144	7200	11500	4′-9″	6′-7″	11′-9″	4′-0″	6′-7″	15″	7′-10″	2′-7″	14″ x37″	5′-8″	193	10,000
H-150	7500	12000	5′-0″	6′-11″	9′-10″	4′-3″	6′-11″	15″	8′-2″	2′-8″	14″ x44″	3′-8″	181	10,200
H-160	8000	12800	5′-0″	6′-11″	10′-10″	4′-3″	6′-11″	15″	8′-2″	2′-8″	14″ x44″	4′-8″	195	10,850
H-170	8500	13600	5′-0″	6′-11″	11′-10″	4′-3″	6′-11″	15″	8′-2″	2′-8″	14″ x44″	5′-8″	208	11,500

FITZGIBBONS Large Steel Boilers

The **Fitzgibbons Boiler** owes its high standing among architects, engineers and builders to (1) its capacity to carry its rating with ease (2) its coal-saving as compared with other types, and (3) its absence of maintenance cost.

Construction: The design embodies the strongest possible construction with a minimum of internal bracing. The combustion chamber is concentric with the vertical shell possessing similar strength. The interior of the boiler is readily visible and accessible in all parts for inspection and cleaning. Numerous handhole openings together with the manhole in the top head facilitate getting at all parts. Built completely of steel, eliminating all brick work.

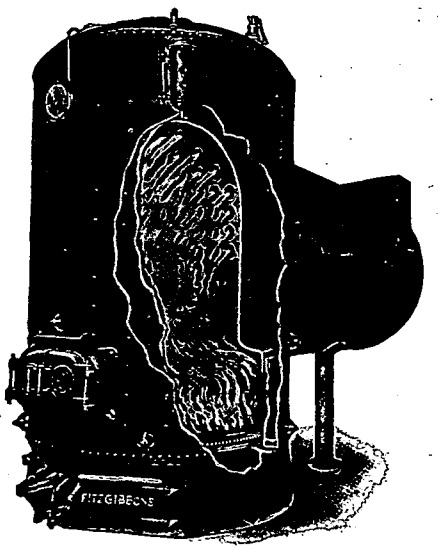
Steam Pressures: The Fitzgibbons Boiler for heating is built for 15 lbs. steam pressure to conform with the rigid requirements of the A. S. M. E. Boiler Code.

Combustion: Complete combustion of the fuel and its consumable gases in the combustion chamber with a minimum of excess air is a requisite of economical operation. The Fitzgibbons Boiler has a circular grate with no dead corners. The combustion chamber is over six feet in height, giving the ample furnace volume now recognized as essential for complete combustion. The lower crown-sheet of the furnace diverts the gases into a thorough mixture with the air admitted through the special opening over the fire-door. This mass of consumable gas is completely burned in the high combustion chamber before entering the tubes. Smokeless operation with semi-bituminous coal indicates the thoroughness of this combustion. Furnace temperatures have run close to 3000° F.

Circulation: The second requisite of economical operation is the rapid absorption of the heat by the water. This can be effected only by properly arranged heating surfaces over which a fast circulation is maintained. The horizontal shell with the tubes in the Fitzgibbons Boiler is completely submerged. The water-line is in the vertical cylinder immediately over the combustion chamber. As a result of this unique arrangement, the circulation is always towards the front of the boiler along a fixed path increasing its speed as it approaches the combustion chamber where the source of greatest heat exists. The perfection of this circulation is evidenced by (1) the quick-steaming ability of the boiler (2) less than one per cent moisture in the steam regardless of overload carried and (3) unusually low flue-gas temperatures.

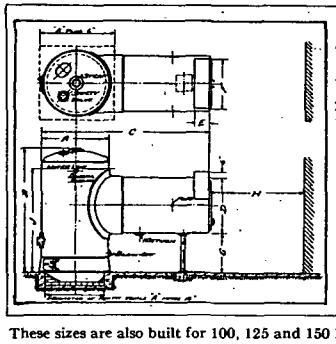
Economy: Forty years of operation under all sorts of conditions of fuel, supervision and load requirements have placed the fuel-saving characteristic of the boiler at over 20 per cent of the fuel ordinarily required by boilers of the rectangular-grate design. This economy results directly from the boiler's cylindrical construction, its complete combustion and its rapid water circulation.

Adaptability: The boiler requires little boiler-room space. To overcome unusual space limitations caused by irregular column or girder construction, the boiler can be specially built with the fire-door placed on any radius. Any fuel can be burned; semi-bituminous; anthracite buckwheat; oil; gas; wood or sawdust. An ever-increasing yearly production of this single boiler attests to its correctness of design, its economy in operation and its all-around efficient service.



Fitzgibbons Boiler

FITZGIBBONS BOILERS—Ratings and Specifications



Number of Boiler	Steam Rating Sq. Ft.	Horse Power	Diam. Vert. Shell A	Height Over-all B	Length Bare Boiler C	Diam. Hor. Shell D	Smoke Uptake E x F	Height of Stand G	Space to Draw Tubes H	Water Line J
23	4200	40	4'-1"	8'-6"	9'-4"	3'-5"	12" x24"	3'-2"	4'-8"	7'-1"
24	5400	50	4'-5"	8'-9"	10'-6"	3'-8"	12" x31"	3'-2"	5'-2"	7'-4"
25	6400	60	4'-8"	9'-2"	10'-9"	3'-11"	13" x36"	3'-3"	5'-6"	7'-8"
26	7500	70	4'-10"	9'-5"	12'-2"	4'-1"	13" x42"	3'-4"	6'-10"	7'-11"
27	8500	80	5'-1"	9'-9"	12'-3"	4'-4"	13" x48"	3'-4"	6'-10"	8'-2"
29	11000	100	5'-5"	10'-1"	13'-7"	4'-7"	14½" x49"	3'-4"	7'-9"	8'-5"
30	13500	125	5'-11"	10'-8"	13'-11"	5'-1"	15½" x58"	3'-4"	7'-8"	8'-11"
31	16500	150	6'-3"	11'-0"	15'-1"	5'-3"	17" x58"	3'-4"	8'-6"	9'-1"
32	19000	175	6'-7"	11'-11"	15'-4"	5'-7"	18" x62½"	3'-9"	8'-4"	9'-10"
33	22000	200	6'-9"	12'-1"	16'-2"	5'-9"	19" x65"	3'-10"	8'-10"	10'-1"
34	25000	225	6'-11"	12'-2"	17'-5"	5'-9"	19" x65"	3'-10"	10'-0"	10'-1"
35	28000	250	7'-3"	12'-6"	18'-2"	6'-1"	20" x68"	3'-10"	10'-5"	10'-5"
36	32000	300	7'-5"	12'-11"	22'-0"	6'-2"	20" x70"	4'-0"	12'-6"	10'-9"

These sizes are also built for 100, 125 and 150 lbs. W. S. P.

Burnham Boiler Corporation

Irvington, N. Y.

Factories:

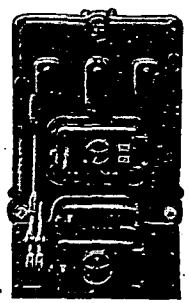
IRVINGTON, N. Y. ELIZABETH, N. J. LANCASTER, PA.

Offices:

BOSTON, MASS. CHICAGO, ILL. BALTIMORE, MD. PHILADELPHIA, PA.
NEW YORK CITY, N. Y. SAN FRANCISCO, CALIF.

Makers of Low Pressure and High Pressure Cast Iron Boilers

BURNHAM WATER TUBE TYPE BOILER



Here's a Burnham Boiler that is designed for high pressure Hot Water Heating up to 80 lb. and tested according to the A. S. M. E. Code at 2½ times its actual working pressure.

It is especially adapted for hot water supply for apartment houses, office buildings, hospitals, stores, garages, theaters, etc.

The tank capacities given are figured for a 22 deg. rise per hour per gallon of water, based on an eight (8) hour firing period. For commercial work or high class apartments the tank sizes may be proportioned and fire period raised to meet any prevailing condition.

Like other Burnhams, its water tube sections are connected with handy, short tie-bolts; its shaker grates operate half at a time; every flue has its own clean out door.

Special equipment furnished with this high pressure series:

Automatic Damper Regulator, Water Relief Valve, Two 2 in. Brass Cleanout plugs, on front section.

MEASUREMENTS AND RATINGS

Size	Number of Sections	Grate Area Sq. Ft.	Size of Grate Inches	Water Rating Sq. Ft.
W-21-4	4	2.47	21x17	1,000
W-21-5	5	3.20	21x22	1,300
W-21-6	6	3.93	21x27	1,600
W-21-7	7	4.66	21x32	1,900
W-21-8	8	5.39	21x37	2,200
W-21-9	9	6.12	21x42	2,500
W-21-10	10	6.85	21x47	2,800

Size	Tank Capacity Gallons	Size Storage Tank	Number of Families*	Total Length
W-21-4	865	42"x12'	28-31	24"
W-21-5	1,000	42"x14'	32-37	29"
W-21-6	1,130	48"x12'	38-42	34"
W-21-7	1,300	48"x14'	43-47	39"
W-21-8	1,500	48"x16'	48-52	44"
W-21-9	1,665	54"x14'	53-57	49"
W-21-10	1,757	60"x12'	58-62	54"

*Average 3 to 4 room apartments.

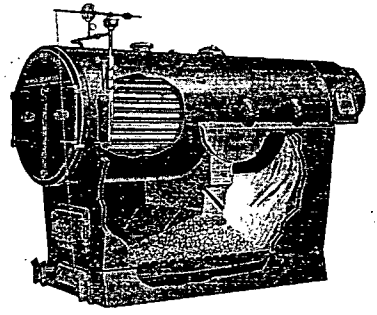
Tappings: Two 3 in. Supplies. Two 3 in. Returns on Rear Section. Size of Smoke Pipe, 10 ins.

General Boilers Company

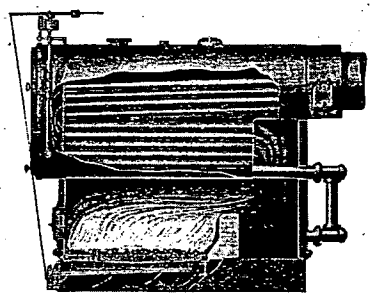
Manufacturers of

Pacific Steel Heating Boilers, Pacific Circulating Tanks

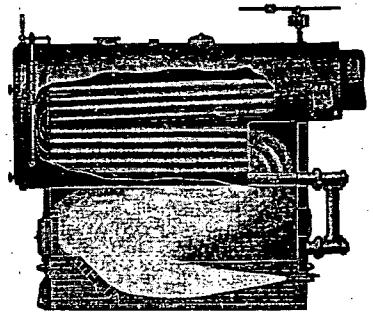
Waukegan, Illinois



For Burning Soft Coal Smokelessly



For Soft or Hard Coal, Gas or Wood



For Burning Oil

P A C I F I C

STEEL HEATING BOILERS

Pacific Steel Heating Boilers are built for steam or hot water heating using soft coal, hard coal, oil, gas, or wood as fuel.

They are constructed of steel according to the *A. S. M. E.* Code for building low pressure steel heating boilers. Every joint and seam in the Pacific is electrically welded and each boiler is built and tested to a pressure many times its normal working pressure under the supervision of an inspector stationed in our plant by one of the largest insurance companies. A standard boiler policy is furnished with each steam boiler.

Because of the compact design Pacific Boilers save from 25 to 40 per cent. of the boiler room floor space required by other steel firebox boilers, (see dimensions given on opposite page).

The catalog ratings on Pacific Boilers are based on heating surface with steam at two pounds gauge pressure, hot water at 180 deg. at boiler. Any Pacific Boiler will carry its full rated load in direct cast iron radiation. Extra capacity must be allowed for exposed piping, storage tank, pipe coils or indirect radiators and for buildings where normal temperatures below 70 deg. F. are to be maintained.

STEAM—Specifications

Catalogue Number	Net Rating	Height Water Line, Inches	Diameter Smoke Connec. Inches	Diameter Stack Inches	Minimum Height Stack, Feet	Grate Area, Square Feet	Heating Surface, Square Feet	Size of Outlet, Inches	Size of Return, Inches
606	1200	60	12	11	45	5.11	100.0	3	2
607	1300	60	12	11	45	5.68	114.0	3	2
608	1500	60	12	11	45	6.27	122.0	3	2
609	1900	64	14	13	50	6.77	152.0	4	2½
610	2400	64	14	13	50	8.16	189.0	4	2½
611	2900	68	16	15	55	9.47	234.0	5	3
612	3400	68	16	15	55	11.06	279.0	5	3
613	4000	68	18	17	60	11.85	318.0	5	3
614	4500	68	18	17	60	12.70	372.0	5	3
615	5000	75	18	17	60	12.07	392.0	6	3
616	5500	75	18	17	65	13.10	425.0	6	3
617	5800	75	18	17	65	15.15	457.6	6	3
618	6500	81	24	22	65	16.42	508.5	7	4
619	7500	81	24	22	70	18.83	594.8	7	4
620	8500	81	24	22	70	20.00	637.5	7	4
621	9000	89	26	24	70	19.11	708.7	8	4
622	10000	89	26	24	75	20.50	809.5	8	4
623	12000	99	30	28	75	25.14	864.5	8	4
624	14000	99	30	28	75	26.64	988.8	8	4
625	15500	106	32	30	85	32.6	1183.8	8	5
626	18000	106	32	30	85	34.7	1332.9	8	5
627	20500	106	32	30	90	36.7	1482.0	10	6
628	22000	119	36	33	100	39.1	1583.1	10	6
629	25000	119	36	33	100	41.4	1759.0	10	6
630	28000	119	36	33	100	43.7	1934.9	10	6
631	31000	119	36	33	110	43.7	2110.8	12	6
632	34000	119	36	33	110	46.1	2286.7	12	6

STEAM—Specifications

Catalogue Number	Net Rating	Height Water Line, Inches	Diameter Smoke Connec. Inches	Diameter Stack Inches	Minimum Height Stack, Feet	Grate Area, Square Feet	Heating Surface, Square Feet	Size of Outlet, Inches	Size of Return, Inches
206	1050	60	12	11	40	5.11	100.0	3	2
207	1200	60	12	11	40	5.68	114.0	3	2
208	1350	60	12	11	40	6.27	122.0	3	2
209	1600	64	14	13	45	6.77	152.0	4	2½
210	1900	64	14	13	45	8.16	189.0	4	2½
211	2400	68	16	15	50	9.47	234.0	5	3
212	2900	68	16	15	50	11.06	279.0	5	3
213	3300	68	18	17	55	11.85	318.0	5	3
214	3800	68	18	17	55	12.70	372.0	5	3
215	4100	75	18	17	55	12.07	392.0	6	3
216	4500	75	18	17	60	13.10	425.0	6	3
217	5000	75	18	17	60	15.15	457.6	6	3
218	5500	81	24	22	60	16.42	508.5	7	4
219	6500	81	24	22	65	18.83	594.8	7	4
220	7000	81	24	22	65	20.00	637.5	7	4
221	7500	89	26	24	65	19.11	708.7	8	4
222	8500	89	26	24	70	20.50	809.5	8	4
223	10000	99	30	28	70	25.14	864.5	8	4
224	11500	99	30	28	70	26.64	988.8	8	4
225	13000	106	32	30	75	32.6	1183.8	8	5
226	15000	106	32	30	75	34.7	1332.9	8	5
227	17000	106	32	30	80	36.7	1482.0	10	6
228	19000	119	36	33	90	39.1	1584.1	10	6
229	22000	119	36	33	90	41.4	1759.0	10	6
230	25000	119	36	33	90	43.7	1934.9	10	6
231	28000	119	36	33	100	43.7	2110.8	12	6
232	31000	119	36	33	100	46.1	2286.7	12	6

HOT WATER—Specifications

Catalogue Number	Net Rating	Height Water Line, Inches	Diameter Smoke Connec. Inches	Diameter Stack Inches	Minimum Height Stack, Feet	Grate Area, Square Feet	Heating Surface, Square Feet	Size of Outlet, Inches	Size of Return, Inches
506	1900	....	12	11	45	5.11	120.0	4	4
507	2100	....	12	11	45	5.68	136.9	4	4
508	2400	....	12	11	45	6.27	153.7	4	4
509	3000	....	14	13	50	6.77	196.0	2-4	2-4
510	3800	....	14	13	50	8.16	245.0	2-4	2-4
511	4700	....	16	15	55	9.47	234.0	2-4	2-4
512	5500	....	16	15	55	11.06	279.0	2-4	2-4
513	6400	....	18	17	60	11.85	318.0	2-5	2-5
514	7400	....	18	17	60	12.70	372.0	2-5	2-5
515	8300	....	18	17	60	12.07	392.3	2-6	2-6
516	8800	....	18	17	65	13.10	415.6	2-6	2-6
517	9300	....	18	17	65	15.15	457.6	2-6	2-6
518	10700	....	24	22	65	16.42	508.5	2-6	2-6
519	12400	....	24	22	70	18.83	594.8	2-6	2-6
520	13400	....	24	22	70	20.00	637.5	2-6	2-6
521	14500	....	26	24	70	19.11	708.7	2-7	2-7
522	16500	....	26	24	75	20.50	809.5	2-7	2-7

HOT WATER—Specifications

Catalogue Number	Net Rating	Height Water Line, Inches	Diameter Smoke Connec. Inches	Diameter Stack Inches	Minimum Height Stack, Feet	Grate Area, Square Feet	Heating Surface, Square Feet	Size of Outlet, Inches	Size of Return, Inches
106	1700	....	12	11	40	5.11	120.0	4	4
107	1900	....	12	11	40	5.68	136.9	4	4
108	2200	....	12	11	40	6.27	153.7	4	4
109	2600	....	14	13	45	6.77	196.0	2-4	2-4
110	3000	....	14	13	45	8.16	245.0	2-4	2-4
111	3800	....	16	15	50	9.47	234.0	2-4	2-4
112	4700	....	16	15	50	11.06	279.0	2-4	2-4
113	5300	....	18	17	55	11.85	318.0	2-5	2-5
114	6100	....	18	17	55	12.70	372.0	2-5	2-5
115	6500	....	18	17	55	12.07	392.3	2-6	2-6
116	7200	....	18	17	60	13.10	415.6	2-6	2-6
117	8000	....	18	17	60	15.15	457.6	2-6	2-6
118	8800	....	24	22	60	16.42	508.5	2-6	2-6
119	10500	....	24	22	65	18.83	594.8	2-6	2-6
120	11200	....	24	22	65	20.00	637.5	2-6	2-6
121	12000	....	26	24	65	19.11	708.7	2-7	2-7
122	13500	....	26	24	70	20.50	809.5	2-7	2-7

Pacific Boilers are constructed with smoke outlet at the rear and all of the tubes, both upper and lower banks, can be cleaned or removed from the front of the boiler through the front flue doors. Space at rear of boiler is not necessary.

Complete catalog showing all types and sizes Pacific Boilers will be furnished on request.

Handon Boiler Corporation

Foundry
POUGHKEEPSIE
N. Y.

General Sales Office
101 PARK AVE.,
NEW YORK

HANDON

Steam and Hot Water Boilers

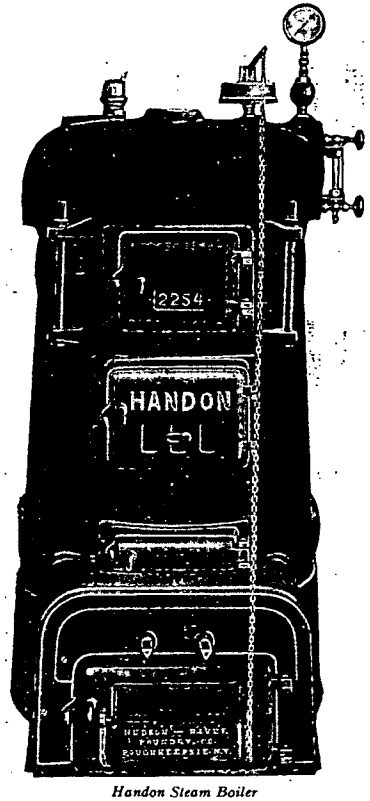
Tank Heaters and Radiators

Handon Boilers are made of high-grade charcoal iron which produces a casting of very high tensile strength. They are carefully tested with hydraulic pressure before leaving our works, and are guaranteed only to the extent of our furnishing new castings for any found defective in manufacture.

The greatest amount of prime heating surface is brought in contact with the direct rays of the fire by the formation of the Firepot, with its many **Radial Arms** and its extraordinarily **Deep Coal Carrying Capacity.** The walls are corrugated throughout thus increasing the heating surface, as well as materially aiding combustion.

The rated capacities shown here are made conservatively and in accordance with accepted standards. The steam ratings are based on a standard of 2 lb. pressure at boiler. Water ratings are based on a standard of 180 deg. fahr. as water leaves heater.

Trimmings furnished with steam heaters consist of Steam Gage with cock and syphon, Safety Valve, Water Column, Water Gage and Cocks, Automatic Damper Regulator and Chain, and necessary pipe and fittings to connect same with heater.



Handon Steam Boiler

SPECIFICATIONS

Handon Steam Boilers

No.	Rating	Actual Dia. Grate —Grate and Firepot in. In.	Size of Smoke Pipe In.	Inlets and Outlets In.	Grate Area Sq. Ft. In.	Water Line In.
17S3	350	17¼	7	2-2	1.62	40¼
17S4	400	17¼	7	2-2	1.62	45
17S5	425	17¼	7	2-2	1.62	49¾
19S3	425	19¼	7	2-2½	2.02	41
19S4	475	19¼	7	2-2½	2.02	45¾
19S5	500	19¼	7	2-2½	2.02	50½
22S3	550	22¼	8	2-3	2.70	42½
22S4	625	22¼	8	2-3	2.70	47¾
22S5	700	22¼	8	2-3	2.70	53
25S3	750	25¼	9	2-3	3.48	45½
25S4	825	25¼	9	2-3	3.48	51½
25S5	925	25¼	9	2-3	3.48	57½

Handon Hot Water Boilers

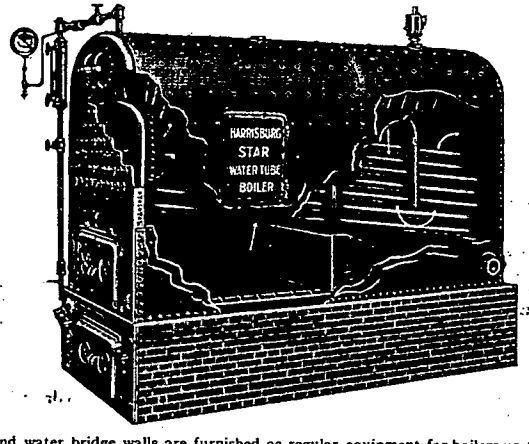
17W3	550	17¼	7	2-2	1.62	....
17W4	625	17¼	7	2-2	1.62	....
17W5	700	17¼	7	2-2	1.62	....
19W3	675	19¼	7	2-2½	2.02	....
19W4	750	19¼	7	2-2½	2.02	....
19W5	825	19¼	7	2-2½	2.02	....
22W3	925	22¼	8	2-3	2.70	....
22W4	1050	22¼	8	2-3	2.70	....
22W5	1175	22¼	8	2-3	2.70	....
25W3	1250	25¼	9	2-3	3.48	....
25W4	1375	25¼	9	2-3	3.48	....
25W5	1500	25¼	9	2-3	3.48	....

All Boilers are equipped with Triangular Grates.

Harrisburg Star Boiler Corporation

15 PARK ROW - NEW YORK

LOW PRESSURE HEATING BOILERS



Steel bases and water bridge walls are furnished as regular equipment for boilers up to and including No. 715 boilers. No brick work required.

Brick bases and bridge walls must be furnished by customers for boilers No. 716 and larger. Front and rear base plates with necessary doors are furnished as regular equipment. Prices for steel bases will be quoted on application.

Regular trimmings include steam gage, water column, safety valve or valves, and shaking grates.

Regular firing tools include hoe, poker, slice bar, cleaning nozzle and wire brushes for cleaning inside and outside of tubes.

Catalogue No.	Capacity Steam Sq. Ft.	Water Evaporation, Lbs.	Heating Surface Sq. Ft.	Horse Power	Grate Area Sq. Ft.	DIMENSIONS * Total Length	Total Width	Total Height	Water Line	Base Height Inches	Steam Outlet Inches	Return Openings, Inches	Flue Connection, Outside Inches	Stack Diameter Required One Boiler	Stack Diameter Required Two Boilers	Brick Required Red	Brick Required Fire	Cover Required Sq. Ft.	Weight Approx., Lbs.
705	3450	862.5	250	25	10.6	84¼	42½	69	58¼	12	5	2-2½	13x22	18	24	None		77	5500
706	4150	1035	300	30	12.1	99¼	42½	69	58¼	12	6	2-3	13x28	28	25	"		91	6000
707	5000	1242	360	36	14.8	99¼	51½	72½	60	12	6	2-3	13x31	20	27	"		99	6900
708	5800	1449	420	42	14.8	99¼	51½	76	63¼	12	7	2-3	13x31	21	29	"		103	7400
709	6900	1725	500	50	18.3	109¼	55⅛	77¼	65	12	7	2-3	13x38	23	31	"		118	8300
710	8300	2070	600	60	20.3	129½	55⅛	77¼	65	12	7	2-3	13x42	25	33	"		141	9300
711	9000	2242.5	650	65	21.8	129½	59⅜	83¼	69	15	8	2-3½	16x36	25	34	"		148	9900
712	9700	2415	700	70	24.0	139¼	59⅜	83¼	69	15	8	2-3½	16x39	26	35	"		160	10400
713	10400	2587.5	750	75	26.2	149¼	59⅜	83¼	69	15	8	2-3½	16x43	26	36	"		171	11925
713A	11000	2760	800	80	26.2	139¼	59⅜	86¾	72½	15	8	2-3½	19x36	27	36	"		167	11500
714	11700	2932.5	850	85	28.3	149½	59⅜	86¾	72½	15	8	2-3½	19x39	28	37	"		178	12165
715	12400	3105	900	90	30.5	157¼	59⅜	86¾	72½	15	8	2-4	19x42	29	38	"		202	12400
716	13800	3450	1000	100	31.8	141½	70½	94½	76¼	15	8	2-4	19x43	30	40	805	50	188	14400
717	15200	3795	1100	110	34.4	154½	70½	94½	76¼	15	8	2-4	19x47	31	42	850	50	206	15400
718	17300	4312.5	1250	125	37.0	175¼	70½	94½	76¼	15	10	2-4	19x50	32	43	915	50	234	16800
719	18600	4657.5	1350	135	41.3	149½	89½	109⅛	82¼	18	10	2-4	21x46	33	44	1070	75	244	19800
720	20700	5175	1500	150	44.7	165½	89½	109⅛	82¼	18	10	2-5	21x51	34	46	1160	75	260	22150
721	24200	6037.5	1750	175	51.0	192½	89½	109⅛	82¼	18	12	2-5	21x61	36	48	1260	75	304	24250
722	27600	6900	2000	200	55.4	169	102½	122¼	90	18	12	2-6	21x66	37	51	1275	90	304	30250
723	31600	7762.5	2250	225	55.4	169	102½	126¼	94	18	12	2-6	21x66	37	52	1275	90	312	32550
724	35000	8625	2500	250	59.4	189	102½	126¼	94	18	12	2-6	21x71	39	54	1350	90	351	34750
725	42000	10350	3000	300	63.3	206	102½	130¼	98	18	12	2-6	21x76	40	60	1425	100	394	35650

* Note low water lines.

INTERNATIONAL HEATER COMPANY

Makers of Heating Apparatus

Utica, N. Y.

NEW YORK	CHICAGO	CLEVELAND	DETROIT	NASHAU, N. H.
Broadway and 57th St.	1933-35 Wentworth Ave.	1441 Davenport Ave., N. E.	3962 Cass Ave.	110 Chestnut St.

ECONOMY BOILERS

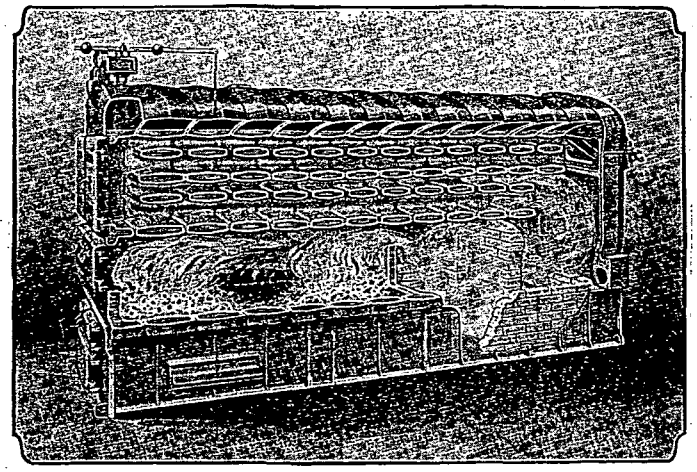
On the following pages we present condensed data on the INTERNATIONAL ECONOMY SECTIONAL BOILERS, Steam and Water.

Both the Regular and the Smokeless types have the following distinctive features in common: *Conservative ratings* from actual tests according to the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS Code the evaporative power and efficiency are exceptionally high; a *long* fire travel and all heating surface *below* the water line; a *low steady* water line with water gauge tapped directly into the section; *dry steam guaranteed without a header and only one main outlet from boiler;* grate bar connections of sectional boilers are *outside* the ashpit; all heating surface easily *cleaned from front* of boiler through large flue doors.

The temperature of the gases in the first pass or lower flues is at least 200 degrees higher than in the fire box for an hour or two after firing due to the special mixing or carburetor feature of all Regular type boilers. In the secondary combustion chamber of the Smokeless type, the temperature at times exceeds 2000 deg. fahr. which means high efficiency due to proper combustion conditions as regards, time, temperature, and mixture.

The INTERNATIONAL ECONOMY SMOKELESS BOILER is an up draft boiler designed for the smokeless combustion of any bituminous fuels commonly used for heating purposes. It is built on the Kent *Wing Wall principle* in which the rear portion of the boiler contains a mixing chamber and a secondary combustion chamber, separated by a brick wing wall; so that the smokeless feature is entirely outside of the firebox.

This type of boiler is very simple to control and does not require the services of a skilled or expert fireman.

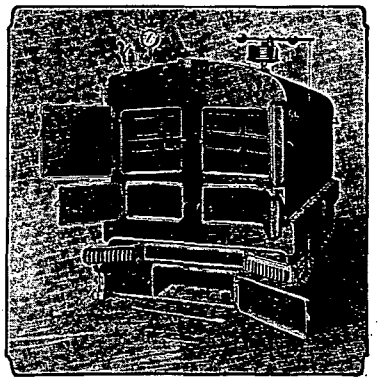


Cut-Away View of No. 140-47 Economy Smokeless Boiler

INTERNATIONAL HEATER COMPANY

SECTIONAL MEASUREMENTS
Smokeless Steam Sizes

Sizes	Height of Water Line, Inches	Diameter of Smoke Outlet, Inches	Height to Supply Outlet, Inches	Add to Height for Trimmings, Inches	Width of Boiler, Including Trimmings, Inches	Height from Floor to Center of Return Tappings, Inches	Height of Fire Box to Crown, Inches	Height, Grate to Middle of Feed Door, Inches	Size of Feed Door, Inches
22	47	12	57	11	40	19	22	16	9x17
28	50	14	64½	11	45	19½	24	18	9x17
34	54	16	68	11	52	20	26	18	11x17
47	59	24	73	12	61	21½	26	18	2-10x17



47 in. Series Economy Smokeless Boiler Showing Access for Cleaning

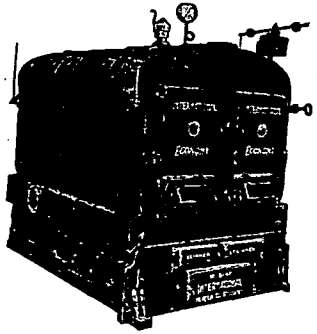
Ratings and Dimensions
ECONOMY SMOKELESS BOILERS
Steam Pattern

Number	*Rating Square Feet	†Tappings		Minimum Chimney Dimensions		Size of Grate Inches	Additional Area of Side Grate Fingers Sq. In.
		Supply and Return		Size Flue Inches	Height Feet		
80-22	1700	3-3½"	2-3½"	12x12	40	22x32	380
90-22	2000	3-3½"	2-3½"	12x12	45	22x40	432
100-22	2300	3-3½"	2-3½"	12x16	50	22x48	484
80-28	2450	3-4"	2-4"	16x16	40	28x32	432
90-28	2800	3-4"	2-4"	16x16	45	28x40	484
100-28	3150	3-4"	2-4"	16x16	50	28x48	536
90-34	4000	3-5"	2-5"	16x16	50	34x40	523
100-34	4500	3-5"	2-5"	16x20	50	34x48	580
110-34	5000	3-5"	2-5"	20x20	55	34x56	632
120-34	5500	3-5"	2-5"	20x20	55	34x64	684
130-34	6000	3-5"	2-5"	20x20	60	34x64	684
140-34	6500	3-5"	2-5"	20x24	60	34x64	684
150-34	7000	3-5"	2-5"	20x24	60	34x72	736
90-47	8300	3-6"	2-6"	24x24	60	47x50	677
100-47	9300	3-6"	2-6"	24x24	65	47x60	742
110-47	10300	3-6"	2-6"	24x24	70	47x60	742
120-47	11300	4-6"	2-6"	24x28	70	47x60	742
130-47	12300	4-6"	2-6"	24x28	75	47x70	807
140-47	13300	4-6"	2-6"	24x28	75	47x70	807
150-47	14300	4-6"	2-6"	28x28	80	47x70	807
160-47	15300	4-6"	2-6"	28x28	85	47x70	807
170-47	16300	4-6"	2-6"	28x32	90	47x70	807
180-47	17300	4-6"	2-6"	28x32	95	47x80	872
190-47	18300	4-6"	2-6"	28x32	100	47x80	872
200-47	19300	4-6"	2-6"	32x32	105	47x80	872
210-47	20300	4-6"	2-6"	32x32	110	47x80	872

*Judgment should be used in fitting the boiler to a job. As an example: Do not attach a short boiler to a relatively high stack, or a long boiler to a relatively low stack. Suit the boiler to the job.

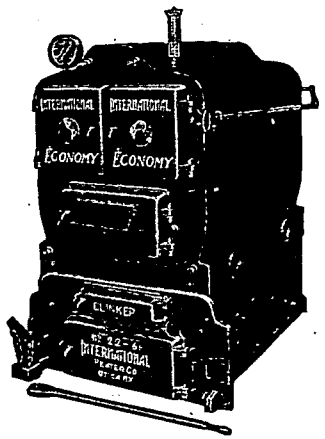
†The Economy line of boilers does not require a header. Plug and bush tappings to size of mains.

INTERNATIONAL HEATER COMPANY



No. 8-47 Steam Pattern





No. 22-6 Water Pattern

ECONOMY SECTIONAL BOILERS

Steam Pattern

No.	Rating Sq. Ft.	Size of Grate Inches	Additional Area of Side Grate Fingers Sq. In.	Size of Smoke Flue Inches	Supply Tappings	Return Tappings
4-19	750	19x24	308	9	2-3"	2-3"
5-19	1000	19x32	360	9	2-3"	2-3"
6-19	1250	19x40	412	9	2-3"	2-3"
4-22	850	22x24	328	10	2-3½"	2-3½"
5-22	1100	22x32	380	10	2-3½"	2-3½"
6-22	1350	22x40	432	10	2-3½"	2-3½"
7-22	1600	22x48	484	10	2-3½"	2-3½"
5-28	1400	28x32	432	12	2-4"	2-4"
6-28	1750	28x40	484	12	2-4"	2-4"
7-28	2100	28x48	536	12	3-4"	2-4"
8-28	2450	28x56	588	12	3-4"	2-4"
5-34	2000	34x32	476	16	2-5"	2-5"
6-34	2500	34x40	528	16	2-5"	2-5"
7-34	3000	34x48	580	16	3-5"	2-5"
8-34	3500	34x56	632	16	3-5"	2-5"
9-34	4000	34x64	684	16	3-5"	2-5"
10-34	4500	34x72	736	16	3-5"	2-5"
6-47	5300	47x50	677	20	2-6"	2-6"
7-47	6300	47x60	742	20	2-6"	2-6"
8-47	7300	47x70	807	20	3-6"	2-6"
9-47	8300	47x80	872	20	3-6"	2-6"
10-47	9300	47x90	937	20	3-6"	2-6"

SERIES	19"	22"	28"	34"	47"
Height of Water Line	44"	47"	50"	54"	59"
Height to Supply Outlets	53"	57"	62½"	68"	73"
Add to height for Trimmings	9"	11"	11"	11"	12"
Width of Ashpit	27"	29¾"	35"	40¾"	53"
Width of Boiler, including Trimmings	35"	40"	45"	52"	61"
Height from Floor to Center of Return Tappings	18"	19"	19½"	20"	21½"
Height of Fire Box to Crown	22"	22"	24"	26"	26"
Height, Grate to Middle of Feed Door	16"	16"	18"	18"	18"
Size of Feed Door	9x14"	9x17"	9x17"	11x21"	2-10x17"

Water Pattern

No.	Rating Sq. Ft.	Size of Grate Inches	Additional Area of Side Grate Fingers Sq. In.	Size of Smoke Flue Inches	Supply Tappings	Return Tappings
19-4	1250	19x24	308	9	1-3"	2-3"
19-5	1650	19x32	360	9	2-3"	2-3"
19-6	2050	19x40	412	9	2-3"	2-3"
22-4	1400	22x24	328	10	2-3½"	2-3½"
22-5	1800	22x32	380	10	2-3½"	2-3½"
22-6	2200	22x40	432	10	2-3½"	2-3½"
22-7	2600	22x48	484	10	2-3½"	2-3½"
28-5	2300	28x32	432	12	2-4"	2-4"
28-6	2900	28x40	484	12	2-4"	2-4"
28-7	3500	28x48	536	12	3-4"	4-4"
28-8	4100	28x56	588	12	3-4"	4-4"
34-5	3300	34x32	476	16	2-5"	2-5"
34-6	4100	34x40	528	16	2-5"	2-5"
34-7	4900	34x48	580	16	3-5"	2-5"
34-8	5800	34x56	632	16	3-5"	4-5"
34-9	6600	34x64	684	16	3-5"	4-5"
34-10	7400	34x72	736	16	3-5"	4-5"
47-6	8750	47x50	677	20	2-6"	2-6"
47-7	10400	47x60	742	20	2-6"	2-6"
47-8	12050	47x70	807	20	3-6"	4-6"
47-9	13700	47x80	872	20	3-6"	4-6"
47-10	15350	47x90	937	20	3-6"	4-6"

SERIES	19"	22"	28"	34"	47"
Height to Supply Outlets	50"	54"	59"	68"	73"
Width of Boiler	33"	36"	42"	48"	59"
Height from Floor to Center of Return Tappings	18"	19"	19½"	20"	21½"
Height of Fire Box to Crown	22"	22"	24"	26"	26"
Height, Grate to Middle of Feed Door	16"	16"	18"	18"	18"
Size of Feed Door	9x14"	9x17"	9x17"	11x21"	2-10x17"
Width of Ashpit	27"	29¾"	35"	40¾"	53"

INTERNATIONAL HEATER COMPANY

ECONOMY ROUND BOILERS

These Boilers are designed to meet the most rigid demands for economical heating.

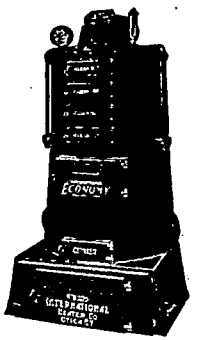
The carburetor principle of combustion is embodied in the design, also the positive cross fire travel, an exclusive feature of **Economy Round Boilers.**

Have deep firepot section, positive circulation, ample steam dome, individual cleanout doors, and side draft door.

Equipped with patented herring-bone triangular grate or flat grate for soft coal and the small sizes of anthracite coal.

Made in twenty-one sizes, 16 to 30 in. grate diameters. Steam ratings 350 to 1475 ft. of radiation, corresponding sizes for water.

See Catalog 1746-G for additional data.



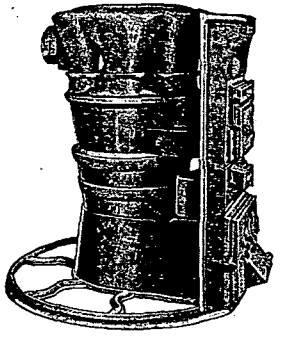
Economy Round Water

Data on ECONOMY ROUND BOILERS

	Steam Pattern				Water Pattern			
Number	Rating Sq. Ft.	Height to Flow Outlet Inches	Height Water-line Inches	Tappings Supply and Return	Number	Rating Sq. Ft.	Height to Flow Outlet Inches	Tappings Supply and Return
3E16 and 32E16	300	45	41	1-2½"	16E3 and 16E32	500	40½	1-2½"
4E16 and 42E16	320	49	45	1-2½"	16E4 and 16E42	540	44½	1-2½"
5E16 and 52E16	340	53	49	1-2½"	16E5 and 16E52	580	48½	1-2½"
3E18 and 32E18	350	45	41	1-2½"	18E3 and 18E32	600	40½	1-2½"
4E18 and 42E18	390	49	45	1-2½"	18E4 and 18E42	650	44½	1-2½"
5E18 and 52E18	430	53	49	1-2½"	18E5 and 18E52	700	48½	1-2½"
B221 and B2221	360	46½	43½	2-2½"	B212 and B2122	625	42¾	2-2½"
B321 and B3221	435	50½	47½	2-2½"	B213 and B2132	725	46½	2-2½"
B421 and B4221	500	54½	51½	2-2½"	B214 and B2142	825	50¼	2-2½"
B224 and B2224	475	47¾	44½	2-3"	B242 and B2422	800	43½	2-3"
B324 and B3224	550	52¼	49	2-3"	B243 and B2432	925	48	2-3"
B424 and B4224	625	56¾	53½	2-3"	B244 and B2442	1050	52½	2-3"
B524 and B5224	675	61¼	58	2-3"	B245 and B2452	1175	57	2-3"
B227 and B2227	600	50	46¼	2-3½"	B272 and B2722	1025	45½	2-3½"
B327 and B3227	700	54¾	51	2-3½"	B273 and B2732	1175	50¼	2-3½"
B427 and B4227	800	59½	55¾	2-3½"	B274 and B2742	1325	55	2-3½"
B527 and B5227	875	64¼	60½	2-3½"	B275 and B2752	1475	59¾	2-3½"
B230 and B2230	875	52¾	47½	2-4"	B302 and B3022	1475	48	2-4"
B330 and B3230	1020	58	52¼	2-4"	B303 and B3032	1700	53¼	2-4"
B430 and B4230	1150	63¼	58	2-4"	B304 and B3042	1925	58½	2-4"
B530 and B5230	1250	68½	63¼	2-4"	B305 and B3052	2100	63¾	2-4"

SERIES	16"	18"	21"	24"	27"	30"
Outside Diameter at Base	22½"	25½"	29"	32"	35"	39"
Height, Floor to Center Return Tappings	15¾"	15¾"	16"	17"	17½"	17½"
Size of Smoke Flue	7"	7"	9"	9"	10"	10"
Extreme Width of Firepot Section	22¼"	23"	26½"	28⅜"	32¼"	35"

INTERNATIONAL HEATER COMPANY



Carlon Furnace

INTERNATIONAL CARTON FURNACE

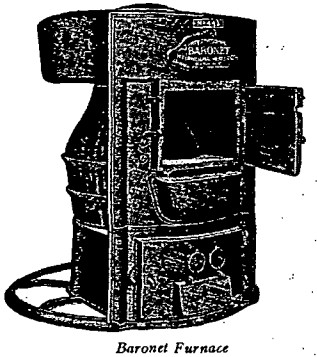
The **International Carton Furnace** is a sturdy, powerful heater made entirely of heavy cast iron with but five principal castings used in its assemblage.

It is very economical in the use of any fuel commonly used for heating purposes because of its *self cleaning* radiator.

Deep *sealed* cup joints are provided wherever castings join. The base and lower casing ring are in one piece, feed chute and combustion chamber are cast as a unit, and the ashpit is in one piece. Has patented herring-bone triangular grate, large double feed door, and roomy ashpit.

Made in six sizes. Firepot diameters 20 to 33 in. Casing diameters 40 to 60 in.

Complete Catalog 1563-G sent on request.



Baronet Furnace

INTERNATIONAL BARONET FURNACE

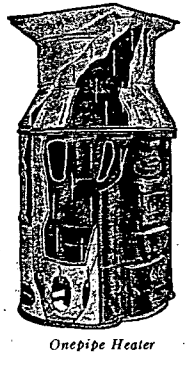
The **International Baronet Furnace** is a heavily constructed, medium priced, modern Heater—attractive in appearance, carefully mounted and fitted.

Furnished with specially designed, *one-piece cast radiator* (egg shaped in cross section), or steel radiator as desired.

Fitted with patented herring-bone triangular revolving grate hung in drop frame assembled without bolts or cotter pins. Large double feed door, coil openings, deep ashpit, two-piece firepot —corrugated outside, smooth inside—one-piece feed chute, and combustion dome.

Made in seven sizes for hard or soft coal. Firepot diameters 16 to 28 in., casing diameters 30 to 52 in.

Send for Catalog 1270-G giving complete data.



Onepipe Heater

INTERNATIONAL ONEPIPE HEATER

The **International Onepipe Heater** is designed to deliver large volumes of warm air through one register correctly proportioned to firepot diameter.

The castings with the exception of special flanged front are the same as those used in the Baronet Furnace.

Heavy galvanized casings. *Inner casing triple lined* with heavy asbestos and corrugated tin. Both casings extend down to the rings which are integral with the base.

Top is adjustable to various heights without cutting.

Furnished with cast or steel radiator for hard or soft coal. Firepot diameters 16 to 24 in. Casing diameters 36 to 50 in., register sizes 24 x 24 in. to 40 x 40 in.

Complete data in Catalog 1610-G.

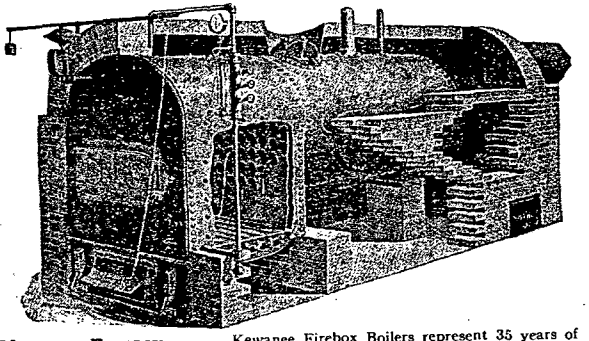
Special Types for Warming and Ventilating School Houses. Send for Bulletins 1505-G and 1757-G.

KEWANEE BOILER COMPANY

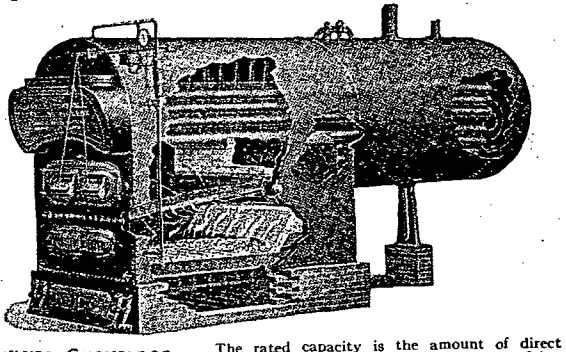
Kewanee, Illinois

BRANCHES IN ALL PRINCIPAL CITIES

Steel Heating and Power Boilers, Water Heating Garbage Burners, Tabasco Heaters, Tanks and Radiators



KEWANEE FIREBOX BOILER—*Brick-set—for Heating* Kewanee Firebox Boilers represent 35 years of intensive study and effort to make the highest grade equipment for heating buildings. They are adapted to the burning of any grade of fuel and will maintain high efficiency when operating to supply the variable demands of a heating load.



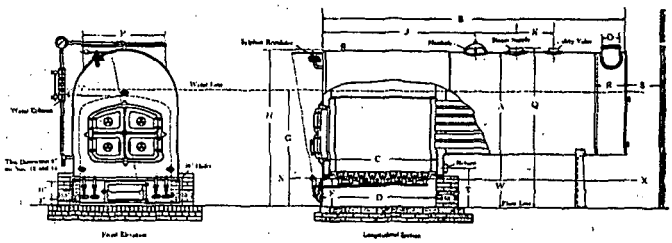
KEWANEE SMOKELESS BOILER—*Portable—for Heating* The rated capacity is the amount of direct radiation that the boiler will carry with a firing interval of three to four hours depending upon the grade of fuel used. No discount in rating is advised as reserve capacity has been allowed to care for the most severe weather conditions.

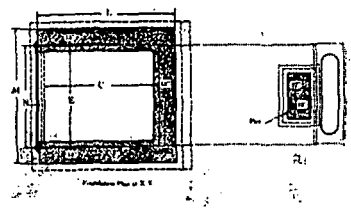
Kewanee Boilers are built of steel (riveted) using as a minimum basis the rules of construction adopted by the *American Society of Mechanical Engineers*, known as the *A. S. M. E.* Boiler Code.

Ratings

The rated capacity of Kewanee Boilers, as shown, is the number of square feet of direct radiation or equivalent which the boiler will carry, if sufficient radiation is installed to heat the building to 70 degrees.

The ratings are based on a standard for steam of 2 lb. pressure at the boiler, and for water on a mean temperature of 180 deg. fahr. as the water leaves the boiler.

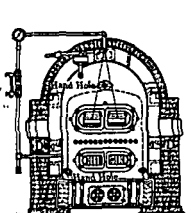




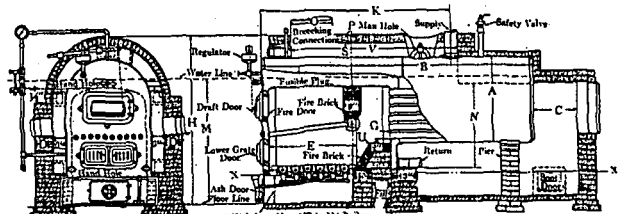
KEWANEE BOILERS PORTABLE TYPE K—UP-DRAFT

Number of Boiler	0K	1K	2K	3K	4K	5K	6K	8K	9K	10K	11K	12K	13K	14K	15K	16K	17K	18K	19K	20K
Capacity, Steam....sq. ft.	600	850	1000	1150	1300	1600	1900	2450	2850	3300	3800	4300	5200	6200	7100	8200	9500	10400	11400	13300
Heating Surface....sq. ft.	47	83	93	104	139	164	190	241	275	298	338	378	447	537	603	708	791	896	992	1129
Area of Grate....sq. ft.	3.5	4.4	5.4	6.4	6.8	8.0	93	11.1	12.6	12.9	14.7	16.5	18.8	20.8	22.9	25.1	25.5	28.0	30.8	33.5
Diameter of Boiler....in.	24	30	30	30	36	36	36	42	42	48	48	48	54	54	60	60	66	66	72	72
Length of Boiler Over-all....ft. in.	7-9	7-10	8-10	9-10	8-10	10-4	11-10	11-4	12-10	11-10	13-4	14-10	15-4	17-10	17-0	19-6	17-6	19-6	17-6	19-6
Diameter of Stack....in.	10	12	12	14	14	16	16	18	20	20	22	22	26	26	30	30	30	30	34	34
Height of Stack....ft.	35	35	35	35	35	40	40	40	40	40	45	45	45	45	50	50	55	55	55	55
Diameter of Stack, Two Boilers....in.	16	18	18	20	20	22	22	26	28	28	30	32	34	34	36	36	36	38	40	42
Height of Stack, Two Boilers....ft.	40	40	40	40	40	40	40	45	45	45	45	45	50	55	55	65	65	65	65	65
Size of Steam Opening....in.	3	4	4	5	5	6	6	6	6	6	6	7	7	7	7	7	8	8	8	8
Size of Return....in.	2	2½	2½	3	3	3	3	4	4	4	4	5	5	5	5	5	6	6	6	6
Size of Safety Valve....in.	1	1¼	1¼	1¼	1¼	1½	2	2	2	2	2½	2½	2½	3	3	3½	3½	3½	4	4
C—Length of Grate....in.	26	26	32	38	32	38	44	44	50	44	50	56	56	62	68	62	68	68	71	74
D—Length of Ash-pit....in.	31	33	39	45	39	45	51	51	57	51	57	63	59	65	65	71	65	71	71	77
E—Width of Ash-pit....in.	19	24	24	24	30	30	30	36	36	42	42	42	49	49	54	54	60	60	66	66
F—Height of Ash-pit....in.		14	14	14	14	14	14	14	14	14	14	14	14	14	17	17	17	17	17	17
G—Height of Water-line....in.	45	52	52	52	55	55	55	58½	58½	61	61	61	66	66	75	75	80	80	85½	85½
H—Height of Boiler....in.	51	59	59	59	65	65	65	71	71	77	77	77	83	83	93	93	99	99	105	105
J—Location of Steam Supply....ft. in.	4-0	4-0	4-8	5-6	4-11	5-11	6-11	6-8	7-2	7-0	7-10	8-6	9-2	9-8	9-6	10-8	9-8	10-8	9-9	10-9
K—Location of Safety Valve....in.	12	12	15	16	15	18	18	13	13	16	18	18	21	30	26	30	26¼	30	20	34
L—Length of Foundation....in.	32	34	40	46	40	46	52	52	58	52	58	64	72	78	78	84	78	84	84	90
M—Width of Foundation....in.	27	34	34	34	40	40	40	46	46	52	52	52	75	75	80	80	86	86	92	92
N—Center to Center Bolts in Ash-pit Front....in.													54	54	60	60	66	66	72	72
O—Width of Breeching Connection....in.	10	8	8	8	10	10	10	10	10	10	10	10	10	10	12	12	12	12	13	13
P—Length of Breeching Connection....in.	10	16	16	16	24	24	24	30	30	36	36	36	46	46	50	50	54	54	68	68
Q—Height of Steam Supply....in.	53	61	61	61	67	67	67	73	73	79	79	79	85	85	95	95	101	101	107	107
R—Depth of Smoke-Box....in.	12	16	16	16	16	16	16	16	16	16	16	16	16	16	18	18	18	18	18	18
S—Minimum Space Required at Rear....in.	24	18	18	18	21	21	21	24	24	27	27	27	30	30	33	33	36	36	39	39
T—Height of Return....in.	18	18	18	18	19	19	19	19	19	19	19	19	19	19	23	23	23	23	23	23
W—Floor Line to Bottom of Cylinder....in.		29	29	29	29	29	29	29	29	29	29	29	29	29	33	33	33	33	33	33
†Req'd at Front to Draw Tubes....in.		19	20	20	20	26	31	26	32	32	38	44	49	67	55	73	61	73	49	62
†Req'd at Rear to Draw Tubes....in.		32	39	45	39	51	63	57	69	63	75	87	92	116	102	126	108	126	102	122
*Number of Common Brick													460	490	710	740	740	760	790	820
Outside Surface to be Covered....sq. ft.	53	68	77	85	91	106	120	133	149	157	177	197	200	235	275	314	311	345	338	366

*Foundations not included. †If space is available at front, it is not necessary at rear, and vice-versa. Boilers No. 0K to No. 12K are furnished with cast iron base.
Full height back stand furnished with all boilers, no pier, see Letter W.



Type of Doors on Boilers Nos. 118 to 120

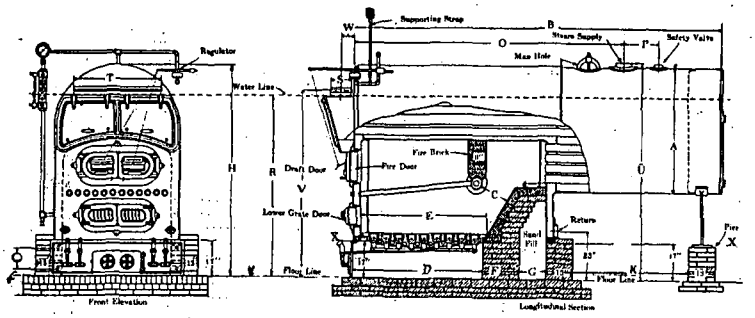


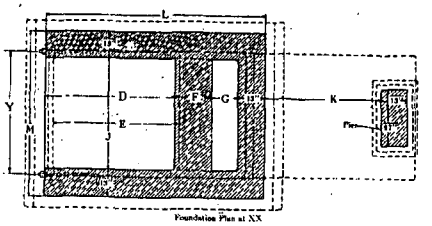
Front Elevation and Section Through Brickwork at FF — Ash Pit 14" High from Nos. 107 to 114 Boilers and 17" High from Nos. 115 to 120 Boilers — Longitudinal Section

KEWANEE SMOKELESS BOILERS—BRICK-SET TYPE

Number of Boiler	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
Capacity, Steam....sq. ft.	1600	2000	2300	2600	3100	3600	4000	4700	5500	6500	7500	8500	10000	11500	13000	14000	16000
Heating Surface....sq. ft.	206	243	288	297	345	393	425	480	535	628	741	839	973	1064	1194	1291	1456
Area of Upper Grate....sq. ft.	5.9	7.2	8.4	8.6	10.1	11.4	11.8	13.2	15.0	17.1	19.1	21.1	23.3	23.5	25.9	28.5	31.3
Diameter of Boiler....in.	36	36	36	42	42	42	48	48	48	54	54	60	60	66	66	72	72
Length Boiler Over-all....ft. in.	8-7	10-2	11-7	9-10	11-4	12-10	12-4	13-10	15-4	15-9	18-3	17-10	20-4	18-4	20-4	18-4	20-4
Diameter of Stack....in.	18	18	20	20	20	22	22	24	24	28	28	32	32	34	34	36	36
Height of Stack....ft.	45	45	45	50	50	50	50	55	55	60	60	60	60	70	70	70	70
Diameter of Stack, Two Boilers....in.	24	24	26	26	28	30	30	32	32	34	36	38	38	40	42	44	46
Height of Stack, Two Boilers....ft.	55	55	55	60	60	60	60	60	60	70	70	70	75	75	80	80	80
Size of Steam Opening....in.	5	6	6	6	6	6	6	6	7	7	7	7	7	8	8	8	8
Size of Return....in.	3	3	3	4	4	4	4	4	5	5	5	5	5	6	6	6	6
Size of Safety Valve....in.	1½	2	2	2	2	2½	2½	2½	3	3	3½	3½	4	4	4	2-2½	2-3
C—Rear Space....in.	19	17	17	22	22	22	22	22	22	24	24	24	24	24	24	28	28
D—Thickness Wall....in.	9	9	9	9	9	9	9	9	9	13	13	13	13	13	13	13	13
E—Length Grate....in.	31	37	43	37	43	49	43	49	55	55	61	61	67	61	67	67	73
J—Width Ash-pit....in.	31	31	31	37	37	37	43	43	43	49	49	54	54	60	60	66	66
F—Thickness Bridge Wall....in.	9	9	9	9	9	9	13	13	13	18	18	18	18	18	1°	18	18
G—Grate to Tube Sheet....in.	14	14	14	17	17	17	23	23	23	23	23	29	29	29	29	29	29
U—Header to Bridge Wall....in.	7	8	9	9	10	12	10	11	12½	13	14	14	15½	14	15½	16	17
H—Height Brickwork....ft. in.	77	77	77	83	83	83	90	90	90	96	96	108	108	114	114	120	120
K—Location Steam Supply....ft. in.	6-0	7-0	8-0	7-6	8-0	8-9	8-10	9-8	10-4	11-0	11-6	11-10	13-0	12-0	13-0	12-1	13-1
L—Length Over-all....in.	10-9	12-3	13-9	12-5	13-11	15-5	14-11	16-5	17-11	18-10	21-4	20-11	23-5	21-5	23-5	21-9	23-9
M—Height Water-line....in.	55	55	55	58½	58½	58½	61	61	61	66	66	75	75	80	80	85½	85½
N—Height Side Flue....in.	36	36	36	39	39	39	42	42	42	48	48	51	51	58	58	65	65
O—Diameter Breeching Connection....in.	20	20	22	22	22	24	24	27	27	30	30	34	34	36	36	38	38
S—Top Flue Space....in.	7	7	7	7	7	7	8	8	8	8	8	10	10	10	10	10	10
V—Length of Arch....ft. in.	5-3	6-3	7-3	7-0	7-6	8-0	8-1	8-11	9-9	10-0	10-6	10-10	12-0	11-0	12-0	11-1	12-1
W—Width Over-all....ft. in.	5-6	5-6	5-6	6-0	6-0	6-0	6-6	6-6	6-6	7-8	7-8	8-2	8-2	8-8	8-8	9-2	9-2
Req'd at Rear to Draw Tubes....ft. in.	2-5	3-5	4-5	2-8	3-8	4-8	4-0	5-0	6-0	5-11	7-11	6-11	8-11	7-5	8-11	6-7	8-1
*Number Common Brick	2200	2350	2450	2600	2850	3100	3700	4000	4300	6000	6600	7350	7900	7800	8300	8700	9300
Number Fire Brick	85	85	85	100	100	100	130	130	130	155	155	215	215	250	250	310	310
*Common Brick for Two Boilers	3900	4100	4300	4500	4950	5350	6500	7000	7550	10500	11500	12750	13700	13200	14200	15000	16000

*Foundations not included.

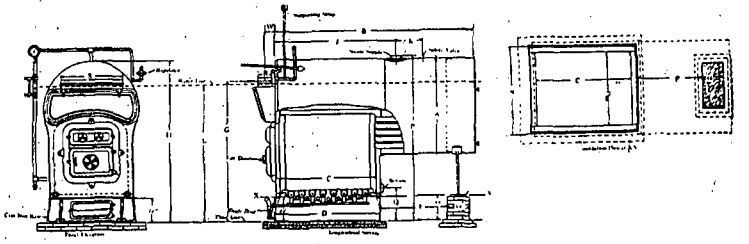




KEWANEE SMOKELESS BOILERS—PORTABLE TYPE

Number of Boiler	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324
Capacity, Steam....sq. ft.	3000	3500	4000	4500	5000	5500	6000	6500	7500	8500	10000	12000	14000	16000	18000	20000	25000	30000
Heating Surface....sq. ft.	297	352	391	446	496	546	592	643	721	773	912	1053	1204	1316	1458	1549	2074	2629
Area of Upper Grate....sq. ft.	8.8	10.1	11.4	12.9	14.7	16.5	17.1	18.5	20.0	21.4	23.5	25.9	28.5	29.9	32.6	34.6	41.7	44.8
Diameter of Boiler....in.	48	48	48	54	54	54	60	60	60	60	66	66	72	72	78	78	84	84
Length of Boiler Over-all....ft. in.	9-1	10-5	11-5	10-11	11-11	12-11	12-11	13-11	15-3	16-3	15-9	17-9	16-7	17-11	17-10	18-10	20-1	24-1
Diameter of Stack....in.	20	20	20	22	22	22	24	24	26	26	28	30	32	32	34	34	38	40
Height of Stack....ft.	50	55	55	55	55	60	60	60	65	65	65	70	70	70	80	90	90	100
Diameter of Stack, Two Boilers....in.	28	28	28	31	31	31	34	34	36	36	40	42	46	46	48	48	54	54
Height of Stack, Two Boilers....ft.	60	65	65	65	65	70	70	70	75	75	75	80	80	80	90	100	100	110
Size of Steam Opening....in.	6	6	6	6	6	6	7	7	7	7	8	8	8	8	8	8	10	10
Size of Return....in.	4	4	4	4	4	4	5	5	5	5	6	6	6	6	6	6	6	6
Size of Safety Valve....in.	2	2	2½	2½	3	3	3	3½	3½	4	4	4	2-2½	2-3	2-3	2-3	2-3½	2-3½
Distance Required to Open Rear Flue Doors....in.	26	26	26	28	28	28	32	32	32	32	35	35	37	37	40	40	43	43
E—Length Grate....in.	37	43	49	49	55	61	55	61	61	67	61	67	67	73	73	73	79	85
C—Header to Bridge Wall....in.	9	10	11½	11	12½	14	12½	14	14	15	15	16	16	17	17	18	18	19
D—Length Ash-pit....in.	38	44	50	50	56	62	56	62	63	69	63	69	69	75	75	75	81	87
K—Rear Wall to Pier....in.	29	39	45	27	33	39	45	51	57	63	62	80	63	74	72	79	84	126
J—Width Ash-pit....in.	37	37	37	43	43	43	49	49	53	53	59	59	65	65	71	71	77	77
M—Width Foundation....in.	46	46	46	60	60	60	66	66	79	79	85	85	91	91	97	97	103	103
L—Length Foundation....in.	61	67	73	84	90	96	90	96	107	113	107	113	113	119	119	125	131	137
H—Height Boiler....in.	84	84	84	89	89	89	98	98	101	101	107	107	113	113	115	115	121	121
U—Height Supply....in.	85	85	85	90	90	90	99	99	103	103	109	109	115	115	117	117	123	123
R—Height Water-line....in.	71	71	71	76	76	76	83	83	87	87	90	90	96	96	97	97	105	105
V—Height of Breeching Connection....in.	76	76	76	80	80	80	88	88	90	90	93	93	100	100	101	101	109	109
O—Location Supply....ft. in.	5-11	6-8	7-3	7-6	8-2	8-9	8-9	9-3	10-11	11-6	11-0	11-9	11-7	12-2	12-2	12-9	13-8	15-0
P—Location Safety Valve....in.	12	14	14	13	13	15	15	18	16	18	16	18	15	18	15	16	18	20
W—Center Breeching Connection to Front of Boiler....in.	8	8	8	8	8	8	9¼	9¼	9¼	9¼	10½	10½	11½	11½	11½	11½	13	13
S—Width Breeching Connection....in.	10	10	10	10	10	10	12½	12½	12½	12½	15	15	17	17	17	17	20	20
T—Length Breeching Connection....in.	36	36	36	42	42	42	46	46	46	46	50	50	54	54	60	60	64	64
†Req'd at Front to Draw Tubes....ft. in.	7-7	8-11	9-11	9-5	10-5	11-5	11-5	12-5	13-8	14-8	14-0	16-0	14-8	16-0	16-0	17-0	18-0	22-0
†Req'd at Rear to Draw Tubes....ft. in.	6-0	7-4	8-4	7-10	8-10	9-10	9-10	10-10	12-2	13-2	12-4	14-4	12-10	14-2	14-1	15-1	16-0	20-0
*Number Common Brick	200	200	200	800	825	850	1025	1050	1300	1350	1300	1350	1375	1450	1400	1475	1575	1600
Number Fire-brick	115	115	115	155	155	155	195	195	210	215	240	240	255	255	290	315	425	425
Outside Surface to be Covered....sq. ft.	148	157	173	184	212	221	255	265	266	280	290	330	335	360	370	400	455	545

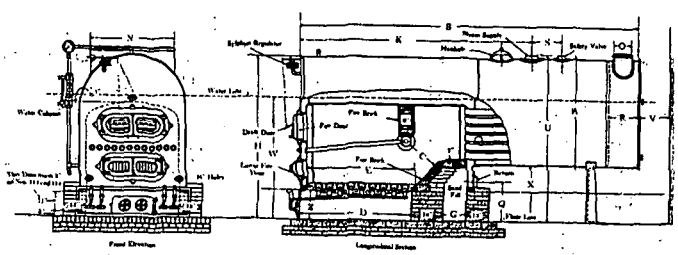
*Foundations not included. †If space is available at front, it is not necessary at rear, and vice-versa.

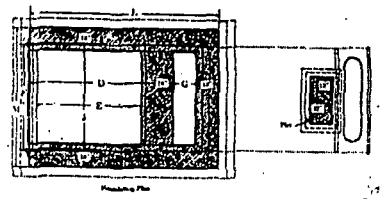


KEWANEE BOILERS—PORTABLE TYPE

Number of Boiler	407	408	409	410	411	412	413	414	415	416	417	418	419	420	421	422	423	424
Capacity, Steam....sq. ft.	2500	2900	3500	4000	4500	5000	5500	6000	7000	8000	9500	11000	13000	15000	17500	20000	25000	28000
Heating Surface....sq. ft.	278	310	373	416	465	515	565	626	676	778	929	1040	1168	1303	1514	1711	2209	2427
Area of Grate....sq. ft.	9.6	11.1	12.6	12.9	14.7	16.5	18.8	20.8	20.7	22.9	25.5	28.0	30.8	33.5	36.6	39.6	42.9	46.1
Diameter of Boiler....in.	48	48	48	54	54	54	60	60	60	60	66	66	72	72	78	78	84	84
Length of Boiler....ft. in.	8-7	9-6	11-1	10-0	11-1	12-1	12-5	13-7	14-4	16-2	15-9	17-4	15-11	17-6	17-11	19-11	20-1	22-1
Diameter of Stack....in.	20	20	20	22	22	22	24	24	26	26	28	30	32	32	34	34	38	40
Height of Stack....ft.	50	50	55	55	55	60	60	60	65	65	65	70	70	70	80	90	90	100
Diameter of Stack, Two Boilers....in.	28	28	28	31	31	31	34	34	36	36	40	42	46	46	48	48	54	54
Height of Stack, Two Boilers....ft.	60	60	65	65	65	70	70	70	75	75	75	80	80	80	90	100	100	110
Size of Steam Opening....in.	6	6	6	6	6	6	7	7	7	7	8	8	8	8	8	8	10	10
Size of Return....in.	4	4	4	4	4	4	5	5	5	5	6	6	6	6	6	6	6	6
Size of Safety Valve....in.	2	2	2	2	2½	2½	2½	3	3	3	3½	3½	4	4	2-2½	2-3	2-3	2-3
Distance Required to Open Rear Flue Doors....in.	26	26	26	28	28	28	32	32	32	32	35	35	37	37	40	40	43	43
C—Length of Fire-box....in.	38	44	50	44	50	56	56	62	56	62	62	68	68	74	74	80	80	86
D—Length of Ash-pit....in.	45	51	57	47	53	59	59	65	60	66	66	72	72	78	78	84	84	90
E—Width of Fire-box....in.	36	36	36	43	43	43	49	49	53	53	59	59	65	65	71	71	77	77
F—Ash-pit Base to Pier....ft. in.	3-3	3-8	4-9	3-9	4-4	4-10	5-2	5-10	6-7	7-11	7-5	8-5	6-11	7-11	8-4	9-10	9-10	11-4
G—Height Breeching Connection....in.	76	76	76	80	80	80	88	88	90	90	93	93	100	100	101	101	109	109
H—Height of Boiler....in.	84	84	84	89	89	89	98	98	101	101	107	107	113	113	115	115	121	121
P—Height of Steam Supply....in.	85	85	85	90	90	90	99	99	103	103	109	109	115	115	117	117	123	123
L—Height of Water-line....in.	71	71	71	76	76	76	83	83	87	87	90	90	96	96	97	97	105	105
J—Location of Steam Supply....ft. in.	4-8	5-3	6-3	5-6	6-4	8-0	8-3	8-8	8-5	9-5	9-4	10-2	9-8	11-1	11-3	12-0	12-6	12-6
K—Location of Safety Valve....in.	13	14	18	16	18	13	16	18	21	27	18	30	18	24	24	30	24	21
W—Center of Breeching Connection to Front of Boiler....in.	8	8	8	8	8	8	9¼	9¼	9¼	12½	10½	10½	11½	11½	11½	11½	13	13
R—Width Breeching Connection....in.	10	10	10	10	10	10	12½	12½	12½	12½	15	15	17	17	17	17	20	20
S—Length Breeching Connection....in.	36	36	36	42	42	42	46	46	46	46	50	50	54	54	60	60	64	64
†Req'd at Front to Draw Tubes....ft. in.	7-1	8-0	9-7	8-7	9-7	10-7	11-0	12-2	12-10	14-8	14-1	15-8	14-1	15-8	16-1	18-1	18-1	20-0
†Req'd at Rear to Draw Tubes....ft. in.	5-6	6-5	8-0	6-11	7-11	8-11	9-4	10-6	11-3	13-1	12-4	13-11	12-2	13-9	14-2	16-2	16-2	18-2
*Number Common Brick	560	680	710	740	760	790	820	840	885	900	935							
Outside Surface to be Covered....sq. ft.	115	130	150	155	175	185	190	220	250	280	290	310	315	345	385	425	455	505

*Foundations not included. †If space is available at front, it is not necessary at rear, and vice-versa.

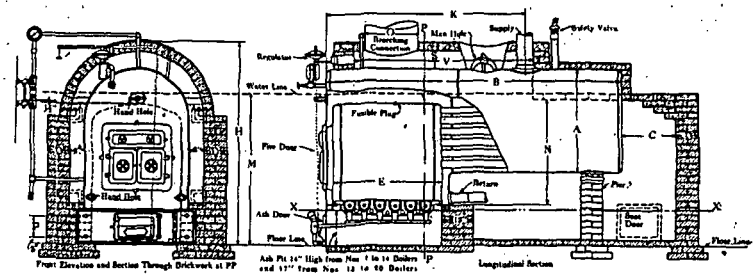


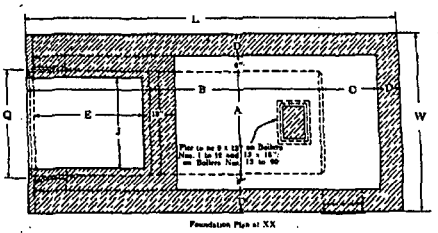


KEWANEE PORTABLE SMOKELESS BOILERS TYPE K

Number of Boiler	104K	105K	106K	107K	108K	109K	110K	111K	112K	113K	114K	115K	116K	117K	118K	119K	120K
Capacity, Steam...sq. ft.	1500	1900	2200	2500	2900	3400	3800	4400	5200	6200	7100	8100	9500	10900	12300	13300	15200
Heating Surface...sq. ft.	157	185	220	234	271	308	338	381	425	500	590	677	787	879	987	1090	1230
Area of Upper Grate...sq. ft.	5.9	7.2	8.4	8.6	10.1	11.4	11.8	13.2	15.0	17.1	19.1	21.1	23.3	23.5	25.9	28.5	31.3
Diameter of Boiler...in.	36	36	36	42	42	42	48	48	48	54	54	60	60	66	66	72	72
Length Boiler Over-all...ft. in.	9-11	11-5	12-11	11-2	12-8	14-2	13-8	15-2	16-8	17-1	19-7	19-4	21-10	19-10	21-10	19-10	21-10
Diameter of Stack...in.	18	18	20	20	20	22	22	24	24	28	28	32	32	34	34	36	36
Height of Stack...ft.	40	40	40	45	45	45	45	50	50	55	55	55	55	65	65	65	65
Diameter of Stack, Two Boilers...in.	24	24	26	26	28	30	30	32	32	34	36	38	38	40	42	44	46
Height of Stack, Two Boilers...ft.	50	50	50	55	55	55	55	55	55	65	65	65	70	70	75	75	75
Size of Steam Opening...in.	5	6	6	6	6	6	6	6	7	7	7	7	8	8	8	8	8
Size of Return...in.	3	3	3	4	4	4	4	4	5	5	5	5	5	6	6	6	6
Size of Safety Valve...in.	1¼	2	2	2	2	2½	2½	2½	3	3	3½	3½	4	4	4	2-2½	2-3
C—Header to Bridge Wall...in.	7	8	9	9	10	12	10	11	12½	13	14	14	15½	14	15½	16	17
D—Length of Ash-pit...in.	32	38	44	38	44	50	44	50	56	57	63	63	69	63	69	69	75
E—Length of Grate...in.	31	37	43	37	43	49	43	49	55	55	61	61	67	61	67	67	73
F—Center to Center Bolts in Ash-pit Front...in.										54	54	60	60	66	66	72	72
G—Bridge Wall to Rear Wall...in.										6	6	12	12	12	12	12	12
H—Height of Boiler...in.	65	65	65	71	71	71	77	77	77	83	83	93	93	99	99	105	105
J—Width of Ash-pit...in.	31	31	31	37	37	37	43	43	43	49	49	54	54	60	60	66	66
K—Location of Steam Supply...ft. in.	6-0	7-0	8-0	7-6	8-0	8-9	8-10	9-8	10-4	11-0	11-6	11-10	13-0	12-0	13-0	12-1	13-1
L—Length of Foundation...in.	51	57	63	60	66	72	72	78	84	94	100	106	112	106	112	112	118
M—Width of Foundation...in.	40	40	40	46	46	46	54	54	54	75	75	80	80	86	86	92	92
N—Length of Breeching Connection...in.	24	24	24	30	30	30	36	36	36	46	46	50	50	54	54	68	68
O—Width of Breeching Connection...in.	10	10	10	10	10	10	10	10	10	10	10	12	12	12	12	13	13
Q—Height of Return...in.	19	19	19	19	19	19	19	19	19	19	19	23	23	23	23	23	23
R—Depth of Smoke Box...in.	16	16	16	16	16	16	16	16	16	16	18	18	18	18	18	18	18
S—Location of Safety Valve...in.	15	18	18	13	12	13	16	18	18	21	30	26	30	30	30	20	34
U—Height of Steam Supply...in.	67	67	67	73	73	73	79	79	79	85	85	95	95	101	101	107	107
V—Minimum Space Required at Rear...in.	21	21	21	24	24	24	27	27	27	30	30	33	33	36	36	39	39
W—Height of Water-line...in.	55	55	55	58½	58½	58½	61	61	61	66	66	75	75	80	80	85½	85½
X—Floor Line to Bottom of Cylinder...in.	29	29	29	29	29	29	29	29	29	29	29	33	33	33	33	33	33
Z—Height of Ash-pit...in.	14	14	14	14	14	14	14	14	14	14	14	17	17	17	17	17	17
†Req'd at Front to Draw Tubes...in.	7	13	19	4	10	16	10	16	22	27	45	26	44	32	44	20	32
†Req'd at Rear to Draw Tubes...in.	39	51	63	45	57	69	63	75	87	92	116	102	126	108	126	102	120
*Number of Common Brick										955	980	1300	1350	1300	1350	1375	1450
Number of Fire Brick	85	85	85	115	115	115	155	155	155	195	195	210	215	240	240	255	255
Outside Surface to be Covered...sq. ft.	93	102	115	131	148	164	180	199	218	243	278	311	350	350	384	380	407

*Foundations not included. †If space is available at front, it is not necessary at rear, and vice-versa. Boilers No. 104K to 112K are furnished with cast iron bases.





KEWANEE FIREBOX BOILERS—BRICK-SET TYPE

Number of Boiler	1	2	3	4	5	6	8	9	10	11	12	13	14	15	16	17	18	19	20
Capacity, Steam...sq. ft.	900	1050	1200	1400	1700	2000	2600	3000	3500	4000	4500	5500	6500	7500	8700	10000	11000	12000	14000
Diameter of Boiler...in.	30	30	30	36	36	36	42	42	48	48	48	54	54	60	60	66	66	72	72
Length of Boiler Over-all...ft.	6½	7½	8½	7½	9	10½	10	11½	10½	12	13½	14	16½	15½	18	16	18	16	18
Heating Surface...sq. ft.	113	131	147	180	215	250	305	350	368	420	472	560	673	745	873	954	1080	1167	1329
Area of Grate...sq. ft.	4.4	5.4	6.4	6.8	8.0	9.3	11.1	12.6	12.9	14.7	16.5	18.8	20.8	22.9	25.1	25.5	28.0	30.8	33.5
Diameter of Breeching...in.	12	14	16	16	18	18	20	22	22	24	24	28	28	32	32	32	32	36	36
Diameter of Stack...in.	12	12	14	14	16	16	18	20	20	22	22	26	26	30	30	30	30	34	34
Minimum Height of Stack...ft.	40	40	40	40	40	45	45	45	45	50	50	50	50	55	55	60	60	60	60
Diameter of Breeching, Two Boilers...in.	18	20	22	22	24	24	28	32	32	32	34	36	36	40	40	40	42	44	46
Diameter of Stack, Two Boilers...in.	18	18	20	20	22	22	26	28	28	30	32	34	34	36	36	36	38	40	42
Minimum Height of Stack, Two Boilers...ft.	45	45	45	45	45	45	50	50	50	50	50	55	60	60	70	70	70	70	70
Size of Steam Opening...in.	4	4	5	5	6	6	6	6	6	6	7	7	7	7	7	8	8	8	8
Size of Return...in.	2½	2½	3	3	3	3	4	4	4	4	5	5	5	5	5	6	6	6	6
Size of Safety Valve...in.	1¼	1¼	1¼	1½	1½	2	2	2	2	2½	2½	2½	3	3	3½	3½	3½	4	4
C—Rear Space...in.	17	17	17	17	17	17	22	22	22	22	22	24	24	24	24	24	24	28	28
D—Thickness Wall...in.	9	9	9	9	9	9	9	9	9	9	9	13	13	13	13	13	13	13	13
E—Length Grate...in.	26	32	38	32	38	44	44	50	44	50	56	56	62	62	68	62	68	68	74
J—Width Ash-pit...in.	25	25	25	31	31	31	37	37	43	43	43	49	49	54	54	60	60	66	66
H—Total Height...in.	70	70	70	77	77	77	83	83	90	90	90	96	96	108	108	114	114	120	120
K—Location of Supply...ft. in.	4-0	4-8	5-6	4-11	5-11	6-11	6-8	7-2	7-0	7-10	8-6	9-2	9-8	9-6	10-8	9-8	10-8	9-9	10-9
M—Height of Water-line...in.	52	52	52	55	55	55	58½	58½	61	61	61	66	66	75	75	80	80	85½	85½
N—Height of Side Flue...ft. in.	2-8	2-8	2-8	3-0	3-0	3-0	3-3	3-3	3-6	3-6	3-6	4-0	4-0	4-3	4-3	4-10	4-10	5-3	5-3
O—Diameter Breeching Connection...in.	12	14	16	16	18	18	20	22	22	24	24	28	28	32	32	32	32	36	36
S—Top Flue Space...in.	6	6	6	7	7	7	7	7	8	8	8	8	8	10	10	10	10	10	10
V—Length of Arch...ft. in.	3-2	3-10	4-9	4-1	5-1	6-1	6-3	6-9	6-3	7-3	7-9	8-1	8-7	8-5	9-7	8-7	9-8	8-9	9-9
P—Anchor Bolt Centers for Ash-pit Front...	8	8	8	8	8	8	8	8	8	8	8	8	8	11	11	11	11	11	11
Q—Anchor Bolt Centers for Ash-pit Front...	30	30	30	36	36	36	42	42	48	48	48	54	54	60	60	66	66	72	72
L—Total Length...ft. in.	8-7	9-8	10-8	9-8	11-2	12-8	12-7	14-1	13-1	14-7	16-1	17-0	19-6	18-7	21-1	19-1	21-1	19-5	21-5
W—Total Width...ft. in.	5-0	5-0	5-0	5-6	5-6	5-6	6-0	6-0	6-6	6-6	6-6	7-8	7-8	8-2	8-2	8-8	8-8	9-2	9-2
*Number of Common Brick	1450	1600	1750	1900	2150	2400	2650	2900	3000	3300	3600	5300	5900	6500	7200	12400	13450	13250	13850
*Common Brick for Two Boilers	2450	2700	2950	3300	3750	4100	4750	5350	5400	5900	6450	8350	10350	11350	12550	12400	13450	13250	13850

*Foundations not included. NOTE—A Firing Space of about 8'-0" should be maintained at front of Boilers. This provides sufficient space to draw tubes through firedoor.

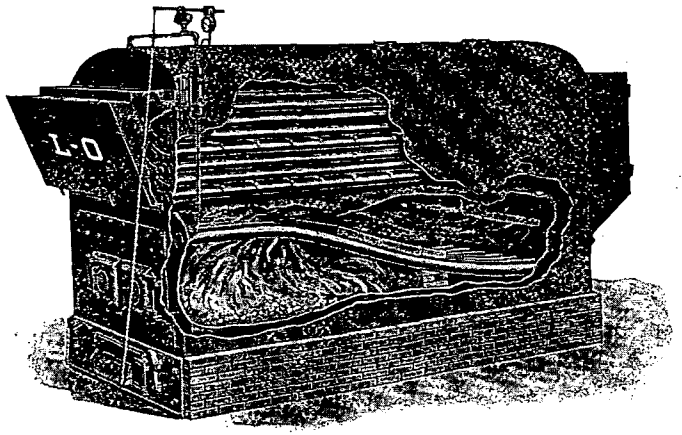
Lebanon Boiler Works

J. K. PETTY & CO., Inc., Proprietors

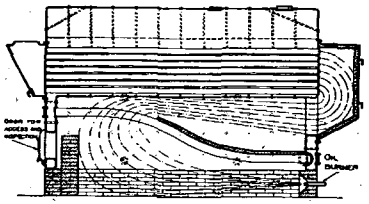
1242 Buttonwood Street - Lebanon, Pa.

SALES OFFICES

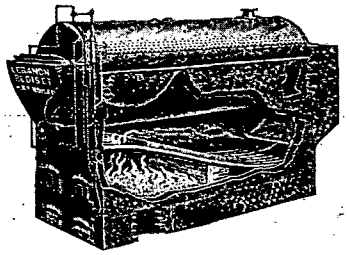
39 Cortlandt St., N. Y. Harrison Bldg., Philadelphia



Lebanon L-O Boiler



L-O Oil Burning Setting

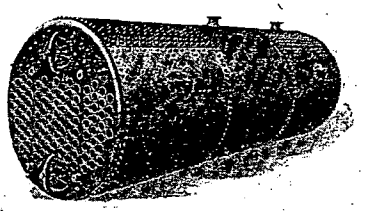


Lebanon "Redisel" H. R. T. Boiler. High Pressure and Heating up to 400 H. P. Units

Steam Radiation Capacity

Blr No.	Shell Dimensions W x H x L	Steam Radiation (Sq. Ft.)
L-21	44" x 61" x 8'-3"	4100
L-22	50" x 68" x 9'-0"	5600
L-23	56" x 74" x 10'-0"	7800
L-24	62" x 80" x 10'-0"	10200
L-25	62" x 82" x 12'-0"	12600
L-26	68" x 87" x 11'-0"	15100
L-27	68" x 87" x 13'-0"	17700
L-28	68" x 93" x 13'-0"	20100
L-29	74" x 95" x 14'-0"	22900
L-210	74" x 99" x 15'-0"	26200
L-211	74" x 103" x 16'-0"	30700

Built also in Power Type from 18 to 60 H. P.



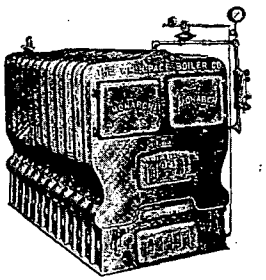
"Lebanon Improved" H. R. T. Boiler Brickset Type

THE WM. H. PAGE BOILER CO.

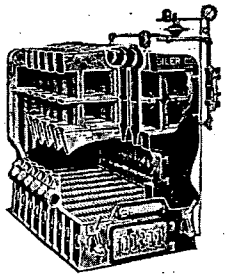
GENERAL OFFICE: **58 West 40th Street, NEW YORK**

Branches: 123 Beverly Street, Boston
Rose Building, Cleveland
1718 Sansom Street, Philadelphia
Factory: Meadville, Pa.

Manufacturers of a Complete Line of Round and Square Steam and Hot Water Boilers



Monarch Up-Draft Smokeless



Monarch Regular Type, Sectional View

†Monarch Sectional Steam and Water Boilers
Dimensions and Ratings

Number	Commercial Rating* Sq. Ft. Steam	Page Safe Rating★ Sq. Ft. Steam	Size of Grate,‡ Inches	Area of Grate,‡ Sq. Ft.	Height Over All, Inches, Steam	Width Over All, Inches, Steam	Height Over All, Inches, Water	Width Over All, Inches, Water	Total Length, Inches	Water Line, Inches, Steam	Outlets and Inlets, Inches	Size of Smoke Pipe, Inches
604	850	650	22x20	3.06	60½	39¼	52	35	34	41	2-3	10
605	1075	850	22x26⅜	4.03	60½	39¼	52	35	40⅜	41	2-3	10
606	1300	1050	22x32¼	5.00	60½	39¼	52	35	46¼	41	2-3	10
607	1525	1250	22x39⅛	5.98	60½	39¼	52	35	53⅛	41	2-3	10
608	1750	1450	22x45½	6.95	60½	39¼	52	35	59½	41	2-3	10
504	1600	1200	28x24¼	4.82	73	45¼	64½	41	43⅜	51	2-5	13
505	2050	1600	28x33⅛	6.45	73	45¼	64½	41	52	51	2-5	13
506	2500	2000	28x41½	8.07	73	45¼	64½	41	60⅜	51	2-5	13
507	2950	2400	28x49⅞	9.70	73	45¼	64½	41	68½	51	2-5	13
508	3400	2800	28x58¼	11.32	73	45¼	64½	41	77⅛	51	2-5	13
509	3850	3200	28x66⅝	12.96	73	45¼	64½	41	85⅞	51	2-5	13
510	4300	3600	28x66⅝	14.58	73	45¼	64½	41	93⅞	51	2-5	13
511	4750	4000	28x66⅝	16.21	73	45¼	64½	41	102¼	51	2-5	13
512	5200	4400	28x66⅝	17.84	73	45¼	64½	41	110⅝	51	2-5	13
405	3400	2400	40x33⅛	9.20	81	59¼	72½	55	52	58	2-5	21
406	4200	3000	40x41½	11.52	81	59¼	72½	55	60⅜	58	2-5	21
407	5000	3600	40x49⅞	13.85	81	59¼	72½	55	68¼	58	2-5	21
408	5800	4200	40x58¼	16.18	81	59¼	72½	55	77⅛	58	2-5	21
409	6600	4800	40x66⅝	18.50	81	59¼	72½	55	85½	58	2-5	21
410	7400	5400	40x75	20.82	81	59¼	72½	55	93⅞	58	2-5	21
411	8200	6000	40x83⅜	23.13	81	59¼	72½	55	102¼	58	3-5	21
412	9000	6600	40x91¾	25.50	81	59¼	72½	55	110⅝	58	3-5	21
413	9800	7200	40x91¾	27.81	81	59¼	72½	55	119	58	3-5	21
414	10600	7800	40x91¾	30.14	81	59¼	72½	55	127⅜	58	3-5	21
415	11400	8400	40x91¾	32.47	81	59¼	72½	55	135¼	58	3-5	21
416	12200	9000	40x91¾	34.79	81	59¼	72½	55	144⅛	58	3-5	21

Monarch Boilers are built in conformity with the Boiler Code of the *American Society of Mechanical Engineers.*

*Commercial Ratings, as given, are derived from tests made in accordance with the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS' Low-Pressure Boiler Code, Revision of 1924.

★Page Safe Ratings are conservatively made, derived from careful and exhaustive tests, during years of service under every condition—which proved their safety—and are based on an 8-hour firing period.

Ratings are based on a standard of 2 lb. pressure maintained at the boiler for steam and 180 deg. for hot water.

All piping (mains and risers, flows and returns) is to be figured as radiating surface in addition to the direct and indirect radiation attached to same.

‡Bridgewall sections are furnished for shortening grates. Grate areas as given above are for entire length of boilers, but unless otherwise ordered, bridgewall section will be shipped with boilers larger than No. 509 and No. 412 to reduce grate to length in table of dimensions.

†These boilers can also be furnished with header connections, and in both up-draft and down-draft smokeless types.

NATIONAL RADIATOR COMPANY

General Offices: JOHNSTOWN, PA.

NEW YORK, 47 W. 42nd Street
PHILADELPHIA, 121 N. Broad Street
BALTIMORE, 2622 Frisby Street
WASHINGTON, 1228 H Street

Branches

RICHMOND, 1538 E. Cary Street
PITTSBURGH, 1402 Arrott Building
CLEVELAND, 6308 Kinsman Road
CINCINNATI, Suite 826-827 Union Central Building
CHICAGO, 1038 S. Kolmar Ave.

Plants

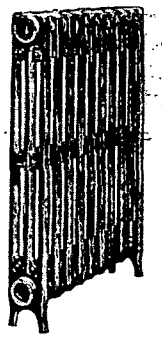
JOHNSTOWN, PA. NEW CASTLE, PA. TRENTON, N. J.

Warehouses

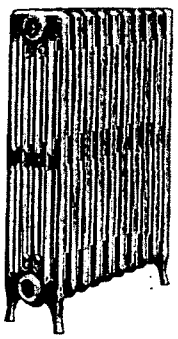
NEW YORK NEW ROCHELLE CLEVELAND BALTIMORE CINCINNATI WASHINGTON CHICAGO RICHMOND

Manufacturers

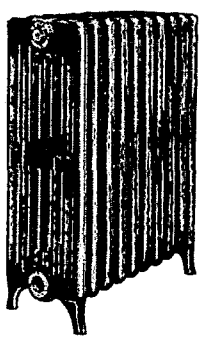
National Smokeless, Novus Upright and Sectional, Acme Round, Radium Gas and Hot Water Supply Boilers, also Aero Radiators.



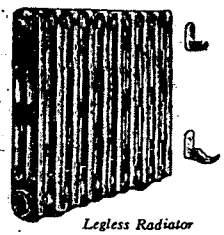
Three-Column



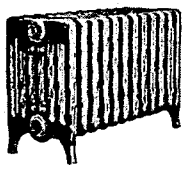
Five-Column



Seven-Column



Legless Radiator



Window Radiator

Patents Applied For

AERO RADIATORS

The Aero Radiator was designed by Engineers with more than 30 years experience in radiator manufacture. In the Aero line is represented a real effort to simplify the multiplicity of radiator patterns and heights.

Large buildings are now warmed with the more modern, efficient, economical and easily controlled vapor and vacuum systems. These necessitate the use of a radiator pattern with top and bottom nipple connection—the type known as a water section. The demand for the straight steam section, with bottom nipple connection only, is consequently negligible.

The Aero Radiator is made in one type only—the top and bottom nipple connected section.

It is tapped top and bottom both ends. The top tappings are plugged and the bottom tappings bushed to size required.

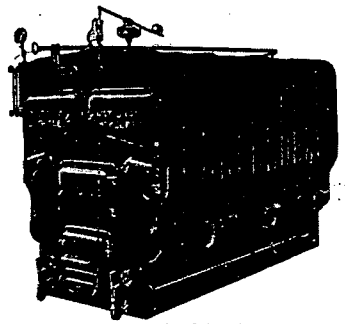
All radiators are vented for both steam and hot water. One vent is plugged. Any Aero Radiator can be used for either steam, hot water or vapor.

Aero Radiators are made in three patterns—Three, Five and Seven Column. A total of 16 heights composes the entire line.

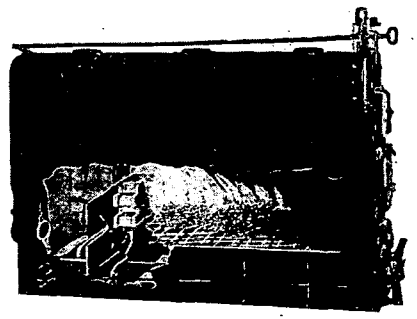
Roughing-in measurements are standard. All sections measure 2½ in. from center to center.

The Three-Column pattern is 5⅛ in. wide, the Five-Column pattern 8⅜ in. wide and the Seven-Column pattern 12 in. With these widths and standard roughing-in measurements they can be used on any standard specification.

Aero radiators are sold at the same price as standard radiation.



National Smokeless Boiler



Sectional View

Patented

LIST PRICES AND RATING

Size	Steam Rating	Water Rating	Number Sections	Number Grates	Grate Area sq. ft.	Combustion Chamber Area sq. ft.	Height Water Line Inches	Height Top Outlets Inches	Height Including Trimmings	Width Boiler Inches	Width Including Trimmings Inches	Length Including Smoke-hood Inches	Size Base Inches	Outlets No. and Size	Size Smoke Pipe
25- 9	2525	4175	9	5	6.11	3.48	49	57¼	65⅝	36½	40¾	74⅛	27⅞x 60⅜	3-4"	12
25-10	2825	4675	10	6	7.27	3.48	49	57¼	65⅝	36½	40¾	81⅛	27⅞x675⁄8	3-4"	12
25-11	3125	5175	11	7	8.43	3.48	49	57¼	65⅝	36½	40¾	88⅛	27⅞x74⅝	3-4"	12
25-12	3425	5675	12	8	9.59	3.48	49	57¼	65⅝	36½	40¾	95⅛	27⅞x 81⅝	3-4"	12
31- 9	3625	5975	9	5	8.55	5.07	52	61	71¼	50	54	79¼	33⅜x 65¼	3-5"	15
31-10	4050	6675	10	6	10.24	5.07	52	61	71¼	50	54	88	33⅜x 74	3-5"	15
31-11	4475	7375	11	7	11.93	5.07	52	61	71¼	50	54	95½	33⅜x 81½	3-5"	15
31-12	4900	8075	12	8	13.62	5.07	52	61	71¼	50	54	103	33⅜x 89.	3-5"	15
31-13	5325	8775	13	9	15.31	5.07	52	61	71¼	50	54	110½	33⅜x 96½	3-5"	15
36- 9	5125	8475	9	5	11.50	6.75	60¼	70	78¾	56	60	87½	41⅜x 73½	3-5"	16
36-10	5750	9500	10	6	13.75	6.75	60¼	70	78¾	56	60	95⅞	41⅜x 81⅞	3-5"	16
36-11	6375	10,525	11	7	16.00	6.75	60¼	70	78¾	56	60	104¼	41⅜x 90¼	3-5"	16
36-12	7000	11,550	12	8	18.25	6.75	60¼	70	78¾	56	60	112⅝	41⅜x 98⅝	3-5"	16
36-13	7625	12,575	13	9	20.50	6.75	60¼	70	78¾	56	60	121	41⅜x107	4-5"	16
36-14	8250	13,600	14	9	20.50	9.50	60¼	70	78¾	56	60	129⅜	41⅜x115⅜	4-5"	16
36-15	8875	14,625	15	10	22.75	9.50	60¼	70	78¾	56	60	137¾	41⅜x123¾	4-5"	16
36-16	9500	15,650	16	10	22.75	12.25	60¼	70	78¾	56	60	146⅛	41⅜x132⅛	4-5"	16
48- 9	9200	15,100	9	5	18.23	10.65	68	80	89	67	71	109¼	53⅞x 89¼	3-6"	20
48-10	10,325	16,950	10	6	21.78	10.65	68	80	89	67	71	119⅝	53⅞x 99⅞	3-6"	20
48-11	11,450	18,800	11	7	25.33	10.65	68	80	89	67	71	130½	53⅞x110½	4-6"	20
48-12	12,575	20,650	12	8	28.88	10.65	68	80	89	67	71	141⅛	53⅞x121⅛	4-6"	20
48-13	13,700	22,500	13	9	32.43	10.65	68	80	89	67	71	151¾	53⅞x131¼	5-6"	20
48-14	14,825	24,350	14	9	32.43	14.20	68	80	89	67	71	162⅝	53⅞x142⅛	5-6"	20
48-15	15,950	26,200	15	10	35.98	14.20	68	80	89	67	71	173	53⅞x153	5-6"	20
48-16	17,075	28,050	16	10	35.98	17.75	68	80	89	67	71	183⅛	53⅞x163⅜	5-6"	20



Sylph-Oil Air Regulator Patents Applied For

The National Up-Draft Smokeless Boiler will conform to any smoke ordinance.

Burning smoke depends upon the temperature to which the air discharged over the fire is preheated. The National Preheating Air device heats air to in excess of 1000 deg. It is discharged into the smoke and gases as they pass over the Refractory Bridge wall into the Combustion Chamber.

The National Smokeless Boiler will clear to the No. 1 Smoke Screen in from 10 to 15 seconds and to a clear stack in less than one minute after firing a charge of green coal.

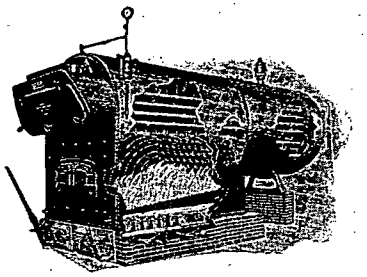
National Smokeless boilers show an average increase of 28 per cent in evaporation on the same fuel charge and consequently are very economical in operation.

The volume of preheated air necessary to burn smoke varies with the state of combustion. The air should be gradually decreased and cut off almost completely during a period of about 20 minutes from the time fuel is charged. Unless this is done the preheated air has a tendency to chill rather than increase the gas temperatures and the boiler efficiency and evaporation is decreased.

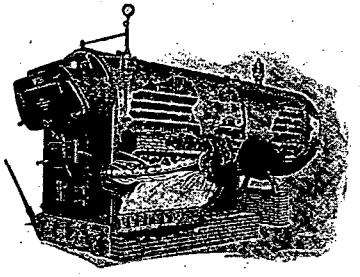
The Sylph-Oil Regulator operates the Preheating Air Device automatically and positively can be regulated to close the air intake in any time from one half-a minute to one hour after fuel is charged.

OIL CITY BOILER WORKS — Oil City ~ Pa.

NEW YORK, N. Y., 501 Fifth Ave.
PHILADELPHIA, PA., 1043 Real Estate Trust Bldg.
PITTSBURGH, PA., 1116 House Bldg.
ATLANTA, GA., 315 Glenn Bldg.
BALTIMORE, MD., Dukehart Bldg.
INDIANAPOLIS, IND., 321 N. Pennsylvania Ave.
DETROIT, MICH., 715 Donovan Bldg.
SAN FRANCISCO, CALIF., 417 Market St.
CHICAGO, ILL., 19 W. Jackson Blvd.
LOS ANGELES, CALIF., 1003 Union Bank Bldg.
DENVER, COLO., 1621 Fifteenth St.
CINCINNATI, O., S.W. Cor. 3rd and Walnut Sts.
RICHMOND, VA., American National Bank Bldg.



"Oil City" Direct Draft Boiler



"Oil City" Smokeless Boiler

"OIL CITY" low pressure boilers are offered to the trade as the last word in "Heating Economy" comprising in one unit all the elements of a modern plant for steam or hot water heating, especially adapted for Schools, Office Buildings, Hotels, Churches, Club Houses, Hospitals or for any purpose where the service of a universally recognized fire box boiler of high merit is desired.

"OIL CITY" boilers are designed and constructed to meet all requirements of modern engineering as formulated by the *American Society of Mechanical Engineers*, the boiler laws of the various states and cities, and are backed by 35 years of successful practical experience.

Description—"OIL CITY" boilers are built in smokeless and straight draft types for portable and brick settings, self contained with all steel construction thoroughly braced, stayed, inspected, and tested for 15 lb. working pressure.

These boilers have large fire boxes thereby insuring ample combustion space in which heat-giving gases and air freely mix before entering tubes.

The arrangement of tubes in relation to shell allows free circulation of water at all times, together with large steam space, insuring dry steam and steady water level.

All parts of the boiler are made accessible for cleaning by the use of manholes, handholes, and wash-out plugs.

Ratings—Ratings are very conservative, only such parts of the boiler coming in actual contact with passage of the hot gases, and lying below the zone of normal water level being considered as heating surface.

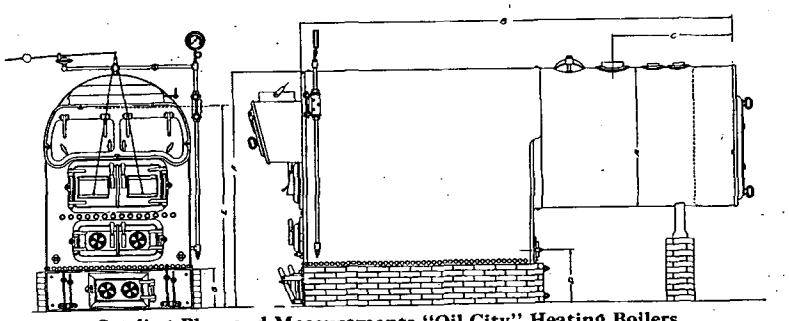
Equipment—Equipment with all boilers includes, in addition to complete set of shaking grates, all the necessary castings, safety valves, steam gauge, water column, etc., required for a complete installation.

Oil Fired—Where oil is used exclusively we recommend our new Series 9000 Portable Return Tubular Fire Box Oil Burning Boiler. Complete specifications and measurements shown in Circular H-18.

Every "OIL CITY" boiler bears the official stamp of the *A. S. M. E.* Boiler Code, indicating the pressure at which the boiler may be worked.

At a small increase in cost "OIL CITY" boilers are furnished, braced and stayed, for a safe working pressure of 100 lb. Complete specifications, measurements and weights shown in Catalog H-9.

SPECIFICATIONS AND GENERAL DIMENSIONS ON NEXT PAGE.



Settling Plan and Measurements "Oil City" Heating Boilers

"Oil City" Smokeless

NUMBER OF BOILER			307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324
CAPACITY - STEAM		Sq. Ft.	3000	3500	4000	4500	5000	5500	6000	6500	7500	8500	10000	11000	12000	13500	14000	15000	17500	20000
CAPACITY - WATER		Sq. Ft.	5000	5000	6600	7400	8300	9100	9900	10700	12400	14000	16500	18200	19800	22300	23100	24800	28900	33000
BOILER DIAMETER	A	In.	48	48	48	54	54	54	60	60	60	60	66	66	72	72	78	78	84	96
BOILER LENGTH	B	Ft & In.	9-1	10-5	11-5	10-11	11-11	12-11	12-11	13-11	15-3	16-3	15-9	17-9	16-7	17-11	17-8	18-10	19-1	19-1
REAR TO OUTLET	C	Ft & In.	3-2	3-9	4-2	3-3	3-9	4-2	3-2	3-8	3-8	4-3	3-8	4-3	5-3	5-9	5-8	6-1	6-3	7-1
FLOOR TO RETURN	D	In.	19	19	19	19	19	19	22½	22½	22½	22½	23	23	23	23	23	23	23	23
FLOOR TO WATER LINE	E	In.	71	71	71	78	78	78	87	87	87	87	90	90	96	96	97	97	105	105
HEIGHT OVER BOILER	F	Ft & In.	7-0	7-0	7-0	7-3	7-3	7-3	8-3	8-3	8-3	8-3	8-11	8-11	9-3	9-3	9-7	9-7	10-1	10-1
HEIGHT ASH PIT	G	Ft & In.	14	14	14	14	14	14	17	17	17	17	17	17	17	17	17	17	17	17
SIZE OUTLET		In.	6	6	6	6	6	6	7	7	7	7	8	8	8	8	8	8	10	10
SIZE RETURN		In.	4	4	4	4	4	4	5	5	5	5	6	6	6	6	6	6	6	6
SIZE SMOKE OUTLET		In.	10-36	10-36	10-36	10-42	10-42	10-42	12-42	12-42	12-42	12-42	15-30	15-30	17-34	17-34	17-60	17-60	20-66	20-66
DIA. BREECHING - ONE BOILER		In.	22	22	22	24	24	24	28	28	28	28	30	32	34	34	36	36	40	42
DIA. BREECHING - TWO BOILERS		In.	30	30	30	34	34	34	38	38	40	40	44	46	50	50	52	52	58	58
DIA. STACK - ONE BOILER		In.	20	20	20	22	22	22	26	26	28	28	28	30	32	32	34	34	38	40
DIA. STACK - TWO BOILERS		In.	28	28	28	30	31	31	34	34	36	36	40	42	46	46	48	48	54	54
HEIGHT STACK - ONE BOILER		Ft.	50	55	55	55	55	60	60	60	65	65	65	70	70	70	80	80	80	100
HEIGHT STACK - TWO BOILERS		Ft.	60	65	65	65	65	70	70	70	75	75	75	80	80	80	90	90	100	110
REQD TO OPEN REAR DOORS		In.	28	28	28	28	28	28	32	32	32	32	35	35	37	37	40	40	43	43

"Oil City" Direct Draft Type

NUMBER OF BOILER			307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324
CAPACITY - STEAM		Sq. Ft.	1500	1800	2500	3000	3500	4000	4500	5000	6000	7000	8000	9000	10000	12000	13500	15000	17500	20000
CAPACITY - WATER		Sq. Ft.	4400	5000	5800	6600	7400	8300	9100	9900	11600	13200	15700	16700	18500	21500	23000	25500	30000	34000
BOILER DIAMETER	A	In.	48	48	48	54	54	54	60	60	60	60	66	66	72	72	78	78	84	96
BOILER LENGTH	B	Ft & In.	8-7	9-6	11-1	10-0	11-1	12-1	12-5	13-7	14-9	16-2	15-3	17-4	15-11	17-8	17-11	19-11	20-1	22-1
REAR TO OUTLET	C	Ft & In.	3-11	4-3	4-10	4-7	4-9	5-1	4-2	4-11	5-11	6-3	6-5	7-2	6-3	6-5	6-5	7-11	7-7	9-7
FLOOR TO RETURN	D	In.	19	19	19	19	19	19	22½	22½	22½	22½	23	23	23	23	23	23	23	23
FLOOR TO WATER LINE	E	In.	71	71	71	78	78	78	87	87	87	87	90	90	96	96	97	97	105	105
HEIGHT OVER BOILER	F	Ft & In.	7-0	7-0	7-0	7-3	7-3	7-3	8-3	8-3	8-3	8-3	8-11	8-11	9-3	9-3	9-7	9-7	10-1	10-1
HEIGHT ASH PIT	G	Ft & In.	14	14	14	14	14	14	17	17	17	17	17	17	17	17	17	17	17	17
SIZE OUTLET		In.	6	6	6	6	6	6	7	7	7	7	8	8	8	8	8	8	10	10
SIZE RETURN		In.	4	4	4	4	4	4	5	5	5	5	6	6	6	6	6	6	6	6
SIZE SMOKE OUTLET		In.	10-36	10-36	10-36	10-42	10-42	10-42	12-42	12-42	12-42	12-42	15-30	15-30	17-34	17-34	17-60	17-60	20-66	20-66
DIA. BRECHING - ONE BLR.		In.	22	22	22	24	24	24	28	28	28	28	30	32	34	34	36	36	40	42
DIA. BRECHING - TWO BLRS.		In.	30	30	30	34	34	34	38	38	40	40	44	46	50	50	52	52	58	58
DIA. STACK - ONE BLR.		In.	20	20	20	22	22	22	26	26	28	28	28	30	32	32	34	34	38	40
DIA. STACK - TWO BLRS.		In.	28	28	28	30	31	31	34	34	36	36	40	42	46	46	48	48	54	54
HEIGHT STACK - ONE BLR.		Ft.	50	50	55	55	55	60	60	60	65	65	65	70	70	70	80	80	80	100
HEIGHT STACK - TWO BLRS.		Ft.	60	60	65	65	65	70	70	70	75	75	75	80	80	80	90	90	100	110
REQD TO OPEN REAR DOORS		In.	28	28	28	28	28	28	32	32	32	32	35	35	37	37	40	40	43	43

Pierce, Butler & Pierce Mfg. Corp.

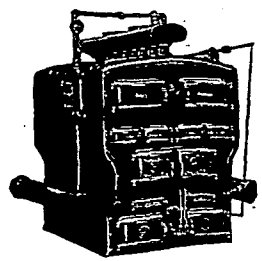
41 East 42nd St. NEW YORK CITY

Factories:
Eastwood, Syracuse and Oswego, N. Y.; Huntingdon, Pa.; Zanesville, O.

Branch Offices:
New York, Brooklyn, Syracuse, Newark, Worcester, Boston, Philadelphia, Detroit, New London, Pittsburgh

Cast iron water boilers 100 to 23,450 sq. ft. capacity. Cast iron steam boilers 325 to 14,200 sq. ft. capacity. Firebox heating boilers, capacity steam radiation 2,500 to 25,000 sq. ft.; capacity water radiation 4,000 to 40,000 sq. ft. Radiators—all types.

The Pierce-American Boiler



A 30-year record of proved successful performance

Sizes and Dimensions

No.*	Sections	Length	BOILER AND HEADERS Width	BOILER AND HEADERS Height	Height Water Line on S. B.	No. and Size, Outlets	No. and Size, Returns	Smoke Pipe Dia.	Size of Flue	Chimney Height	CAPACITY SQ. FT. Steam Boilers	CAPACITY SQ. FT. Water Boilers
214	4	47	45	56 1/8	40 1/4	2-3	2-3	9 1/2	10x10	30	600	1000
215	5	55	45	56 1/8	40 1/4	2-3	2-3	9 1/2	10x10	30	800	1325
216	6	63	45	56 1/8	40 1/4	2-3	2-3	9 1/2	10x10	35	1000	1650
265	5	55	51	64 1/2	47 1/8	2-3	2-3	11 3/4	12x12	35	1400	2325
266	6	63	51	64 1/2	47 1/8	2-4	2-4	11 3/4	12x16	35	1750	2900
267	7	71	51	64 1/2	47 1/8	2-4	2-4	11 3/4	12x16	40	2100	3475
268	8	79	51	64 1/2	47 1/8	2-4	2-4	11 3/4	16x16	40	2450	4050
325	5	55	59 1/4	67	49	2-4	2-4	14	12x16	35	1700	2825
326	6	63	59 1/4	67	49	2-5	2-5	14	12x16	40	2250	3700
327	7	71	59 1/4	67	49	2-5	2-5	14	16x16	40	2800	4625
328	8	79	59 1/4	67	49	2-5	2-5	14	16x16	45	3350	5525
329	9	87	59 1/4	67	49	2-5	2-5	14	16x20	50	3900	6450
3210	10	95	59 1/4	67	49	2-5	2-5	14	20x20	60	4450	7350
405	5	55	66 1/2	69 1/4	51	2-4	2-4	15 3/4	16x16	45	2600	4300
406	6	63	66 1/2	69 1/4	51	2-5	2-5	15 3/4	16x20	45	3250	5375
407	7	71	66 1/2	69 1/4	51	2-5	2-5	15 3/4	16x20	50	3900	6450
408	8	79	66 1/2	69 1/4	51	2-5	2-5	15 3/4	20x20	50	4550	7500
409	9	87	66 1/2	69 1/4	51	2-5	2-5	15 3/4	20x20	55	5200	8600
4010	10	95	66 1/2	69 1/4	51	2-5	2-5	15 3/4	20x20	55	5850	9650
4011	11	103	66 1/2	69 1/4	51	2-5	2-5	15 3/4	20x20	60	6500	10725
4012	12	111	66 1/2	69 1/4	51	2-5	2-5	15 3/4	20x24	60	7150	11800
466	6	68	79	82	55 1/4	2-6	2-6	19 1/4	24x24	65	5400	8925
467	7	76	79	82	55 1/4	2-6	2-6	19 1/4	24x24	70	6500	10725
468	8	84	79	82	55 1/4	2-6	2-6	19 1/4	24x24	75	7600	12550
469	9	92	79	82	55 1/4	2-6	2-6	19 1/4	24x28	80	8700	14350
4610	10	100	79	82	55 1/4	2-6	2-6	19 1/4	24x28	85	9800	16150
4611	11	108	79	82	55 1/4	2-6	2-6	19 1/4	28x28	95	10900	18000
4612	12	116	79	82	55 1/4	2-6	2-6	19 1/4	28x28	100	12000	19825
4613	13	124	79	82	55 1/4	2-6	2-6	19 1/4	28x28	105	13100	21625
4614	14	132	79	82	55 1/4	2-6	2-6	19 1/4	28x32	110	14200	23450

*Steam boilers are designated by the letter "S" before the number, as S-214, S-215, etc. Water boilers are designated by the letter "W," as W-214, W-215, etc.

All measurements are in inches, except where otherwise noted. Special sizes or location of tappings can be furnished at prices shown in discount sheet. Blank grates sections for brick fire wall to reduce size of grate will be supplied without extra charge with boiler if so ordered.

(See page 440, Valve Section)

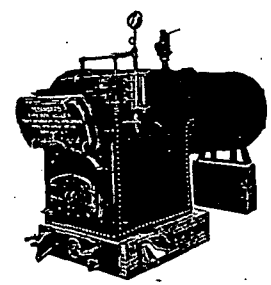
Ames Iron Works

Division of

Pierce, Butler & Pierce Manufacturing Corporation

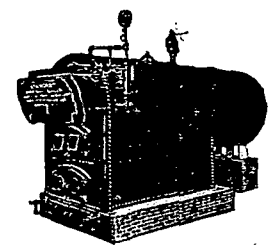
OSWEGO, N. Y.

Builders of highest grade Steel Plate Fire Tube Boilers for Power and Heating
Our Boilers are built to conform to A. S. M. E. Requirements



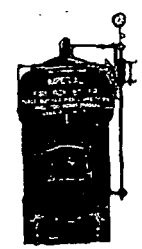
STANDARD Firebox Boiler with Plain Furnace

Our standard lines include Horizontal Tubular, Vertical, Empire Return Tubular Portable and Return Tubular Portable types of Firebox Heating Boilers with both plain and downdraft furnaces, the latter for the smokeless combustion of bituminous coal.



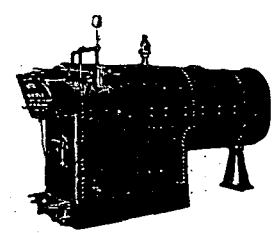
STANDARD Firebox Boiler with Downdraft Furnace

These boilers are all built at our Oswego, N. Y. plant where we have been known throughout the country as one of the leading boiler manufacturers for a period in excess of seventy years.



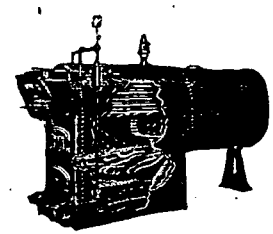
Front View IMPERIAL Firebox Boiler

We have standardized on the sizes and types of Steel Plate Firebox Boilers illustrated on the following pages to meet the exacting requirements of architects and engineers, and believe that the information given will be found of considerable value in providing location and space in building.



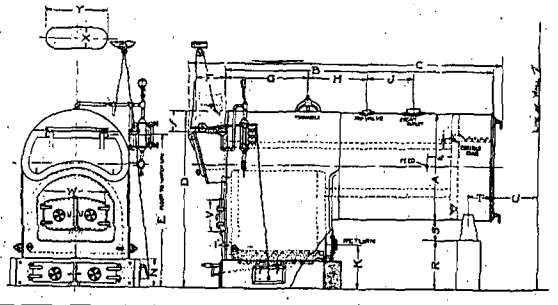
IMPERIAL Firebox Boiler with Plain Furnace

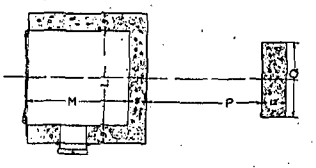
When selecting size of boiler to meet specified requirements please understand that our ratings are safe and conservative.



IMPERIAL Firebox Boiler with Downdraft Furnace

SEE FOUR FOLLOWING PAGES FOR DIMENSIONS

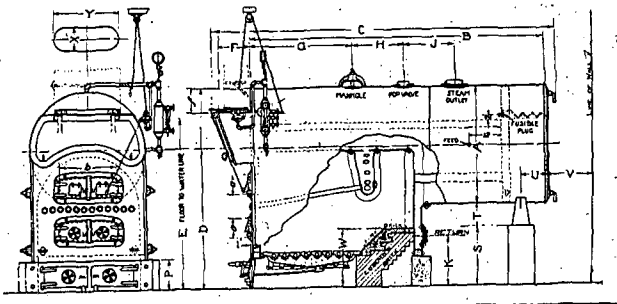


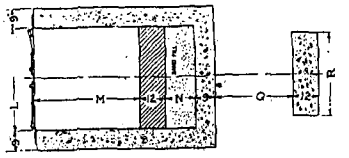


PIERCE, BUTLER & PIERCE MFG. CORP.

STANDARD Firebox Boilers with Plain Furnaces

Number of Size	810	812	813	814	815	816	818	820	823	825	827	830	833	837	840
Capacity Steam Radiation ..... sq. ft.	5150	6500	7200	7600	8250	9000	10000	11500	13000	15000	16500	18000	20000	22500	25000
Grate Area ..... sq. ft.	16.0	18.0	20.0	22.5	22.5	24.7	24.7	27.5	30.0	30.0	33.0	35.7	36.0	42.0	42.0
Heating Surface ..... sq. ft.	511	613	661	726	763	826	900	1027	1158	1255	1349	1501	1644	1877	2017
Size Steam Outlet ..... in.	6	6	6	8	8	8	8	8	8	8	8	8	10	10	10
Size Return ..... in.	4	4	4	6	6	6	6	6	6	6	6	6	6	6	6
A—Diameter Shell ..... in.	54	54	54	60	60	60	60	66	66	66	72	72	78	78	78
B—Length Shell ..... ft. in.	11-9	13-9	14-9	13- 0	13-6	14-6	15-6	14-0	15-6	16-6	15-6	17-0	15-6	17-6	18-6
C—Length Over-all ..... ft. in.	13-6	15-6	16-6	14-11	15-5	16-5	17-5	16-2	17-8	18-8	17-8	19-2	18-0	20-0	21-0
D—Height Top Shell ..... in.	89	89	89	95	95	95	95	101	101	101	111	111	119	119	119
E—Height Water-line ..... in.	76	76	76	83	83	83	83	86	86	86	93	93	103	103	103
F—Depth Smoke Box ..... in.	15	15	15	17	17	17	17	20	20	20	20	20	24	24	24
G—Location Manhole ..... in.	36	42	48	48	48	54	54	54	60	60	48	54	48	60	60
H—Location Pop Valve ..... in.	36	36	36	36	36	36	42	42	42	42	50	50	50	50	50
J—Location Steam Outlet ..... in.	24	30	30	30	30	36	36	30	36	40	45	48	48	48	48
K—Location Return ..... in.	22	22	22	23	23	23	23	23	23	23	27	27	27	27	27
L—Width Ashpit ..... in.	48	48	48	54	54	54	54	60	60	60	66	66	72	72	72
M—Length Ashpit ..... in.	52	58	64	64	64	70	70	70	76	76	76	82	76	88	88
N—Height Ashpit ..... in.	14	14	14	14	14	14	14	14	14	14	18	18	18	18	18
P—Location Rear Pier ..... in.	65	83	89	66	72	78	90	72	84	96	84	96	84	96	108
Q—Length Rear Pier ..... in.	38	38	38	38	38	38	38	44	44	44	50	50	50	50	50
R—Height Rear Pier ..... in.	24½	24½	24½	24½	24½	24½	24½	20	20	20	23	23	24	24	24
S—Height Rear Stand ..... in.	10½	10½	10½	10½	10½	10½	10½	15	15	15	16	16	17	17	17
T—Location Rear Stand ..... in.	10	10	10	12	12	12	12	12	12	12	12	12	12	12	12
U—Required to Open Rear Doors ..... in.	31	31	31	34	34	34	34	37	37	37	40	40	43	43	43
V—Height Fire Door Opening ..... in.	14¼	14¼	14¼	14¼	14¼	14¼	14¼	14¼	14¼	14¼	16	16	16	16	16
W—Width Fire Door Opening ..... in.	29¼	29¼	29¼	29¼	29¼	29¼	29¼	29¼	29¼	29¼	40	40	40	40	40
X—Width Stack Base ..... in.	11	11	11	13	13	13	13	16	16	16	16	16	20	20	20
Y—Length Stack Base ..... in.	37	37	37	43	43	43	43	48	48	48	54	54	56	56	56
f—Top Smoke Box to Top Shell ..... in.	13½	13½	13½	12¼	12¼	12¼	12¼	15¼	15¼	15¾	18½	18½	16	16	16

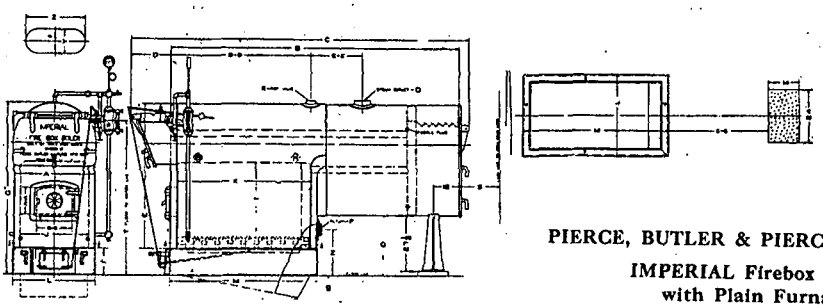




PIERCE, BUTLER & PIERCE MFG. CORP.

STANDARD Firebox Boilers with Downdraft Furnaces

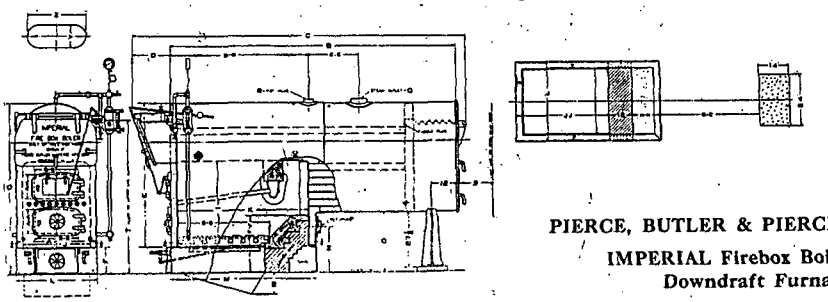
Number of Size	910	912	913	914	915	916	918	920	923	925	927	930	933	937
Capacity Steam Radiation ..... sq. ft.	5200	6100	6500	7500	8200	9000	10250	12000	13500	15250	16000	18000	20000	23500
Grate Area (A. S. M. E. Rating) ..... sq. ft.	20.0	22.5	25.0	28.1	28.1	30.9	30.9	33.7	37.5	40.6	43.7	44.6	44.6	50.3
Heating Surface ..... sq. ft.	517	597	622	718	765	831	901	1009	1154	1286	1330	1500	1662	1810
Size Steam Outlet ..... in.	6	6	6	8	8	8	8	8	8	8	8	10	10	10
Size Return ..... in.	4	4	4	6	6	6	6	6	6	6	6	6	6	6
A—Diameter Shell ..... in.	54	54	54	60	60	60	60	60	66	66	66	72	72	72
B—Length Shell ..... ft. in.	11-9	13-3	13-9	12-10	13-6	14-6	15-6	17- 0	15-6	17-0	17-6	17-0	18-6	20-0
C—Length Over-all ..... ft. in.	13-6	15-0	15-6	14- 9	15-5	16-5	17-5	18-11	17-8	19-2	19-8	19-2	20-8	22-2
D—Height Top Shell ..... in.	92	92	92	98	98	98	98	98	104	104	104	114	114	114
E—Height Water-line ..... in.	79	79	79	86	86	86	86	86	89	89	89	96	96	96
F—Depth Smoke Box ..... in.	15	15	15	17	17	17	17	17	20	20	20	20	20	20
G—Location Manhole ..... in.	48	50	56	56	54	40	40	42	45	52	56	52	48	62
H—Location Pop Valve ..... in.	24	24	24	24	24	48	48	48	48	48	48	48	48	48
J—Location Steam Outlet ..... in.	30	36	36	30	36	36	36	48	36	36	36	36	48	48
K—Location Return ..... in.	22	22	22	23	23	23	23	23	23	23	23	27	27	27
L—Width Ashpit ..... in.	48	48	48	54	54	54	54	54	60	60	60	66	66	66
M—Length Ashpit ..... in.	51	57	63	63	63	69	69	75	75	81	87	81	81	91
N—Width Sand Fill ..... in.	14	12	12	12	13	12	14	12	13	14	12	12	14	14
P—Height Ashpit ..... in.	14	14	14	14	14	14	14	14	14	14	14	18	18	18
Q—Location Rear Pier ..... in.	40	54	54	54	41	48	55	65	79	60	71	73	89	97
R—Length Rear Pier ..... in.	38	38	38	38	38	38	38	38	44	44	44	50	50	50
S—Height Rear Pier ..... in.	27½	27½	27½	27½	27½	27½	27½	27½	23	23	23	26	26	26
T—Height Rear Stand ..... in.	10½	10½	10½	10½	10½	10½	10½	10½	15	15	15	16	16	16
U—Location Rear Stand ..... in.	10	10	10	12	12	12	12	12	12	12	12	12	12	12
V—Distance to Remove 4" Tubes ..... in.	24	38	38	21	28	35	45	59	40	51	53	53	69	77
W—Height Bridge Wall ..... in.	32	32	32	36	36	36	36	36	37	37	37	41	41	41
X—Width Stack Base ..... in.	11	11	11	13	13	13	13	13	16	16	16	16	16	16
Y—Length Stack Base ..... in.	37	37	37	43	43	43	43	43	48	48	48	54	54	54
a—Height Fire Door Opening ..... in.	11¼	11¼	11¼	11¼	11¼	11¼	11¼	11¼	11¼	11¼	11¼	14	14	14
b—Width Fire Door Opening ..... in.	29¼	29¼	29¼	29¼	29¼	29¼	29¼	29¼	29¼	29¼	29¼	40	40	40
f—Top Smoke Box to Top Shell ..... in.	13½	13½	13½	12¼	12¼	12¼	12¾	12¼	15¼	15¼	15¾	18½	18½	18½



PIERCE, BUTLER & PIERCE MFG. CORP.

IMPERIAL Firebox Boilers with Plain Furnaces

Number of Size	22	27	33	40	46	52	58	65	70	75	85	95	110	120	130
Capacity Steam Radiation.....sq. ft.	2250	2750	3300	4000	4600	5200	5800	6500	7000	7500	8500	9300	11000	12000	13000
Grate Area.....sq. ft.	7.3	9.4	10.4	12.9	14.2	15.5	16.5	18.0	19.5	21.0	21.0	22.8	24.5	28.0	28.0
Heating Surface.....sq. ft.	230	280	335	386	446	499	556	604	657	699	782	888	994	1093	1181
A—Width Shell.....in.	30	30	30	36	36	36	42	42	42	42	48	48	48	54	54
B—Length Shell.....ft. in.	8-6	10-0	11-6	11-0	12-4	13-6	11-6	12-4	13-3	14- 0	12-0	13-3	14-6	14-0	14- 9
C—Length Over-all.....ft. in.	10-1	11-7	13-1	12-9	14-1	15-3	13-5	14-3	15-2	15-11	14-1	15-4	16-7	16-1	16-10
D—Depth Smoke Box Over-all.....in.	15	15	15	17	17	17	19	19	19	19	21	21	21	21	21
E—Height Boiler Only.....in.	61⅜	61⅜	61⅜	65⅝	65⅝	65⅝	75¼	75¼	75¼	75¼	82¾	82¼	82¼	86⅝	86⅝
F—Height Channel Base.....in.	12	12	12	12	12	12	12	12	12	12	15	15	15	15	15
G—Floor Line to Top Shell.....in.	73⅝	73⅝	73⅝	77⅝	77⅝	77⅝	87¼	87¼	87¼	87¼	97¾	97¾	97¾	101⅝	101⅝
H—Top Smoke Box to Top Shell..in.	9¼	9¼	9¼	8¼	8¼	8¼	11	11	11	11	12½	12½	12½	14¼	14¼
I—Height Furnace above Grates..in.	30	30	30	33	33	33	36	36	36	36	38	38	38	40	40
J—Width Furnace.....in.	25	25	25	31	31	31	36	36	36	36	42	42	42	48	48
K—Length Furnace.....in.	42	54	60	60	66	72	66	72	78	84	72	78	84	84	84
L—Width Channel Base.....in.	31⅛	31⅛	31⅛	37⅛	37⅛	37⅛	43⅛	43⅛	43⅛	43⅛	49⅛	49⅛	49⅛	55⅛	55⅛
M—Length Channel Base.....in.	48¼	60¼	66¼	66¼	72¼	78¼	74¼	80¼	86¼	92¼	80¼	86¼	92¼	92¼	92¼
N—Location Return.....in.	20½	20½	20½	20¾	20¾	20¾	21	21	21	21	21⅛	21⅛	21⅛	22⅛	22⅛
O—Floor Line to Bottom Shell....in.	27½	27½	27½	27⅝	27⅝	27⅝	30⅛	30⅛	30⅛	30⅛	29¼	29¼	29¼	31¾	31¾
P—Size Return.....in.	3	3	3	4	4	4	4	4	4	4	5	5	5	6	6
Q—Size Steam Outlet.....in.	5	5	5	6	6	6	6	6	6	6	7	7	7	8	8
R—Size Pop Valve.....in.	2½	3	3	3	3½	3½	3½	3½	4	4	4	4	4½	4½	4½
S—Required to Open Rear Doors..in.	35	35	35	39	39	39	25	25	25	25	28	28	28	31	31
T—Height Water-line.....in.	64⅜	64⅜	64⅜	69⅛	69⅛	69⅛	76½	76½	76½	76½	85½	85½	85½	87⅞	87⅞
Y—Width Stack Base.....in.	9	9	9	11	11	11	13	13	13	13	15	15	15	15	15
Z—Length Stack Base.....in.	22	22	22	27	27	27	32	32	32	32	37	37	37	42	42
AA—Height Fire Door Opening....in.	12	12	12	12	12	12	12	12	12	12	14	14	14	13	13
BB—Width Fire Door Opening....in.	16	16	16	16	16	16	20	20	20	20	24	24	24	28	28
CC—Location Rear Pier.....in.	33¾	39¾	51¾	45¼	55¾	63¾	44¼	48¼	53¼	56¼	44¼	53¼	62¼	56¼	65¼
DD—Location Pop Valve.....in.	43	55	61	61	67	73	68	74	80	86	74	80	86	86	86
EE—Location Steam Outlet.....in.	22	24	32	26	34	36	26	30	32	34	26	32	36	48	48



PIERCE, BUTLER & PIERCE MFG. CORP.

IMPERIAL Firebox Boilers with Downdraft Furnaces

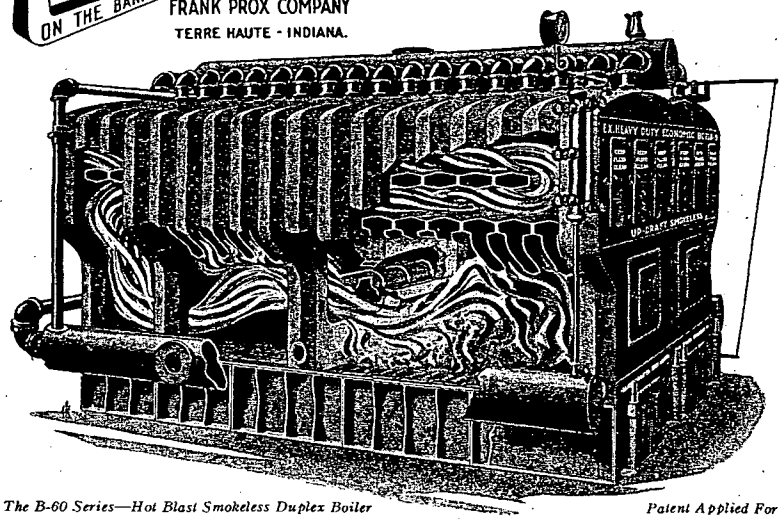
Number of Size	22	27	33	40	46	52	58	65	70	75	85	95	110	120	130
Capacity Steam Radiation.....sq. ft.	2250	2750	3300	4000	4600	5200	5800	6500	7000	7500	8500	9500	11000	12000	13000
Grate Area (A. S. M. E. Rating)...sq. ft.	6.4	9.0	10.3	11.3	12.9	14.5	15.0	16.9	18.8	20.6	19.7	21.9	24.1	27.5	27.5
Heating Surface.....sq. ft.	230	280	335	386	446	499	556	604	657	699	782	888	994	1093	1181
A—Width Shell.....in.	30	30	30	36	36	36	42	42	42	42	48	48	48	54	54
B—Length Shell.....ft. in.	8-6	10-0	11-6	11-0	12-4	13-6	11-6	12-4	13-3	14- 0	12-0	13-3	14-6	14-0	14- 9
C—Length Over-all.....ft. in.	10-1	11-7	13-1	12-9	14-1	15-3	13-5	14-3	15-2	15-11	14-1	15-4	16-7	16-1	16-10
D—Depth Smoke Box Over-all....in.	15	15	15	17	17	17	19	19	19	19	21	21	21	21	21
E—Height Boiler Only.....in.	61⅜	61⅜	61⅜	65⅝	65⅝	65⅝	75¼	75¼	75¼	75¼	82¾	82¼	82¼	86⅝	86⅝
F—Height Channel Base.....in.	12	12	12	12	12	12	12	12	12	12	15	15	15	15	15
G—Floor Line to Top Shell.....in.	73⅝	73⅝	73⅝	77⅝	77⅝	77⅝	87¼	87¼	87¼	87¼	97¾	97¾	97¾	101⅝	101⅝
H—Top Smoke Box to Top Shell..in.	9¼	9¼	9¼	8¼	8¼	8¼	11	11	11	11	12½	12½	12½	14¼	14¼
I—Hgt. Furn. above L'w'r Grates.in.	30	30	30	33	33	33	36	36	36	36	38	38	38	40	40
J—Width Furnace.....in.	25	25	25	31	31	31	36	36	36	36	42	42	42	48	48
K—Length Furnace.....in.	42	54	60	60	66	72	66	72	78	84	72	78	84	84	84
L—Width Channel Base.....in.	31⅛	31⅛	31⅛	37⅛	37⅛	37⅛	43⅛	43⅛	43⅛	43⅛	49⅛	49⅛	49⅛	55⅛	55⅛
M—Length Channel Base.....in.	48¼	60¼	66¼	66¼	72¼	78¼	74¼	80¼	86¼	92¼	80¼	86¼	92¼	92¼	92¼
N—Location Return.....in.	20½	20½	20½	20¾	20¾	20¾	21	21	21	21	21⅛	21⅛	21⅛	22⅛	22⅛
O—Floor Line to Bottom Shell....in.	27½	27½	27½	27⅝	27⅝	27⅝	30⅛	30⅛	30⅛	30⅛	29¼	29¼	29¼	31¾	31¾
P—Size Return.....in.	3	3	3	4	4	4	4	4	4	4	5	5	5	6	6
Q—Size Steam Outlet.....in.	5	5	5	6	6	6	6	6	6	6	7	7	7	8	8
R—Size Pop Valve.....in.	2½	3	3	3	3½	3½	3½	3½	4	4	4	4	4½	4½	4½
S—Required to Open Rear Doors..in.	35	35	35	39	39	39	25	25	25	25	28	28	28	31	31
T—Height Water-line.....in.	64⅜	64⅜	64⅜	69⅛	69⅛	69⅛	76½	76½	76½	76½	85½	85½	85½	87⅞	87⅞
Y—Width Stack Base.....in.	9	9	9	11	11	11	13	13	13	13	15	15	15	15	15
Z—Length Stack Base.....in.	22	22	22	27	27	27	32	32	32	32	37	37	37	42	42
AA—Height Fire Door Opening....in.	11	11	11	11	11	11	11	11	11	11	11¼	11¼	11¼	11¼	11¼
BB—Width Fire Door Opening....in.	20	20	20	20	20	20	20	20	20	20	29¼	29¼	29¼	29¼	29¼
CC—Location Rear Pier.....in.	33¾	39¾	51¾	45¼	55¾	63¾	44¼	48¼	53¼	56¼	44¼	53¼	62¼	56¼	65¼
DD—Location Pop Valve.....in.	43	55	61	61	67	73	68	74	80	86	74	80	86	86	86
EE—Location Steam Outlet.....in.	22	24	32	26	34	36	26	30	32	34	26	32	36	48	48
FF—Height Bridge Wall.....in.	28	28	28	28	28	28	30	30	30	30	29	29	29	35	35
GG—Length Lower Grates.....in.	30	42	48	42	48	54	48	54	60	66	54	60	66	66	66
HH—Width Sand Fill.....in.	5	5	5	11	11	11	12	12	12	12	12	12	12	12	12
JJ—Location Bridge Wall.....in.	31½	43½	49½	43½	49½	55½	50	56	62	68	56	62	68	68	68

PROX
ON THE BANKS OF THE WABASH — SINCE 1854
FRANK PROX COMPANY
TERRE HAUTE - INDIANA.

HOT BLAST SMOKELESS
Continuous Service Type Boilers

Made in

SIX SERIES
Steam Capacities, 1200 to 25,000 sq. ft.



The B-60 Series—Hot Blast Smokeless Duplex Boiler *Patent Applied For*

6 POINTS Paramount In Choosing Boilers

1—Continuous Service—Any heating plant will break if carelessly operated. Broken sections in Prox Boilers can be plugged off and heat maintained, avoiding dismissal of school or closing of building.

2—Fuel Economy—Short wide firebox design, full three-layer fire travel, very low stack temperature, large self-cleaning flues, conservative ratings, ideal design for perfect combustion with soft coals.

3—Long Service—Safety—Prox Cast Sectional Boilers represent maximum permanence.

4—Quick Dry-Steaming—Low water-line, small waterways, quick circulation, dry steam assured by steam separating header over Prox Boilers.

5—Repair Economy—Remove any sections like tilting book from bookcase. Other boilers must be torn down and expensive covering destroyed.

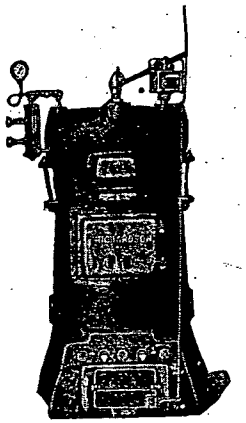
6—Installation Economy—Take flow direct from large steam separating header, saving extra cost of additional header construction necessary to get dry steam with other boilers.

PROX BOILERS—World's best for large installations in Schools, Theatres, Apartments, Churches, Hospitals, Hotels, etc.

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PITTSBURG
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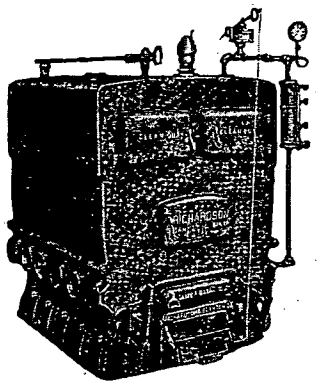
Richardson Round Boiler

RICHARDSON ROUND BOILER
Ratings and Dimensions

Boiler Number	8 Hr. Rating Sq. Ft. Steam	8 Hr. Rating Sq. Ft. Water	Nom. Diam. Grate, In.	Grate Area, Sq. Ft.	Height to Top Outlet, In.		Height Waterline, In.	No. Inlets and Outlets and Size, In.
					Steam	Water		
190	300	500	19	1.97	47½	45¼	42½	2-2½
191	350	575	19	1.97	51½	49¼	46½	2-2½
192	375	625	19	1.97	55½	53¼	50½	2-2½
221	450	750	22	2.64	53	50¼	48¼	2-2½
222	500	825	22	2.64	57	54½	52¼	2-2½
223	550	900	22	2.64	61	58½	56¼	2-2½
251	625	1025	25	3.41	54¼	52	49½	2-3
252	675	1100	25	3.41	58¼	56	53½	2-3
253	725	1200	25	3.41	62¼	60	57½	2-3
281	875	1350	28	4.28	55¾	53¼	51	2-3½
282	950	1550	28	4.28	59¾	57¼	55	2-3½
283	1025	1675	28	4.28	63¾	61¼	59	2-3½

RICHARDSON SECTIONAL BOILER
Ratings and Dimensions

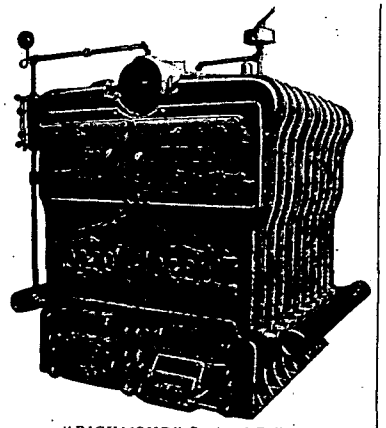
Boiler Number	8 Hr. Rating Sq. Ft. Steam	8 Hr. Rating Sq. Ft. Water	Grate Area, Sq. Ft.	Height to Top Outlet, In.	Height Waterline, In.	Ashpit, Inside, In.	No. Outlets and Size, In.
255	1000	1600	4.57	55	48¼	27½x35½	2-3½
256	1250	2000	5.70	55	48¼	27½x42¾	2-3½
257	1500	2400	6.83	55	48¼	27½x50	2-3½
258	1700	2800	7.97	55	48¼	27½x57¼	2-3½
355	1950	3125	7.85	63	56	39 x33¾	2-4
356	2400	3850	9.81	63	56	39 x41½	2-4
357	2850	4575	11.75	63	56	39 x50	3-4
358	3300	5300	13.70	63	56	39 x58¼	3-4
359	3750	6025	15.65	63	56	39 x66½	3-4
427	3500	5600	13.82	66	60	45 x50	2-5
428	4050	6500	16.11	66	60	45 x58¼	2-5
429	4600	7400	18.40	66	60	45 x66½	2-5
4210	5150	8300	20.69	66	60	45 x74¼	3-5
4211	5700	9200	22.98	66	60	45 x83	3-5
536	6300	10000	18.94	82	70½	55 x55	2-6
537	7300	11600	22.68	82	70½	55 x65¼	2-6
538	8300	13200	26.40	82	70½	55 x76½	3-6
539	9300	14800	30.12	82	70½	55 x87¼	3-6
5310	10300	16400	33.88	82	.....	55 x98	3-6



Richardson Sectional Boiler

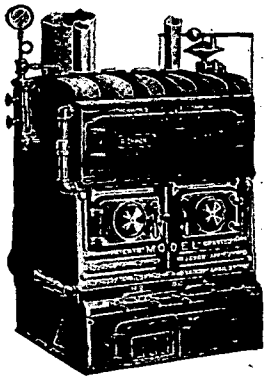
RICHMOND RADIATOR COMPANY

1480 Broadway, NEW YORK
460 Park Square Bldg., BOSTON
Cedar Ave. and Ashland Road, CLEVELAND
568 Wrigley Bldg., CHICAGO
2241 N. American St., PHILADELPHIA
217 North 6th St., HARRISBURG, PA.



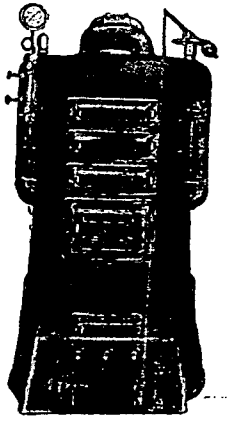
"RICHMOND" Sectional Boiler

Made in sizes: 4800 to 12000 sq. ft. for Steam; 7925 to 19800 sq. ft. for Hot Water.



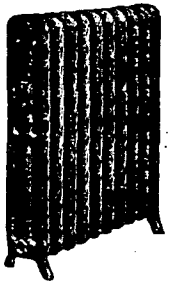
"MODEL" Sectional Boiler

Made in sizes: 350 to 5850 sq. ft. for Steam; 575 to 9650 sq. ft. for Hot Water.



"RICHMOND" Round Boiler

Made in sizes: 400 to 1425 sq. ft. for Steam; 675 to 2350 sq. ft. for Hot Water.



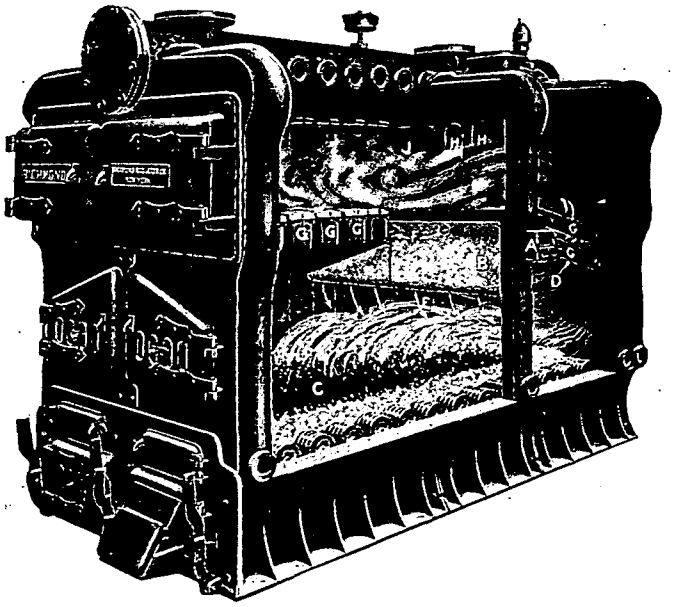
RICHMOND "TUSCAN" Radiators

Made in 1, 2, 3, 4 and 6 columns, window, indirect and wall patterns.

CATALOGS OF BOILERS AND RADIATORS UPON REQUEST

RICHMOND RADIATOR COMPANY

"RICHMOND" SMOKELESS BOILERS BURN COAL SMOKELESSLY



OPERATION OF BOILER

A—Air Intake (1 on each side).
B—Patented Heat Holding and Fire Resistent Fire Brick Arch.
C—Coal and Fire on Primary Grate.
D—Secondary Grate where unburned gases are consumed.
E—Point at which oxygen is supplied for perfect combustion of gases.
F—Gas escaping openings in upper part of fire arch.
G—Overhanging fire surfaces.
H—Flues in which products of combustion travel from rear to front of boiler.
J—Flues in which products of combustion travel to rear of boiler.

Fresh air is drawn through air intakes on either side of boiler, mixes directly with fuel gases, forming a mixture which is instantaneously ignited and in rear chamber bursts into an intense flame changing all smoke particles into colorless carbon dioxide.

MEETS THE REQUIREMENTS OF THE MOST RIGID SMOKE ORDINANCES

Many other interesting points of this boiler are adequately presented in Catalog which will be sent on request.

Made in sizes 4800 to 12000 sq. ft. for Steam.
Made in sizes 7925 to 19800 sq. ft. for Water.

The H. B. Smith Company

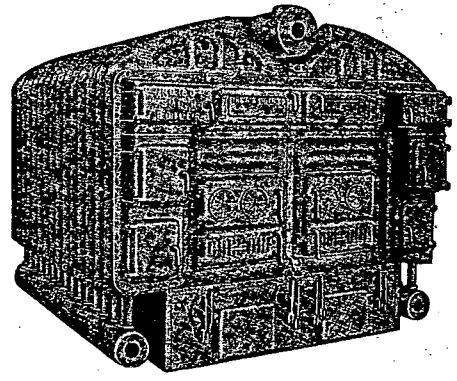
Works: Westfield, Mass.

WESTFIELD, MASS. 57 Main Street

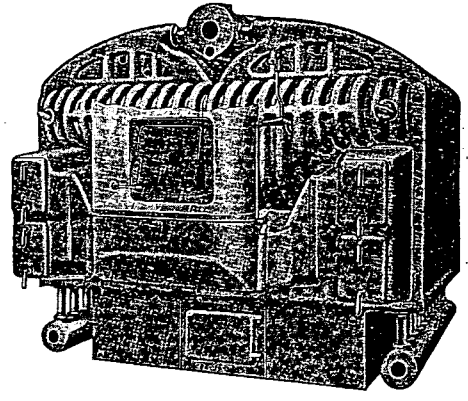
NEW YORK, 10 East 39th Street — BOSTON, 640 Main Street, Cambridge

CLEVELAND, 1108 Webster Avenue, S.E. — PHILADELPHIA, 17th and Arch Streets

Manufacturers of Boilers and Radiators for Steam and Water Heating



No. 60 Smith Boiler—Front



No. 60 Smith Boiler—Back

SMITH SMOKELESS BOILERS

For Anthracite Coal, Oil, Gas, Coke and all Bituminous Coals.
When Bituminous Coal contains over 22½% volatile Oxygen Torch should be installed.
With Oxygen Torch

No. of Sections in Boiler	Nominal Size of Fire Pot, Inches: Width	Nominal Size of Fire Pot, Inches: Length	Total Length of Boiler Inches	Length at Foundation, Inches	Steam Rating, Feet	Water Rating, Feet
No. 27						
10	27	36	77	62	2,700	4,450
11	27	42	83	68	3,000	4,950
12	27	48	89	74	3,300	5,450
13	27	54	95	80	3,600	5,950
14	27	60	101	86	3,900	6,425
15	27	66	107	92	4,200	6,925
16	27	72	113	98	4,500	7,425
No. 36						
11	36	42	87	68	4,300	7,100
12	36	48	93	74	4,800	7,925
13	36	54	99	80	5,300	8,750
14	36	60	105	86	5,800	9,575
15	36	66	111	92	6,300	10,400
16	36	72	117	98	6,800	11,225
17	36	78	123	104	7,300	12,050
18	36	84	129	110	7,800	12,875
No. 60						
12	60	42	110	73	10,800	17,800
13	60	48	116	79	12,000	19,800
14	60	54	122	85	13,200	21,800
15	60	60	128	91	14,400	23,750
16	60	66	134	97	15,600	25,750
17	60	66	140	103	16,800	27,700
18	60	72	146	109	18,000	29,700
19	60	78	152	115	19,200	31,700
20	60	78	158	121	20,400	33,650

No. of Sections in Boiler	Nominal Size of Fire Pot, Inches: Width	Nominal Size of Fire Pot, Inches: Length	Total Length of Boiler Inches	Length at Foundation, Inches	Steam Rating, Feet	Water Rating, Feet
No. 27						
5	27	24	47	32	1,200	1,975
6	27	30	53	38	1,500	2,475
7	27	36	59	44	1,800	2,975
8	27	42	65	50	2,100	3,475
9	27	48	71	56	2,400	3,950
10	27	54	77	62	2,700	4,450
11	27	60	83	68	3,000	4,950
12	27	60	89	74	3,300	5,450
12	27	66	89	74	3,300	5,450
13	27	66	95	80	3,600	5,950
13	27	72	95	80	3,600	5,950
14	27	66	101	86	3,900	6,425
14	27	78	101	86	3,900	6,425
No. 36						
7	36	36	63	44	2,300	3,800
8	36	42	69	50	2,800	4,625
9	36	48	75	56	3,300	5,450
10	36	54	81	62	3,800	6,275
11	36	60	87	68	4,300	7,100
12	36	60	93	74	4,800	7,925
12	36	66	93	74	4,800	7,925
13	36	66	99	80	5,300	8,750
13	36	72	99	80	5,300	8,750
14	36	66	105	86	5,800	9,575
14	36	78	105	86	5,800	9,575
15	36	72	111	92	6,300	10,400
15	36	84	111	92	6,300	10,400
No. 60						
8	60	36	86	49	6,000	9,900
9	60	42	92	55	7,200	11,900
10	60	48	98	61	8,400	13,850
11	60	54	104	67	9,600	15,850
12	60	60	110	73	10,800	17,800
13	60	66	116	79	12,000	19,800
14	60	72	122	85	13,200	21,800
15	60	78	128	91	14,400	23,750
16	60	84	134	97	15,600	25,750
17	60	78†	140	103	16,800	27,700
18	60	84†	146	109	18,000	29,700
19	60	84†	152	115	19,200	31,700
20	60	84†	158	121	20,400	33,650

NOTE—For additional data pertaining to these boilers, see table at bottom of opposite column.

Additional Data Applying to Boilers Both With and Without Smokeless Furnace

Boiler No.	27	36	60
Width at foundation	35″	48¼″	72″
Width of boiler, steam	56″	72″	98″
Width of boiler, water	59″	76″	98″
Height of boiler	80″	83″	87″
Height of water line	57″	59″	66″
Oval smoke pipe equivalent to	13¾″ round	17″ round	26″ round

Tappings Supply Drum*

Outside diameter.....12 in.
Tapped for 2-in. lock-nut nipples. Front end tapped 2 in. Rear end tapped one 4 in. and one 2 in.

Tappings on Top

Number of Sections	Size of Tappings: 4″	5″	6″	8″
	Number of Tappings			
8	2		2	
9	2		2	
10		2		2
11		2		2
12		2		2
13		2		2
14		2		3
15		2		3
16		2		3
17		2		3
18		2		3
19		2		3
20		2		3

Return Drums*

Steam Boilers

Outside diameter.....8 in.
Tapped for 2-in. lock-nut nipples.
Front ends tapped.....2½ in.
Rear ends tapped.....5 in.
Undersides tapped.....1¼ in.

Fire Tools Furnished

Poker, hoe, slice bar, flue brush with handle and ash shovel.

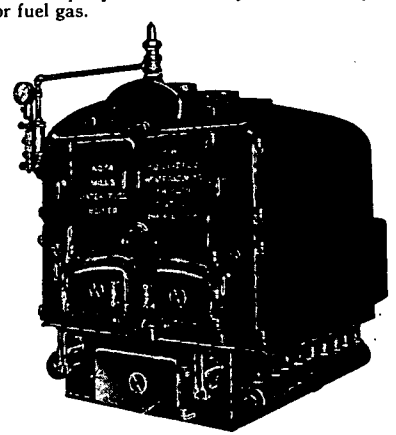
Trimmings Furnished with Steam Boilers

Water column, gage cocks, water gage cocks, water gage glass, steam gage (with cock), steam gage siphon. Damper regulator complete with chain.

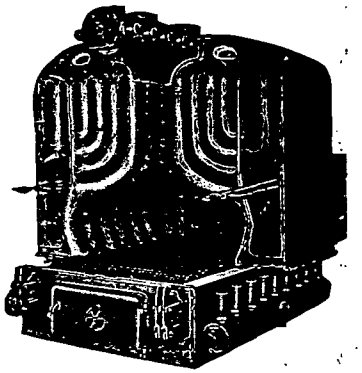
*When boiler is to be used for water warming, specify on order the size of supply and return pipe tappings. Tappings other than those listed are special. Order must specify size.

Mills Water Tube Steam and Water Boilers

Sectional cast iron boilers which are moderate in first cost, low maintenance and extremely economical in fuel. Sectional view shows large combustion chamber and vertical waterways of small area. The latter absorb the heat quickly, circulate the water rapidly and make dry steam. May be fired with anthracite coal, wood, coke or fuel gas.



No. 44 Mills Steam Boiler

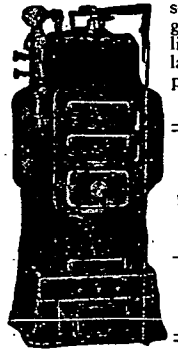


No. 44 Mills Boiler—Interior

Size of Boiler	Nominal Width Fire Pot Inches	Commercial Rating—Capacity in Sq. Ft.		Max. Allowable Working Presser		
		Steam	Water	Steam	Water (Open Tank)	Water (Closed Tank)
No. 24	24	900 to 2025	1500 to 3350	15 lb.	30 lb.	15 lb.
No. 34	34	2000 to 5200	3300 to 8575	15 lb.	30 lb.	15 lb.
No. 44	44	3600 to 9000	5950 to 14,850	15 lb.	30 lb.	15 lb.
No. 48	48	4800 to 12,000	7925 to 19,800	15 lb.	60 lb.	30 lb.

H-B Steam and Water Boilers

H-B Boilers have three waterways between sections. They are the only boilers in which ascending and descending currents of water are circulated through separate connections, giving a steady water line and rapid circulation without back pressure.



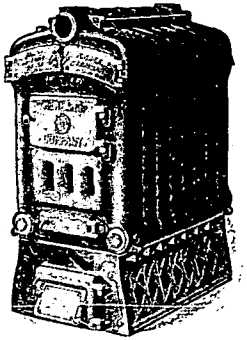
Commercial Ratings

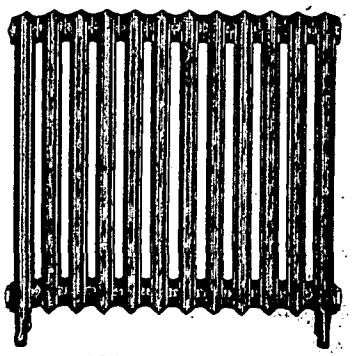
Diam. of Fire Pot Inches	Steam Rating Feet	Water Rating Feet
15 to 27	250 to 1000	425 to 1650

17 Hy-Test Boiler

For Hot Water Supply
A. S. M. E. Standard

Maximum allowable working pressure, 120 lb. Open Tank; 80 lb. Closed Tank.





"Princess" Water Radiator

Princess Direct Radiators

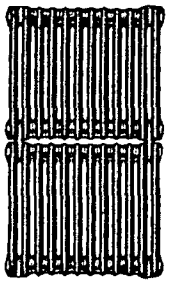
For sanitary reasons, radiators with wide spacing should be demanded.

If ordinary radiators are not sanitary enough for hospitals, they are not sanitary for the home. To meet hospital specifications some manufacturers make special radiators with wide spacing and charge an increased price.

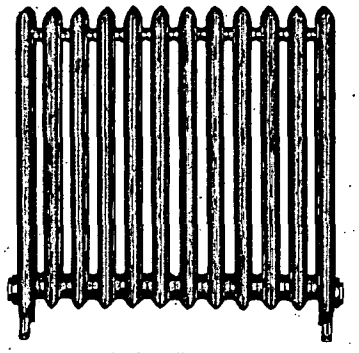
Princess Radiators are the standard radiators of The H. B. Smith Co. and are sold at regular list prices.

Princess Wall Radiators

Suited for all places where direct radiators or pipe coils cannot be used. Especially desirable in locations where floor space is valuable and where wall, column or ceiling space is more available. They possess extreme flexibility of size and arrangement. Made in two heights, 15 and 22 in. Can be furnished with heating surfaces from 5 sq. ft. up, in multiples of 2½ sq. ft. Corresponding lengths in 22 in. radiator are from 9 in. up, in multiples of 4 in. (1 in. allowed in over all length for plugs and bushings). In the 15 in. radiator, corresponding lengths are from 13 in. up, in multiples of 6 in. By combinations of the two heights, these radiators can be arranged in tiers, either for horizontal runs or for column work. Hung horizontally, they make excellent ceiling radiators.



"Princess" Wall Radiator



"Princess" Steam Radiator

Standard Heater Company

Williamsport, Pa.

NEW YORK BOSTON PHILADELPHIA BALTIMORE BUFFALO ROCHESTER
SYRACUSE SCHENECTADY HARRISBURG SCRANTON

Builders of Spencer Heaters

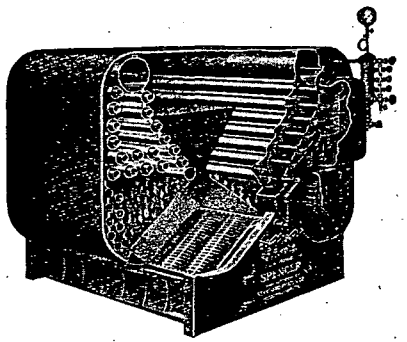
SPENCER HEATERS

Give uniform heat over long periods and use small size hard coal with least attention to the fire.

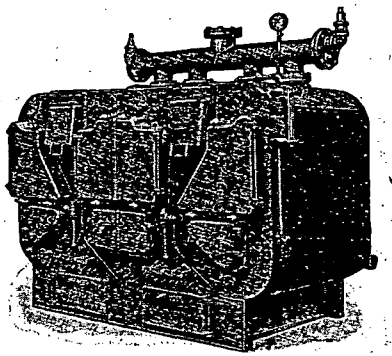
The magazine-feed feature is built into the heater and requires no adjustment. The magazine holds a supply of coal sufficient for 8 to 12 hours in severe weather or for a proportionately longer period in milder weather.

Spencer Heaters are economical and efficient.

Due to the magazine-feed feature of the Spencer Heater it is impracticable to obtain a firing period of less than 8 hours. Therefore ratings of Spencer Heaters are based upon an evaporation of 8 lbs. of water per lb. of coal burned, the rated evaporation having been obtained in actual test using fresh mined No. 1 Buckwheat coal as fuel.



50 Series. Spencer Tubular Heater



100 Series. Spencer Tubular Heater

SPENCER TUBULAR STEAM HEATERS

	Heater Number	Rating Sq. Ft. Radiation	Fire Surface Sq. Ft.	Heating Surface Sq. Ft.	Tapping Flow	Tapping Return	Overall Length Ins.	Overall Width Ins.	Water Line Ins.	Draft to Develop Rating Ins. H_2O	Size Chimney Flue
50 Series	15	2,000	12.00	282	2-4"	2-3"	71	60	56	.23	16"x16"x50"
	17	2,500	13.50	309	2-4"	2-3"	77	60	56	.24	16"x16"x55"
	19	3,000	15.00	337	2-4"	2-3"	83	60	56	.25	16"x16"x60"
	20	3,500	16.50	365	2-4"	2-3"	89	60	56	.26	16"x16"x65"
	21	4,000	18.00	393	2-4"	2-3"	95	60	56	.27	16"x16"x65"
	3-45	4,500	18.05	389	2-5"	1-4"	107¾	81	59	.24	18"x18"x50"
	3-50	5,000	20.24	429	2-5"	1-4"	114	81	59	.25	18"x18"x55"
	3-55	5,500	22.56	468	2-5"	1-4"	120½	81	59	.26	18"x18"x60"
	3-60	6,000	24.83	506	2-5"	1-4"	126½	81	59	.27	18"x18"x65"
	3-70	7,000	27.00	547	2-5"	1-4"	132¼	81	59	.28	18"x18"x70"
100 Series	3-80	8,000	30.35	560	1-8"	1-4"	101½	118½	66	.27	20"x20"x65"
	3-90	9,000	34.70	621	1-8"	1-4"	107¾	118½	66	.28	20"x20"x65"
	3-105	10,500	39.05	683	1-8"	1-4"	114	118½	66	.29	22"x22"x65"
	3-120	12,000	43.40	745	1-8"	1-4"	120¼	118½	66	.30	24"x24"x70"
	3-140	14,000	47.75	807	1-8"	1-4"	126½	118½	66	.32	24"x24"x70"
	3-160	16,000	52.10	869	1-8"	1-4"	132¼	118½	66	.34	24"x24"x70"

Heaters No. 3-45 to 3-160 are furnished with steel jackets and 1½ in. Rockwool asbestos covering, also pipe header.

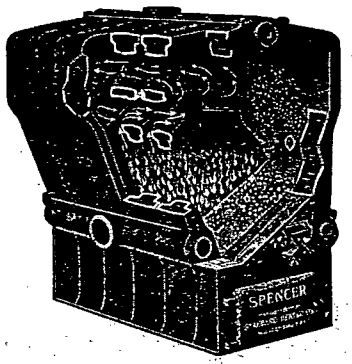
Heaters No. 15-21 are furnished with steel jackets only.

Chimney Flue sizes are based on a maximum Flue Temperature at Boiler Smoke outlet of 500 deg. fahr.

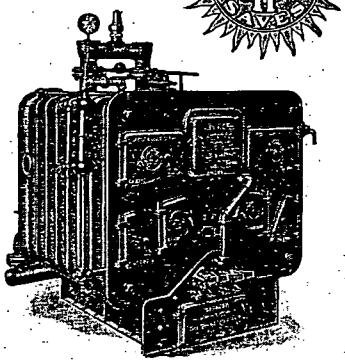
SPENCER HEATERS are adaptable for residences, apartment houses, churches, schools, public and commercial buildings, theatres, green houses, garages and all other types of buildings heated by low pressure steam, vapor, or hot water.

For over 25 years SPENCER HEATERS have been tried and tested under the most severe climatic conditions. There are thousands of successful installations throughout the entire country.

Write for illustrated catalog containing complete information.



15" Series. Spencer Sectional Heater



No. 2 Series. Spencer Sectional Heater

SPENCER SECTIONAL STEAM HEATERS

Heater Number	Rating Sq. Ft. Radiation	Fire Surface Sq. Ft.	Tapping Flow	Tapping Return	Overall Length Ins.	Overall Width Ins.	Water Line Ins.	Draft to Develop Rating Ins. H_2O	Size Chimney Flue
154-S	375	2.29	1-4"	2-3"	33	33½	49	0.16	8"x 8"x30"
155-S	500	3.02	1-4"	2-3"	39½	33½	49	0.16	8"x 8"x30"
156-S	625	3.78	1-4"	2-3"	47	33½	49	0.17	10"x10"x35"
157-S	750	4.54	2-4"	4-3"	54	33½	49	0.18	10"x10"x35"
158-S	900	5.30	2-4"	4-3"	62	33½	49	0.20	10"x10"x40"
2-5	1,000	4.51	2-4"	2-4"	63¾	57⅝	50	0.15	10"x10"x30"
2-6	1,300	5.64	2-4"	2-4"	70	57⅝	50	0.17	10"x10"x35"
2-7	1,600	6.77	2-4"	2-4"	76¼	57⅝	50	0.18	12"x12"x35"
2-8	2,000	7.90	2-4"	2-4"	82½	57⅝	50	0.19	12"x12"x35"
2-9	2,400	9.03	2-4"	2-4"	88¾	57⅝	50	0.20	12"x12"x35"
2-10	2,800	10.16	2-4"	2-4"	95	57⅝	50	0.21	12"x12"x40"
2-11	3,200	11.28	2-4"	2-4"	101¼	57⅝	50	0.21	12"x12"x40"

SPENCER SECTIONAL WATER HEATERS

15-4-W	600	2.29	1-4"	2-3"	33	33½	.....	0.16	8"x8"x30"
15-5-W	800	3.02	1-4"	2-3"	39½	33½	.....	0.16	8"x8"x30"
15-6-W	1,000	3.78	1-4"	2-3"	47	33½	.....	0.17	10"x10"x35"
15-7-W	1,200	4.54	2-4"	4-3"	54	33½	.....	0.18	10"x10"x35"
15-8-W	1,400	5.30	2-4"	4-3"	62	33½	.....	0.20	10"x10"x40"
2-6-W	2,100	5.64	2-4"	2-4"	70	57⅝	.....	0.17	10"x10"x35"
2-7-W	2,600	6.77	2-4"	2-4"	76¼	57⅝	.....	0.18	12"x12"x35"
2-8-W	3,200	7.90	2-4"	2-4"	82¼	57⅝	.....	0.19	12"x12"x35"
2-9-W	3,800	9.03	2-4"	2-4"	88¾	57⅝	.....	0.20	12"x12"x35"
2-10-W	4,500	10.16	2-4"	2-4"	95	57⅝	.....	0.21	12"x12"x40"
2-11-W	5,100	11.28	2-4"	2-4"	101¼	57⅝	.....	0.21	12"x12"x40"

The Sims Company

ERIE, PA.

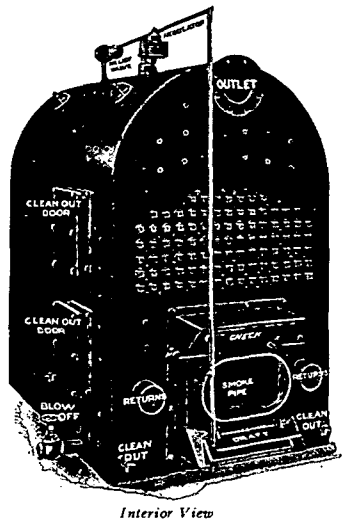
Makers of

"SIMCO" - STEAM BOILERS - WATER HEATERS - GARBAGE BURNERS

"SIMCO" boilers for low-pressure steam and water heating are internally fired water-tube type of electrically welded steel construction and designed to burn any fuel—coal, wood, gas or oil. To secure proper combustion and high heat absorption, "SIMCO" boilers are proportioned carefully as to the relation of grate area to heating surface, combustion chamber size and fire travel. All materials used are of superior quality, construction is according to *A. S. M. E.* boiler Code and every boiler is tested under 120 lb. hydrostatic pressure.

The rated capacity of "SIMCO" boilers is based on proper stack conditions and those recommended in the accompanying table should be followed.

When the "SIMCO" is used for heating water, always figure on the maximum quantity to be used per hour. For instance: if the maximum demand is 1,000 gallons per hour, select R-6. When a storage tank is used, select one having one-half more storage capacity than the maximum demand per hour. The bottom of a horizontal tank should if possible be as high as the top of the boiler. If vertical, it may set on the level of the bottom of the boiler.



Interior View

RATINGS

For radiation duty are based on 8-hour firing periods with anthracite coal of good quality. Any "SIMCO" Boiler will carry its full rated load in direct C. I. Radiation when properly installed and operated. Steam Radiation, 240 B.t.u. per sq. ft. per hour. Water radiation, 165 B.t.u. per sq. ft. per hour. Extra capacity must be allowed for exposed piping, pipe coil radiators, indirect radiation, extreme weather and exposure also for buildings that are heated intermittently.

For Hot Water Supply are based on intermittent firing periods with either hard or run-of-mine soft coal about 12 lbs. of coal per sq. ft. of grate surface per hour. A tank of ample storage capacity should be provided. Any "SIMCO" Boiler will heat the number of gallons of water shown in accompanying table when properly installed and operated.

TABULATION FOR "SIMCO" STEAM BOILERS AND WATER HEATERS

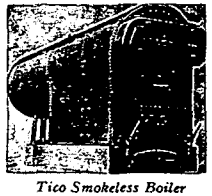
No.	Steam, Sq. Ft. Direct Radiation	Water, Sq. Ft. Direct Radiation	Water Heater G. P. H. 50°-180°	Water Heater G. P. H. 50°-150°	List Price	Weight	Length	Width	Height	Steam Boiler Height to Water Line	Supply	Two Return Connections	Grate Surface Sq. Ft.	Heating Surface Sq. Ft.	Smoke Connections Diameter	Minimum Size Chimney
R-1	750	1250	300	400	$500.00	2000	42"	30"	58"	44"	4"	2"	3	60	9"	10"x40'
R-2	1000	1700	400	520	540.00	2200	47"	30"	58"	44"	4"	2"	4	80	9"	10"x40'
R-3	1500	2500	500	650	585.00	2500	52"	30"	58"	44"	4"	2"	5	100	9"	10"x40'
R-4	1800	3000	600	780	705.00	3000	57"	34"	58"	44"	5"	3"	6	120	12"	12"x50'
R-5	2000	3300	700	910	780.00	3500	67"	34"	58"	44"	5"	3"	7	140	12"	12"x50'
R-6	2300	3800	800	1040	830.00	4000	77"	34"	58"	44"	5"	3"	8	160	12"	12"x50'
R-7	3250	5500	1000	1300	1024.00	5000	72"	48"	72"	56"	6"	4"	10	200	16"	16"x50'
R-8	3900	6600	1200	1560	1120.00	5500	82"	48"	72"	56"	6"	4"	12	240	16"	16"x50'
R-9	4800	8000	1500	1950	1240.00	6100	92"	48"	72"	56"	6"	4"	15	300	16"	16"x50'
R-10	5800	9800	1800	2340	1700.00	8500	96"	60"	84"	66"	8"	6"	18	360	20"	20"x60'
R-11	6600	11000	2000	2600	1880.00	9200	102"	60"	84"	66"	8"	6"	20	400	20"	20"x60'
R-12	7600	13000	2200	2860	1920.00	9600	108"	60"	84"	66"	8"	6"	22	440	20"	20"x60'

The Titusville Iron Works Company

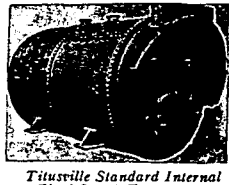
Titusville, Pennsylvania

Manufacturers of Fire Tube Steel Boilers for Power and Heating; Fronts, Grates, Castings, Smoke Stacks, Tanks and Oil Well Boilers; Steam, Gas, Oil and Gasoline Engines; Pumping Powers and Oil Well Machinery

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WASHINGTON OFFICE.....732 Woodward Bldg.



Tico Smokeless Boiler



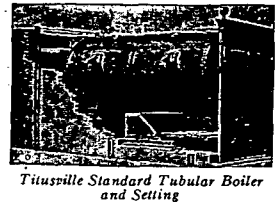
Titusville Standard Internal Fired Scotch Type Boiler



Tico Return Tubular Fire Box Boiler



Titusville Vertical Tubular Boiler



Titusville Standard Tubular Boiler and Setting

The Organization and Facilities

We manufacture a complete line of fire tube steam boilers to meet all general heating and power requirements. We also make a specialty of boilers built to architects' and engineers' specifications.

Our shop is one of the largest and best equipped boiler manufacturing plants in the country. It is provided with the latest improved machinery including hydraulic and pneumatic riveting machines, as well as hydraulic flanging equipment. Engineering skill, careful workmanship and the best of materials are combined to make TITUSVILLE BOILERS better made boilers for every purpose.

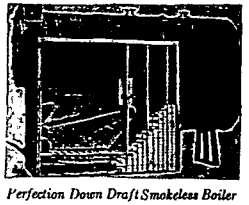
All boilers are made in strict accordance with the latest boiler code of the *American Society of Mechanical Engineers* and can be made, if desired, to conform to local requirements.

A large supply of material for all types of boilers is constantly carried and an adequate stock of completed TICOS and ACME FIREBOX Boilers is always ready for immediate shipment.

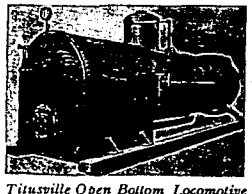
Thorough inspections and tests are constantly made during the construction and all workmanship and material is guaranteed first class in every respect.

In addition to the line of TITUSVILLE Boilers illustrated herewith we manufacture pneumatic and storage tanks of every description.

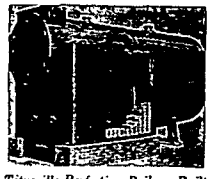
Descriptive bulletins will be sent on request.



Perfection Down Draft Smokeless Boiler



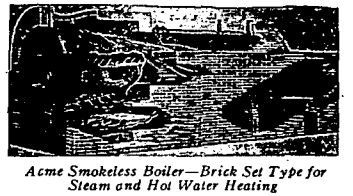
Titusville Open Bottom Locomotive Portable Boiler with Water Front



Titusville Perfection Boiler—Built in Sizes 25 H. P. to 200 H. P. from 15 lbs. to 150 lbs Working Pressure



Titusville Jacketed Tubeless Water Heater —for Heating Domestic Hot Water by Direct Circulation



Acme Smokeless Boiler—Brick Set Type for Steam and Hot Water Heating

UNITED STATES RADIATOR CORPORATION

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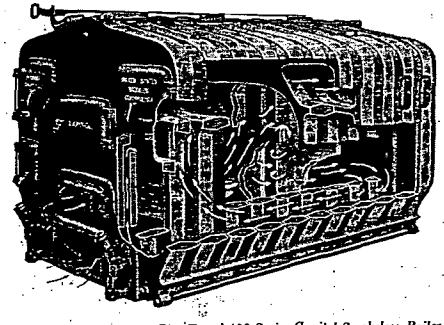
Manufacturers of Capitol Boilers and United States Radiators

CAPITOL SMOKELESS BOILERS

Capitol Smokeless Boilers have been developed to meet a growing demand on the part of the public for boilers which will burn the bituminous coals of the United States without smoke. This demand has been brought about by the educational work of Civic Societies which have taught the public to realize the destructive effect and the menace to health of soft coal smoke in our large cities. Incidentally, the public has come to understand the large monetary loss due to the escape of unburned gases in the form of dense, black smoke. These facts are now so well understood that confirmative argument is unnecessary.

400 and 500 Series

The United States Radiator Corporation has developed a line of cast iron boilers built upon the highly effective "wing wall" principle which is well known in power boilers where smokeless combustion is desired. This type is exemplified by the 400 and 500 Series, of which an interior view is shown at the left.



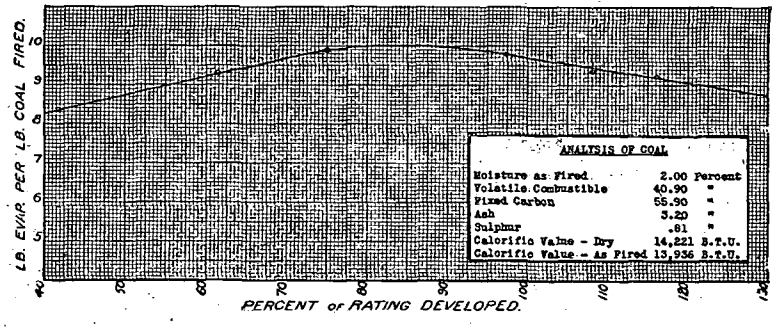
Interior View Showing Fire Travel 400 Series Capitol Smokeless Boiler

These boilers contain a large furnace where bituminous coal undergoes rapid combustion. The main air supply is admitted through the grates and fuel bed. Auxiliary air for smokeless combustion is admitted at the front of the furnace through passages leading from the ashpit to a point just above the level of the fuel bed. This air is properly proportioned for best

results; it is preheated and mixes with the volatile gases distilled from the fuel bed. This combustible mixture passes from the furnace through the bridgewall into a mixing chamber. This mixing chamber is formed by the bridgewall and ignition walls or "wing walls" of high refractory tile. Because of the continuous flow of burning gases from the furnace through the bridgewall and against these ignition walls they are constantly maintained at a temperature of approximately 1600 deg. or about 400 deg. above the ignition point of the gases.

The burning gases enter the mixing chamber through two horizontal openings. Their escape from the mixing chamber at the rear of the boiler is through a long vertical opening between the ignition tiles. The effect of this arrangement is a constriction and intermixture of burning gases and auxiliary air within the mixing chamber in contact with the hot ignition walls.

The burning of these gases is completed in the combustion chamber at the rear of the boiler. From the combustion chamber the gases are rapidly cooled in the large flues passing to the front of the boiler on either side (as shown in the illustration) and returning to the smokehood through the return flues. With this construction combustion is completed before the gases reach the cooling flues.



Performance Curve for No. 411 Capitol Smokeless Boiler

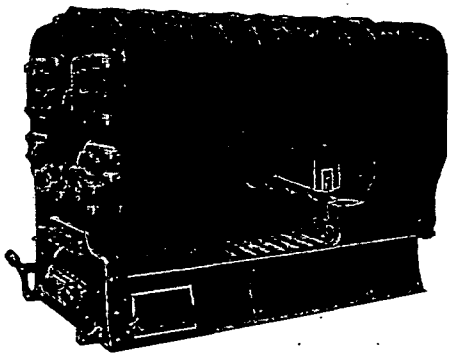
The performance curve of a 411 boiler shown above is typical of the efficiency of 400 and 500 Series boilers. Attention is called to the high volatile coal used in these tests. Capitol Smokeless Boilers will burn such coal without smoke and with great economy.

The operation of this type of boiler is exceedingly simple. No skilled operator is necessary to obtain smokeless results. Any person who can throw coal into the boiler can operate it smokelessly, because no further attention is required.

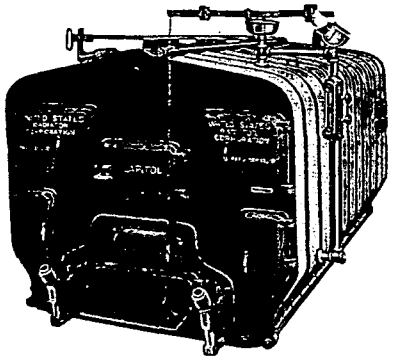
27 Inch, S230 and S270 Series

Another line of Capitol Smokeless Boilers is exemplified by the 27 inch, S230 and S270 Series, of which the latter is illustrated in the interior view at the right.

These are regular updraft boilers so designed that they may be operated smokelessly with proper attention. The important smokeless feature of these boilers is the inverted bridgewall or curtain section through which heated auxiliary air filters over the fire for complete combustion. When firing these boilers the coking method should be applied, that is, the initial fire should be pushed to the rear of the grate and new fuel added at the front. The gases distilled from the green coal pass under the curtain where they mix with auxiliary air. The combustible mixture is forced to pass close to the surface of the hot coke fire at the rear where combustion takes place.



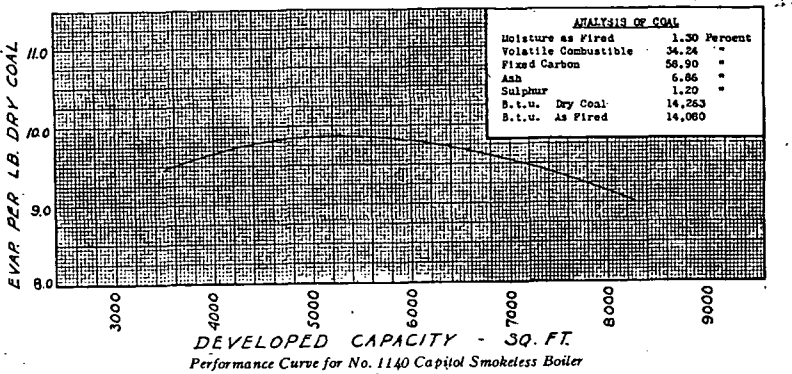
Interior View S270 Series Capitol Smokeless Boiler



40 Series Capitol Smokeless Boiler

40 Inch Series

A more recent Smokeless Boiler development of the United States Radiator Corporation is the 40 Inch Series. The operation of the 40 Inch Series is similar to that of the S230 and S270 except that auxiliary air enters through patented air passages in the front section. Admission of air at the front permits combustion of a large part of the gases before they pass under the curtain. As the gases pass under the curtain they are heated to a higher temperature and combustion is completed as they enter the flues. The Performance Curve shown below is typical of this type of boiler.



Performance Curve for No. 1140 Capitol Smokeless Boiler

50 Inch Series

The largest of the more recent series of Capitol Smokeless Boilers developed by the Capitol Testing Laboratory is that known as the 50 in. series.

These boilers contain a large furnace where bituminous coal undergoes rapid combustion. The main air supply is admitted through the grates and the fuel bed. Auxiliary air for smokeless combustion is admitted at the front of the furnace through passages leading from the ashpit to a point just above the level of the fuel bed. This air is properly proportioned for best results. It is pre-heated and mixes with the volatile gases distilled from the fuel.

An additional supply of auxiliary air is furnished through an inverted bridgewall or curtain section. This air is also pre-heated and filters over the fire, assuring most complete combustion and highest efficiency.

CAPITOL SMOKELESS BOILERS—Ratings and Dimensions

No.	Rating, Square Feet		Height Water Line Inches	Grate Area Square Feet	Coal Capacity Cubic Feet	Outlets and *Inlets Inches	Minimum Chimney Sizes	
	Steam	Water					Height Feet	Dimensions Inches
627	1800	2975	45½	5.32	7.50	2–4"	40	12x12
727	2200	3625	45½	6.55	9.28	2–4"	40	12x12
827	2600	4275	45½	7.78	11.00	3–4"	45	12x12
927	3000	4925	45½	9.01	12.48	3–4"	45	12x16
1027	3400	5575	45½	10.24	14.15	3–4"	45	12x16
1127	3800	6225	45½	11.47	15.81	3–4"	50	12x16
1227	4200	6875	45½	12.70	17.50	4–4"	50	12x16
S237	2800	4650	55	10.94	16.49	3–4"	45	16x16
S238	3250	5450	55	12.77	19.22	3–4"	50	16x16
S239	3700	6150	55	14.61	21.96	3–4"	55	16x16
S240	4150	6900	55	16.44	24.70	4–4"	60	16x16
S241	4600	7600	55	18.27	27.44	4–4"	60	16x20
408	3300	5280	49	8.15	9.00	2–5"	50	18x18
409	3850	6160	49	8.15	10.40	2–5"	50	18x18
410	4400	7040	49	10.31	13.30	3–5"	55	20x20
411	4950	7920	49	12.42	14.70	3–5"	55	20x20
412	5500	8800	49	12.47	16.30	3–5"	55	22x22
413	6050	9680	49	14.63	17.70	3–5"	60	24x24
414	6600	10560	49	14.63	19.25	4–5"	60	24x24
740	4475	7350	49	8.15	10.40	2–5"	50	18x18
840	5250	8650	49	10.31	13.30	2–5"	55	18x20
940	6025	9950	49	10.31	13.30	2–5"	60	20x20
1040	6800	11250	49	12.47	16.30	3–5"	65	20x24
1140	7575	12550	49	14.63	19.25	3–5"	70	24x24
1240	8350	13850	49	14.63	19.25	3–5"	70	24x28
1340	9125	15150	49	16.79	22.20	3–5"	75	24x28
S277	5475	9000	66	18.29	29.67	3–5"	55	24x24
S278	6400	10525	66	21.33	34.68	3–5"	60	24x24
S279	7325	12050	66	24.37	39.69	4–5"	60	24x24
S280	8250	13575	66	24.37	39.69	4–5"	65	24x28
S281	9175	15100	66	27.41	42.20	4–5"	70	28x28
S282	10100	16625	66	27.41	44.71	4–5"	70	28x28
S283	11025	18100	66	30.45	47.22	5–5"	75	28x32
S284	11950	19600	66	30.45	49.72	5–5"	80	32x32
750	7800	12875	66	18.29	30.95	3–5"	55	24x24
850	8850	14600	66	21.33	36.00	4–5"	60	24x24
950	9900	16325	66	21.33	36.00	4–5"	65	24x28
1050	10950	18050	66	24.37	41.20	5–5"	70	24x28
1150	12000	19775	66	24.37	41.20	6–5"	80	28x28
1250	13050	21500	66	27.41	46.22	6–5"	90	28x32
1350	14100	23225	66	27.41	46.22	6–5"	95	32x32
508	6275	10000	66	11.58	18.87	3–5"	60	24x24
509	7150	11400	66	14.62	23.73	4–5"	65	24x24
510	8025	13000	66	17.66	25.80	4–5"	70	24x28
511	8900	14250	66	17.66	28.59	4–5"	80	28x28
512	9775	15650	66	18.49	29.58	5–5"	85	28x32
513	10650	17050	66	21.53	34.51	5–5"	85	32x32
514	11525	18450	66	21.53	37.80	5–5"	90	32x32
515	12400	19850	66	24.57	41.09	6–5"	90	32x36
516	13275	21250	66	27.61	44.37	6–5"	90	36x36

*All 40 and 400 Series have two 6-inch inlets on rear of back section. All 27 Series have two 4-inch inlets on rear of back section.

Dimensions, inclusive of trimmings:

27 Series, height 68½ inches, width 50¾ inches
S230 Series, height 78 inches, width 58¾ inches
400 Series, height 71 inches, width 75 inches
40 Series, height 71 inches, width 75 inches
S270 Series, height 92 inches, width 82 inches
50 Series, height 92 inches, width 82 inches
500 Series, height 92 inches, width 82 inches

Universal Smokeless Boiler Company

100% WATER TUBE SELF-CLEANING BOILERS

Factory and Main Office - - - RAVENNA, OHIO

Guarantee

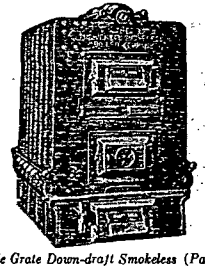
On installation under 5000 ft. steam, we guarantee our boilers to provide sufficient steam to take care of 50 per cent of their rated capacity shown within. On installations over 5000 ft. steam 60 per cent of the rated capacity.

This guarantee is based on using bituminous high volatile coal similar to "Pittsburgh Vein" run-of-mine.

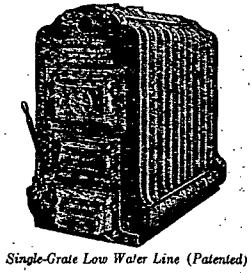
Our SMOKELESS BOILERS comply with the law and are guaranteed to pass the smoke ordinance of all cities, using bituminous coal.

The smokeless feature is fool-proof.

Expert or careful firing not necessary.



Double Grate Down-draft Smokeless (Patented)



Single-Grate Low Water Line (Patented)

All parts and prices subject to change without notice.

24" SINGLE-GRATE, UP-DRAFT

Water-line 47 in. Width overall 36 in. Height overall 57 in.

Boiler No.	Total No. of Sections	Grate Area	Steam Rating	Water Rating	Approx. Shipping Weight
231	6	3.00	1000	1600	2800
241	7	4.00	1200	1920	3000
251	8	5.00	1450	2320	3500
252	9	5.00	1750	2800	4100
253	10	5.00	2000	3200	4280
262	10	6.00	2250	3600	4300
272	11	7.00	2500	4000	4680
273	12	7.00	2750	4400	4735
282	12	8.00	3000	4800	4630
292	13	9.00	3250	5200	5200
293	14	9.00	3500	5600	5700

CAST IRON SECTIONAL BOILERS

100 Per Cent Water Tube Construction

36" SERIES—DOUBLE-GRADE DOWN-DRAFT. SMOKELESS

Water-line 48 in. if base of boiler is set in a pit 13 in. deep. Width overall 49 in. Height overall 73 in. Returns 4–2½ in.

Boiler Number	Steam Rating	Water Rating	Grate Area Square Feet	Grate Length Inches	No. Sections	Approximate Boiler Length Inches	Outlets—3½ in.	Smallest Dimensions Chimney Inside, In.	Height Chimney Sea Level—Square Feet	List Price	Approximate Shipping Weight
32	2600	4160	9.75	19	7	45	2	15	45	$800	5250
33	3100	4960	9.75	19	8	51	2	15	45	950	6250
42	3600	5760	13.0	24	8	51	2	15	45	1010	5800
43	4000	6400	13.0	24	9	57	2	15	45	1150	6760
53	4500	7200	16.26	30	10	64	3	16	50	1260	7360
54	5000	8000	16.26	30	11	70	3	16	50	1310	8140
64	5500	8800	19.5	36	12	77	3	16	50	1410	8750
65	5800	9280	19.5	36	13	85	3	16	50	1560	9300
74	6200	9920	22.74	42	13	85	4	17	55	1610	9300
75	6500	10400	22.74	42	14	92	4	17	55	1750	10065
84	6800	10880	26.0	48	14	92	4	18	60	1700	9900
85	7200	11520	26.0	48	15	99	4	18	60	1800	10725
95	7800	12480	29.26	54	16	105	5	19	65	1900	11250
96	8100	12000	29.26	54	17	111	5	19	65	2000	12200
97	8400	13440	29.26	54	18	117	5	19	65	2100	12850
106	8800	14080	32.52	60	18	120	5	20	70	2200	12700
107	9000	14400	32.52	60	19	127	5	20	70	2300	13530
108	9400	15040	32.52	60	20	134	5	20	70	2400	14355
117	9800	15680	36.0	66	20	140	6	21	75	2500	14135
118	10100	16160	36.0	66	21	147	6	21	75	2650	14960
119	10400	16640	36.0	66	22	153	6	21	75	2800	15785
1110	12000	19200	36.0	66	23	160	6	21	75	2950	17600

24" SERIES—DOUBLE-GRATE, DOWN-DRAFT

Water-line 57 in. Height overall 67 in. Outlets 4 in. Width 36 in. Returns 2 in.

432	1485	2400	5.0	15	7	35	....	12	40	$548	3135
433	1620	2600	5.0	15	8	40	....	12	40	632	3575
443	1980	3200	6.60	20	9	45	....	15	45	686	3900
444	2160	3400	6.66	20	10	50	....	15	45	772	4400
454	2430	3900	8.32	25	11	60	....	16	45	828	4675
455	2700	4300	8.32	25	12	65	....	16	45	914	5060
465	2970	4600	10.0	30	13	70	....	16	45	970	5335
466	3150	5000	10.0	30	14	75	....	18	45	1040	5720
476	3420	5500	11.16	35	15	80	....	18	50	1104	5995
477	3600	5800	11.18	35	16	85	....	18	50	1190	6380

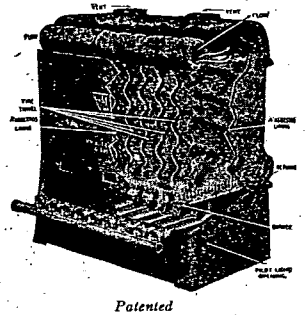
36" SINGLE-GRATE, UP-DRAFT

Water-line 48 in. Width overall 49 in. Height 60 in.

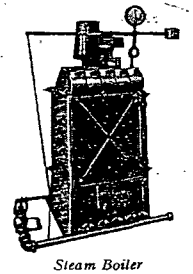
Boiler Number	Total No. Sections	Grate Area	Steam Rating	Water Rating	Approx. Shipp'g Wt.
131	6	5.60	2000	3200	4070
132	7	5.60	2450	4000	4950
142	8	7.45	2900	4800	5335
143	9	7.45	3350	5360	6160
152	9	9.25	3800	6680	6200
153	10	9.25	4250	6800	6625
154	11	9.25	4700	7520	7590
162	10	11.10	5150	8240	6270
163	10	11.10	5600	8960	7122
164	12	11.10	6050	9680	7942
173	12	12.95	6500	10400	7700
174	13	12.95	6950	11120	8437
175	14	12.95	7400	11840	9256
183	13	14.8	7850	12560	8497
184	14	14.8	8300	13280	8932
185	15	14.8	8750	14000	9751
194	15	16.65	9200	14720	9427
195	16	16.65	9650	15440	10246
196	17	16.65	10100	16160	10637
197	18	16.65	10550	16880	11412

Universal Cast Iron Sectional Boilers

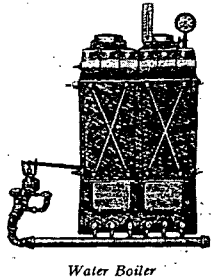
For Gas or Oil



Patented



Steam Boiler



Water Boiler

SECTIONAL GAS AND OIL BOILERS With Special Circulating Section

Boiler Number	Steam Rating	Number Sections	List Price	Approximate Shipping Weight
41 T S	480	4	$185	1137
51 T S	660	5	230	1300
61 T S	840	6	275	1475
32 T S	1020	7	320	1629
42 T S	1200	8	365	1789
52 T S	1380	9	410	1954
62 T S	1560	10	455	2116
72 T S	1740	11	500	2281
33 T S	1920	12	545	2445
43 T S	2100	13	590	2606
53 T S	2280	14	635	2767
63 T S	2460	15	680	2928
73 T S	2640	16	725	3094
34 T S	2820	17	770	3227
44 T S	3000	18	815	3319
54 T S	3180	19	860	3582
64 T S	3360	20	905	3741
74 T S	3540	21	950	3938
35 T S	3720	22	995	4095
45 T S	3900	23	1040	4257
55 T S	4080	24	1085	4431
65 T S	4260	25	1130	4604
75 T S	4440	26	1175	4769
36 T S	4620	27	1220	4932
46 T S	4800	28	1265	5100
56 T S	4980	29	1310	5263
66 T S	5160	30	1355	5433
76 T S	5340	31	1400	5668

Steam Boilers—Height to water-line 26 in. Height to top flue opening 38 in. Returns—Two 3 in. Flows—Two 3 in. Extra 1½ in. flows on boilers over 10 sections.

With Plain Section

Number	Steam Rating	Water Rating	Number Sections	List Water Price	List Steam Price	Approx. Shipping Weight
41 P S and P W	400	665	4	$138	$163	1017
51 P S and P W	550	905	5	175	202	1150
61 P S and P W	700	1145	6	213	240	1293
32 P S and P W	850	1385	7	250	279	1419
42 P S and P W	1000	1625	8	288	317	1549
52 P S and P W	1150	1865	9	325	356	1684
62 P S and P W	1300	2105	10	363	394	1816
72 P S and P W	1450	2345	11	400	433	1951
33 P S and P W	1600	2585	12	438	471	2085
43 P S and P W	1750	2825	13	475	510	2216
53 P S and P W	1900	3065	14	513	548	2347
63 P S and P W	2050	3305	15	550	587	2478
73 P S and P W	2200	3545	16	588	625	2614
34 P S and P W	2350	3785	17	625	664	2717
44 P S and P W	2500	4025	18	663	702	2879
54 P S and P W	2650	4265	19	700	741	3012
64 P S and P W	2800	4505	20	738	779	3141
74 P S and P W	2950	4745	21	775	818	3278
35 P S and P W	3100	4985	22	813	856	3405
45 P S and P W	3250	5225	23	850	895	3537
55 P S and P W	3400	5465	24	888	933	3681
65 P S and P W	3550	5705	25	925	972	3824
75 P S and P W	3700	5945	26	963	1010	3959
36 P S and P W	3950	6185	27	1000	1049	4092
46 P S and P W	4100	6425	28	1038	1087	4231
56 P S and P W	4250	6665	29	1075	1126	4363
66 P S and P W	4400	9605	30	1113	1164	4503
76 P S and P W	4550	7145	31	1150	1203	4708

Steam Boilers—Height to top flue opening 38 in. Height to water-line 26 in. Returns—Two 3 in. Flows—Two 3 in. Extra 1½ in. flows on boilers of over 10 sections.

Water Boilers—Height to top flue opening 38 in. Returns—Two 3 in. Flows—Two 3 in.

Utica Heater Company

UTICA, New York

365 E. Illinois St. CHICAGO, ILL.

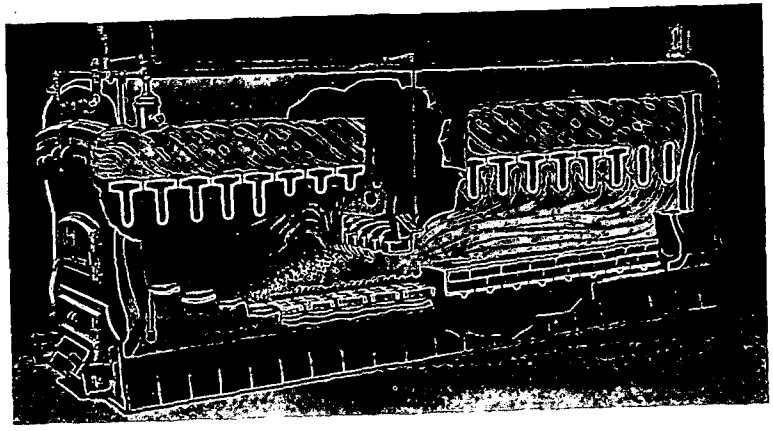
628 Union Building CLEVELAND, O.

1843 Grand Central Term'l NEW YORK, N. Y.

Representatives In Principal Jobbing Centers

Utica-Imperial SUPER-SMOKELESS Boilers

Burn Soft Coal Smokelessly—Use Any Available Fuel



Patented January 10, 1922.

Utica-Imperial SUPER-SMOKELESS Boiler

Cut-away View, Showing Primary and Secondary Combustion Chambers and Air Inlets

SUPER-SMOKELESS BOILERS—

Are designed to operate smokelessly when burning soft coal. They utilize any available fuel, burning either hard coal, soft coal, lignite, coke, fuel oil or gas with exceptional efficiency and decided economy.

ELIMINATION OF SMOKE—

Is attained by consuming the smoke and soot within the boiler. This complete combustion is due to the admission of highly heated air through water-jacketed inlets, in the baffle wall at the rear of the fire box. The admixture of oxygen at this point instantly converts the heavy gases into incandescent flames of unusual heating capacity. The smoke and soot are actually used as fuel and clean chimney and flues are maintained at all times.

SUPER-SMOKELESS Boilers comply with the most rigid smoke ordinances and are recommended by foremost heating engineers and leading architects for important buildings.

CONSTRUCTION—

SUPER-SMOKELESS Boilers have a single grate and are of sectional cast iron construction. Cast iron is highly resistant to corrosion and preferable to steel where low pressure permits using it. The sectional construction permits easy handling in shipment as well as installation in completed buildings.

The baffle wall is a specially designed water section of the boiler. It has a series of water-jacketed air inlets above the firebed and is covered on the side facing the fire by high-test plastic firebrick.

OPERATION—

SUPER-SMOKELESS Boilers are extremely simple to operate. No special skill or high priced help is required. Long firing periods are the rule and little care or attention is required for successful, smokeless operation.

Capacities and Dimensions of Utica-Imperial SUPER-SMOKELESS Boilers

Number Steam	Ratings Sq. Ft.	Number Water	Ratings Sq. Ft.	Grate Area Sq. Ft.	No. and Size of Outlets (Inches)	Diameter of Smoke Collar (Inches)	Length of Smoke Box (Inches)	Length of Sections (Inches)	Length of Sections and Smoke Box (Inches)
S-245	1200	W-245	1920	4.96	1-4	12	21¾	37¼	59
S-246	1500	W-246	2400	6.16	2-4	12	21¾	45½	67¼
S-247	1800	W-247	2880	6.16	2-4	14	20	53¾	73¾
S-248	2100	W-248	3360	7.36	2-4	14	20	62	82
S-249	2400	W-249	3840	7.36	3-4	14	20	70¼	90¼
S-335	2000	W-335	3200	7.32	1-5	15	23	37¼	60¼
S-336	2500	W-336	4000	9.10	2-5	15	23	45½	68½
S-337	3000	W-337	4800	10.87	2-5	15	23	53¾	76¾
S-338	3500	W-338	5600	12.65	2-5	16	21½	62	83½
S-339	4000	W-339	6400	14.42	3-5	16	21½	70¼	91¾
S-3310	4700	W-3310	7520	16.20	3-5	16	21½	78½	100
S-405	2750	W-405	4400	9.68	1-5	18	27½	37¼	64¾
S-406	3500	W-406	5600	12.03	2-5	18	27½	45½	73
S-407	4250	W-407	6800	14.38	2-5	18	27½	53¾	81¼
S-408	5000	W-408	8000	16.73	3-5	18	27½	62	89½
S-409	5750	W-409	9200	19.08	3-5	18	27½	70¼	97¾
S-4010	6500	W-4010	10400	21.43	3-5	18	27½	78½	106
S-4011	7250	W-4011	11600	23.77	3-5	20	26	86¾	112¾
S-4012	8000	W-4012	12800	23.77	4-5	20	26	95	121
S-4013	8750	W-4013	14000	23.77	4-5	20	26	103¼	129¼
S-4014	9500	W-4014	15200	23.77	4-5	20	26	111½	137½
S-4015	10250	W-4015	16400	23.77	4-5	20	26	119¾	145¾
S-4016	11000	W-4016	17600	23.77	4-5	20	26	128	154
S-4017	11750	W-4017	18800	23.77	4-5	20	26	136¼	162¼
S-4018	12500	W-4018	20000	23.77	4-5	20	26	144½	170½
S-4019	13250	W-4019	21200	23.77	5-5	20	26	152¾	178¾
S-4020	14000	W-4020	22400	23.77	5-5	20	26	161	187
S-4021	14750	W-4021	23600	23.77	5-5	20	26	169¼	195¼
S-4022	15500	W-4022	24800	23.77	5-5	20	26	177½	203½
S-4023	16250	W-4023	26000	23.77	5-5	20	26	185¾	211¾
S-4024	17000	W-4024	27200	23.77	5-5	20	26	194	220

Capacities and Dimensions of Utica-Duplex SUPER-SMOKELESS Boilers

Number Steam	Ratings Sq. Ft.	Number Water	Ratings Sq. Ft.	Grate Area Sq. Ft.	No. and Size of Outlets (Inches)	Diameter of Smoke Collar (Inches)	Length of Smoke Box (Inches)	Length of Sections (Inches)	Length of Sections and Smoke Box (Inches)
S-827	8500	W-827	13600	28.76	8	28	17	53¾	70¾
S-828	10000	W-828	16000	28.76	8	28	17	62	79
S-829	11500	W-829	18400	33.46	8	28	17	70¼	87¼
S-8210	13000	W-8210	20800	33.46	8	28	17	78½	95½
S-8211	14500	W-8211	23200	38.16	8	28	17	86¾	103¾
S-8212	16000	W-8212	25600	38.16	8	28	17	95	112
S-8213	17500	W-8213	28000	42.86	8	28	17	103¼	120¼
S-8214	19000	W-8214	30400	42.86	8	28	17	111½	128½
S-8215	20500	W-8215	32800	42.86	8	28	17	119¾	136¾
S-8216	22000	W-8216	35200	47.54	8	28	17	128	145
S-8217	23500	W-8217	37600	47.54	8	28	17	136¼	153¼
S-8218	25000	W-8218	40000	47.54	8	28	17	144½	161½

Height of water line: 24 series, 45½ inches; 33 series, 53 inches; 40 series, 57 inches; 82 series, 57 inches.

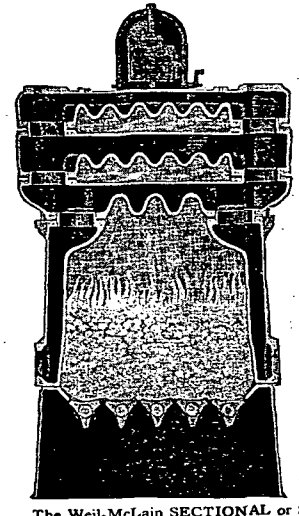
Equipment Shipped with Boilers

All SUPER-SMOKELESS Boilers are provided with equipment of the best type. Steam Boilers are equipped with Water Column with gauge glass and compression cocks; Retard Steam Gauge with Bourdon brass tube spring, Non-Glare Dial, syphon and cock; All-brass Pop Safety Valve, *A. S. M. E.* Standard; and Automatic All-metal Damper Regulator suitable for low pressure. Every boiler is furnished with a complete set of firing tools, consisting of shaker handle, hook, hoe, slice bar and flue brush with handle. Duplex Steam Boilers are equipped with Steam Header, Return Yoke, and Equalizer fitted with Hartford Connection which may be used or not, as desired.

Weil-McLain

SCIENTIFIC COMBUSTION BOILERS

WEIL-McLAIN COMPANY — Michigan City, Ind. — Chicago, Ill.



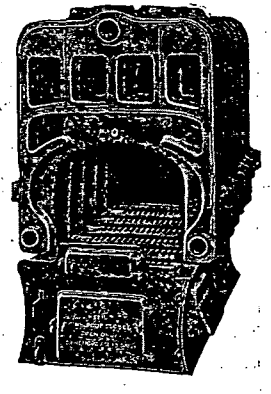
The Weil-McLain ROUND TYPE BOILER with its CORRUGATED FUEL-SAVING HEATING SURFACES and its long "back and forth" fire travel embraces the newest and best conceptions of heating engineers.

Other points of merit in the Weil-McLain Round Type Boiler are: fire-pot and crown sheet cast separately to permit easier handling; large fire door; handy front clean-out doors in every section and triangular type grates which cut and shake out all ordinary clinkers.

STEAM		WATER		Actual Diam. Grate and Fire Pot Inches (Both Steam and Hot Water)
Size Boiler	Rating Sq. Ft.	Size Boiler	Rating Sq. Ft.	
5-S-17	395	5-W-17	650	17
5-S-19	480	5-W-19	795	19
5-S-22	660	5-W-22	1090	22
5-S-25	865	5-W-25	1430	25
5-S-28	1065	5-W-28	1760	28
5-S-31	1350	5-W-31	2225	31
6-S-17	410	6-W-17	675	17
6-S-19	500	6-W-19	825	19
6-S-22	695	6-W-22	1145	22
6-S-25	915	6-W-25	1510	25
6-S-28	1130	6-W-28	1865	28
6-S-31	1425	6-W-31	2350	31

NOTE: Table is not complete; these boilers are also made four section.

The Weil-McLain SECTIONAL or SQUARE TYPE BOILER like the Round Type has corrugated heating surfaces directly above the fire, has a long "back and forth" fire travel—features that add greatly to the efficiency and economy of this boiler.



WATER				STEAM				Grate Area Sq. Ft. (Steam and Water)
Number	Water Rating Sq. Ft.	Total Length Inches	Grate Area Sq. Ft.	Number	Steam Rating Sq. Ft.	Total Length Inches	Water Line Inches	
22-W-5	1500	51	4.88	22-S-5	900	51	46	4.88
22-W-6	1825	58	5.96	22-S-6	1100	58	46	5.96
22-W-7	2150	65	7.03	22-S-7	1300	65	46	7.03
25-W-5	1825	51	5.70	25-S-5	1100	51	51	5.70
25-W-6	2225	58	6.90	25-S-6	1350	58	51	6.90
25-W-7	2650	65	8.10	25-S-7	1600	65	51	8.10
25-W-8	3050	72	9.30	25-S-8	1850	72	51	9.30
28-W-5	2700	63	7.97	28-S-5	1650	63	55	7.97
28-W-6	3275	72	9.72	28-S-6	2000	72	55	9.72
28-W-7	3850	81	11.47	28-S-7	2350	81	55	11.47
28-W-8	4425	90	13.22	28-S-8	2700	90	55	13.22
36-W-5	3850	66	10.25	36-S-5	2350	66	58	10.25
36-W-6	4725	75	12.50	36-S-6	2875	75	58	12.50
36-W-7	5600	84	14.75	36-S-7	3400	84	58	14.75
36-W-8	6475	93	17.00	36-S-8	3925	93	58	17.00
36-W-9	7350	102	19.25	36-S-9	4450	102	58	19.25

NOTE: Table is not complete; this type boiler is also made in a 48" size.

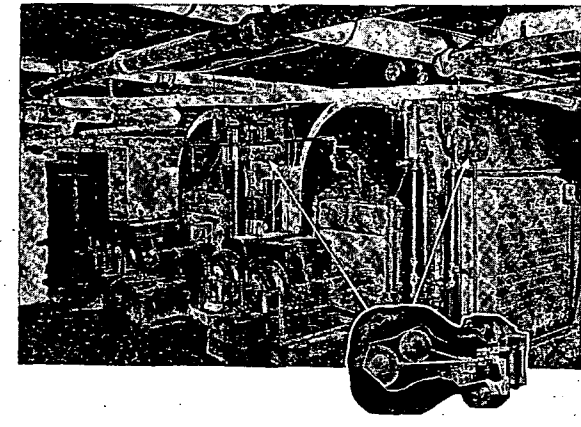
McDonnell & Miller

General Offices:
Wrigley Building
CHICAGO

Eastern Warehouse
Stock
Bush Terminal, N. Y.

"Doing One Thing Well"

The Only Exclusive Manufacturer of Water Feeders



Products: McDONNELL & MILLER DUPLEX WATER FEEDERS

The McDonnell & Miller Duplex Water Feeder is a simple and positive means of controlling the water line in low-pressure steam boilers, automatically supplying make-up water as necessary, and protecting the boilers against flooding by disposing of excess condensate which may be returned from the system.

It is a completely self-contained unit, consisting of two carefully designed float-operated valves, placed in the head and enclosed in a suitable receiver. By means of steam and water equalizing connections in the head, boiler conditions are maintained in the receiver of the feeder itself. Variations in boiler water line are accurately followed. The city water supply connection is also in the head and admits make-up water to the feeder through an integral strainer of large capacity. All pipe connections are so arranged in the head that working parts may be inspected by removing the receiver without breaking a single pipe connection.

Service—The McDonnell & Miller Duplex Water Feeder may be applied to all low-pressure steam boilers, maximum pressure 15 lbs., and is suitable for use under all city water pressures up to 110 lbs. It is particularly adaptable to oil fired boilers where the quick, intense heat of the oil burner causes rapid fluctuations in boiler water line, and where the automatic oil burner controls encourage carelessness of boiler water line.

It is also essential protection where low-pressure steam boilers depend on electrically driven pumps for the return of condensation from the system, for, in case of pump or current failure it will supply adequate make-up water from the city mains.

McDonnell & Miller Duplex Water Feeders are protection against burned boilers and cracked sections. By maintaining a normal water line at all times, they also assure more uniform steaming and better boiler performance.

Automatic Burner Corporation

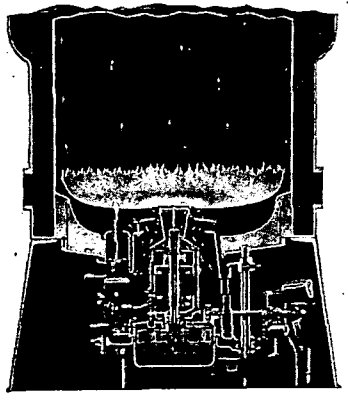
312 North May Street - - CHICAGO, ILL.

How ABC Heats

Your thermostat, placed in one of your living rooms, is set at 70 deg. The temperature in your home drops to 68 deg.—automatically ABC starts.

The lowering of the oil in the burner reservoir drops the float, unseating the three check balls. As the oil flows in from the wall float, which holds one pint of oil, the lowering of the float in its container automatically starts the pump. The pump draws oil from an underground tank.

When enough oil has been admitted into the reservoir the dependable three balls set, stopping



the automatic pump and checking the flow of oil. Observe this: At no time do you have more than one quart of oil in your basement.

The armature shaft by centrifugal force draws the oil through a taper hole up to the atomizing cup. Air is taken in—always the proper amount—through holes in the bottom of the cup.

The oil and air, thoroughly mixed and broken up, are thrown into the boiler, noiselessly, as a fine atomized, instantly inflammable mist. Ignited by the pilot light, the mist of oil burns with a clean, soft flame of circular form.

Twelve Reasons Why A B C Appeals to Engineers

1. **Converts coal boiler into oil burning boiler:** ABC is designed so that it retains the natural functions of a coal heating boiler. All boilers were designed to burn coal—and not to absorb heat traveling at a high velocity. The ABC horizontal circular flame heats from the grate on the water legs. Result: quick heat; low stack temperature; saving in oil.
2. **Oil burned in suspension:** This is the first law of efficient oil burning.
3. **Longer boiler life:** Burners with a concentrated flame in time destroy a boiler. The ABC circular flame, evenly applied all around the boiler, adds to its life.
4. **No carbon or soot:** Engineers know what an immense advantage this is.
5. **No fan or blower:** Heat is not forced up the chimney and wasted.
6. **Less oil required:** Unique means of atomization assures complete combustion. Every particle of oil is burned. The heat rises slowly and is maximumly absorbed by the boiler.
7. **Simple:** The life and amount of service of a piece of machinery is in ratio to the number of moving parts. ABC has only one moving part subject to wear. It is simple. It has no complicated or delicate adjustments.
8. **Burns low-priced oils:** 32–36 gravity oil is recommended.
9. **Odorless:** An ABC heated home is odorless.
10. **No unsightly parts outside of boiler:** The burner is entirely enclosed in the boiler out of the way.
11. **Automatic:** Heat when you want it—as you want it.
12. **Quiet:** The importance of quietness in a domestic oil burner cannot be overestimated. ABC is really quiet.

Full Information will be Sent You Gladly

No.	Maximum Steam Radiation	Max. Hot Water Radiation	Approximate Floor Space Required	Shipping Weight	Price
Type E	3000	4500	Enclosed in Boiler	110 lbs.	$600 to $1,000

A B C OIL BURNER

No Noise - No Carbon

Caloroil Burner Corporation

5 East 40th Street, NEW YORK

CALOROIL BURNERS

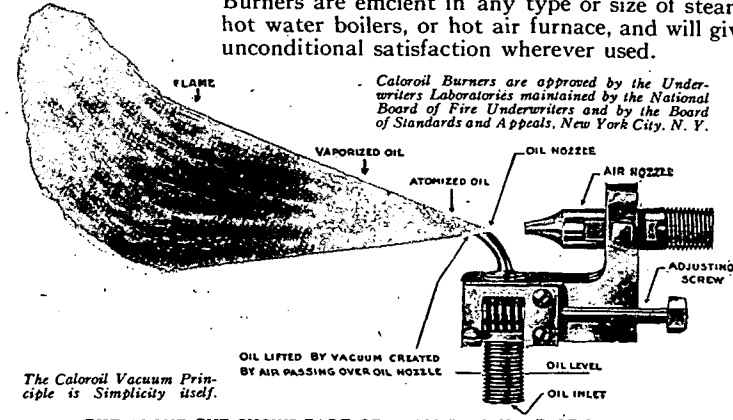
Automatic Fuel Oil Burners Using Air or Steam for Atomization

Why Noted Engineers Endorse Caloroil Burners

Testimonies from leading heating engineers give evidence that the simple, safe and ever-ready operation of Caloroil Burners is the ultimate basis of their selection. In the final analysis—performance tells the story.

Caloroil Burners are the Vacuum type which means that oil is drawn up by a self-created vacuum instead of being fed to the burners under pressure or gravity. A glance at the illustration below gives a good idea of the Caloroil principle. Oil is stored in tanks conveniently located, piped to oil inlet of burner and maintained at a level below nozzle. A small, specially designed motor compressor controlled by a thermostat, furnishes the air, which passing over the oil nozzle, creates the vacuum. As soon as this is accomplished, which is instantaneous, the oil is atomized or broken up into minute particles and ignited by a small gas pilot light. The entire action is fool proof, positive, requires no readjustment of oil supply and insures efficient operation under all conditions. Caloroil Burners burn any grade of oil that readily flow without preheating and burn it completely, without smoke, odor, or carbonization. Caloroil Burners are efficient in any type or size of steam, hot water boilers, or hot air furnace, and will give unconditional satisfaction wherever used.

Caloroil Burners are approved by the Underwriters Laboratories maintained by the National Board of Fire Underwriters and by the Board of Standards and Appeals, New York City, N. Y.



The Caloroil Vacuum Principle is Simplicity itself.

THE ABOVE CUT SHOWS PART OF ATOMIZING HEAD OF BURNER

Caloroil Burners are especially adaptable to the following types of heat requirements:

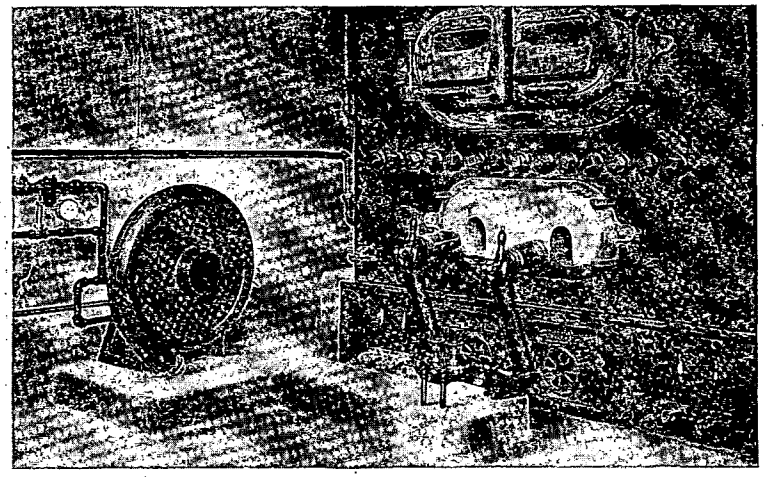
RESIDENCE	SCHOOLS	GREENHOUSES
APARTMENT HOUSE	CHURCHES	GARAGES
OFFICE BUILDINGS	FACTORIES	LAUNDRIES
KILNS	OVENS	METALURGICAL FURNACES

Caloroil Burners manufactured in various sizes

Winslow Boiler & Engineering Co.

Builders of Oil Burners

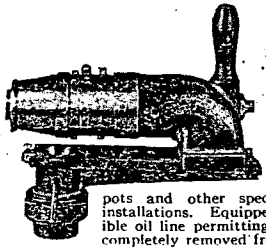
NEW YORK	CHICAGO	Factory GALESBURG
SHOW ROOM: 46 E. 41st St.	208 S. La Salle St.	Illinois



THE WINSLOW INDUSTRIAL BURNER burns efficiently all fuel oils from 14° Mexican Crude up.

The motor blower unit may be located at any convenient point near the boilers and connected to the burner assembly, in front of the boilers, by oil and air piping of correctly proportioned sizes.

The motor blower unit has a high grade gear pump that pulls the oil from the storage tank and delivers it at from 7 lbs. to 10 lbs. pressure to the burners. At the same time the blower is supplying the required air at low pressure, measured in ounces, to effect a thorough atomization of the oil. This unit is complete with a strainer, pressure gauge, check valve and oil relief valve.

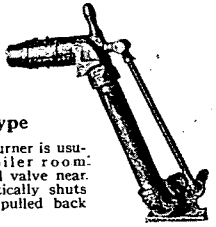


Sliding Type

The sliding type burner is particularly adapted to bake ovens, lead melting pots and other special industrial installations. Equipped with a flexible oil line permitting burner to be completely removed from slide base.

Single motor blower units handle a variety of burner assemblies and where dual units are twinned the capacities are not only doubled but the plant is insured against any shut down. There are several sizes of motor blower units and also of burners.

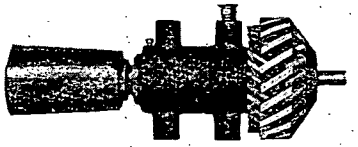
In specifying burners determine whether the boilers are to carry an overload. Ordinarily, steel boilers can be provided with burners rated at the boiler rating unless overloads are contemplated. On the other hand, cast iron boilers can usually be provided with burners rated at about 70 per cent of the boiler rating. This is due to the different methods of rating steel and cast iron boilers.



Tilting Type

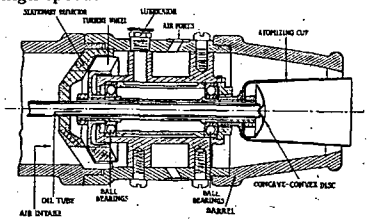
The tilting type burner is usually employed in boiler room work. The angle oil valve near grip handle automatically shuts off when burner is pulled back out of the boiler.

Wherever possible specify two smaller burner nozzles even though one larger one will do the work, so as to assure an easier control of fuel consumption. In nearly all boilers, two burners, by giving a wider flame distribution, reduce excess air, assuring better combustion. At the same time by utilizing more of the heating surface, the efficiency is still further increased. Where loads are apt to be variable the double burner nozzle is ideal.



The cut to the right above shows the method of attaining atomization. The oil travels down the central tube and impinges onto the concave-convex rotating disc. It whirls centrifugally to the edge of the disc and strikes the heel of the revolving cup in a thin film. It then travels along the inner wall of the cup to the rim where it is whirled off at tremendous speed, mixing with the air from the barrel and entering the boiler perfectly atomized.

The cut to the left shows the balanced rotating cup and revolving turbine wheel. Two sets of ball bearings between these units insure low frictional resistance and high speeds.



The following partial list of WINSLOW BURNER assemblages will be of assistance in determining correct sizes for a large scope of work. The ratings in column five are based on 100 square feet of steam radiation per horse power and represent the total load the burners can handle.

Designation	Motor Blower Unit	No. of Burners	Size of Burners	Max. Steam Radiation	Approximate Motor Unit Floor Space	Approximate Shipping Weight	H. P.	Pump	Air
Alexander	B-60	3	T 10	2,400′	24″x24″	290 lbs.	¾	½″	2″
Amos	B-60	1	T 30	4,000′	24″x24″	265 lbs.	¾	½″	2″
Anthony	B-60	2	T 30	6,000′	24″x24″	280 lbs.	¾	½″	2″
Austin	B-60	1	T 40	5,000′	24″x24″	285 lbs.	¾	½″	2″
Barney	B-90	2	T 30	7,000′	24″x24″	300 lbs.	1	½″	2″
Benjamin	B-90	3	T 30	9,000′	24″x24″	315 lbs.	1	½″	2″
Bernard	B-90	1	T 40	5,000′	24″x24″	290 lbs.	1	½″	2″
Blaine	B-90	2	T 40	9,000′	24″x24″	305 lbs.	1	½″	2″
Bruce	B-90	1	T 70	7,000′	24″x24″	300 lbs.	1	½″	2″
Charles	B-120	3	2T 40 1T 30 1T 70	11,000′	24″x24″	320 lbs.	2	½″	2½″
Curtis	B-120	2	1T 40	11,000′	24″x24″	330 lbs.	2	½″	2½″
Daniel	B-180	2	T 70	15,000′	28″x28″	365 lbs.	3	¾″	2½″
David	B-180	3	T 40	14,000′	28″x28″	355 lbs.	3	¾″	2½″
Dean	B-180	4	T 40	17,000′	28″x28″	370 lbs.	3	¾″	2½″
Delbert	B-180	5	T 30	18,000′	28″x28″	365 lbs.	3	¾″	2½″
Earl	B-300	1	T 250	25,000′	28″x28″	400 lbs.	5	¾″	3″
Edward	B-300	4	T 70	30,000′	28″x28″	425 lbs.	5	¾″	3″
Elmer	B-300	6	T 40	30,000′	28″x28″	455 lbs.	5	¾″	3″
Eugene	B-300	8	T 30	30,000′	28″x28″	460 lbs.	5	¾″	3″
Frank	B-500	2	T 250	50,000′	28″x28″	550 lbs.	5	¾″	3″

In addition to the WINSLOW INDUSTRIAL burner described here the Winslow Boiler & Engineering Company manufactures a complete line of fully automatic, residential and apartment house burners.

The gas and the electric ignition KLEEN-HEET burners, with the vacuum oil feed eliminating the usual basement auxiliary tank, are built in a total of nine sizes and are thus suitable for a great range of work.

The Junior KLEEN-HEET burners, without the vacuum feed but completely automatic in operation, are in two sizes. The No. 10 is rated at one thousand feet hot water and is suitable for the average home. The No. 6 is especially adapted to Arcolas and small domestic water heaters.

Inquiries to the INDUSTRIAL DIVISION of the WINSLOW BOILER AND ENGINEERING COMPANY, 208 South La Salle Street, Chicago, Illinois, will be promptly answered.

Lewis M. Ellison

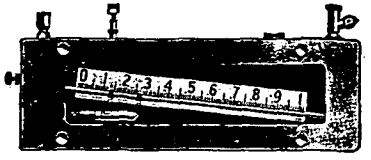
214 West Kinzie Street -:- CHICAGO, ILL.

ELLISON DRAFT GAGES
The Entering Wedge To Boiler Room Efficiency

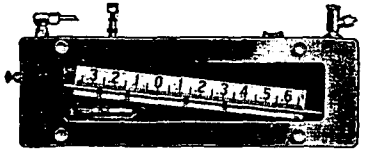
Ellison Draft Gages—the recognized standard for draft measurements—comprise a complete line of draft gages of the highest accuracy, quality, and finish, for every draft condition, completely equipped. The movement of oil in a glass tube is a fixed standard of measurement that stays calibrated—never changes.

The scales have sliding movement for quick zero adjustment, requiring no refilling for several years. Readings with red oil are visible across the boiler room.

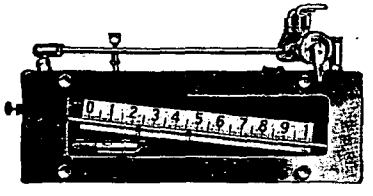
Bulletin of complete line on request



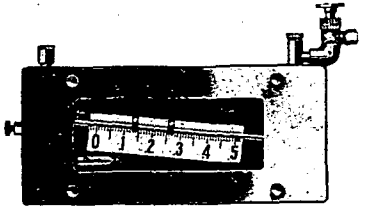
SINGLE-TUBE INCLINED: *This gage, for power boilers, is made in 1, 1½, 2, 3, 4, 6 inches scale range, suction or pressure.*



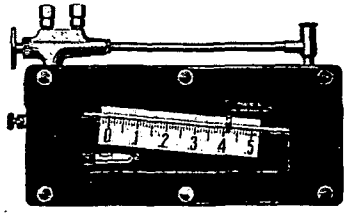
COMPOUND INCLINED: *This gage reads furnace draft to left, flue draft or differential to right of zero.*



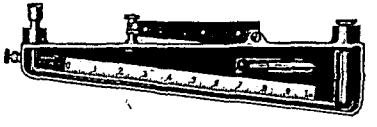
COMBINATION INCLINED: *By turning the handle of the cock, this gage reads furnace draft, flue draft or differential, 1, 1½ inch range.*



SINGLE-TUBE INCLINED: *This gage is for small boilers and furnaces, and for power boilers with operating draft not over the scale range of 3 inches. It is equipped with seal for 400 feet chimney height, natural draft.*



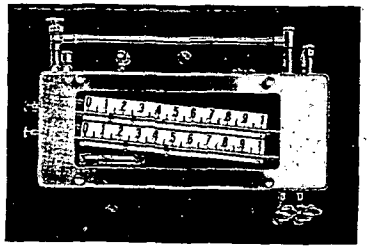
AIR FILTER GAGE: *This gage indicates the differential in air cleaning filters, piped from the inlet and outlet sides, complete with connections and casing inserts. Pointer is set for the highest permissible increase in differential for properly filtering the air—the most satisfactory and efficient filter gage known.*



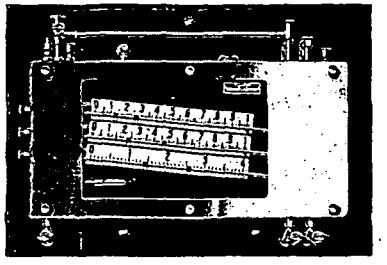
OPEN TYPE INCLINED: *For laboratories and technical institutions, 1, 1½, 2, 3 inches range. Suspension plate relieves the gage from mounting strains, level adjusted with left suspension. Furnished with and without portable attachments. White metal scale.*



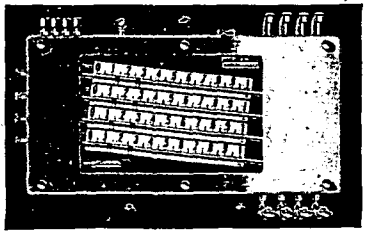
PORTABLE INCLINED: *This gage was designed for traveling engineers, light and compact, ¼, ¾, 1, 1½, 2 inches scale range. Furnished with attachments in pressed aluminum carrying case for one or two gages. Half-inch gage set ideal for heating engineers.*



TWO-TUBE INCLINED: *By means of the differential system, this gage reads 1 to 1½ inch furnace draft and differential simultaneously; flue and furnace drafts when differential cock is closed. Without differential system, 1 to 6 inches range.*

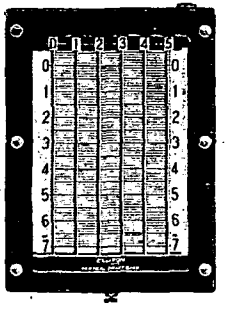


THREE-TUBE INCLINED: *This gage is furnished with or without differential systems, with scales 1 to 1½ inch range of like readings or a combination o readings from 1 to 6 inches scale range.*

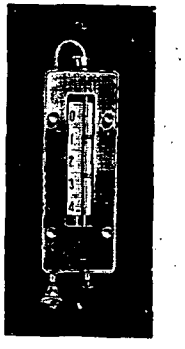


FOUR-TUBE INCLINED: *This gage reads suction or pressure, 1 to 1½ inches of like readings or a combination of readings from 1 to 7½ inches.*

MULTI-TUBE VERTICAL: *This gage is for the duct and zone pressures of forced draft traveling grate stokers. It is made in 3, 4, 5, 6, 7, 8 tubes, in 7 inch scale range, with while enameled sliding scale, requiring no refilling for several years. By means of an equalizer all chambers are filled in one filling. Furnished with panel or for gage board, complete with back connection fittings. Printed paper scales are furnished for marking the load curves, Firing Guide, inserted over the metal scale by simply removing the cover.*



SINGLE-TUBE VERTICAL: *This gage is made in three sizes, 4, 7, 12 inches scale range for suction, pressure or differential, for gage board and with or without panel.*



Like the stationary inclined gages, the scale is white enameled, readings visible across the boiler room. With the sliding scale feature, the gage requires no refilling for several years.

The efficient pressure range is carried between pointers, set by removing the cover.

DRYING SYSTEMS Inc.

ENGINEERS

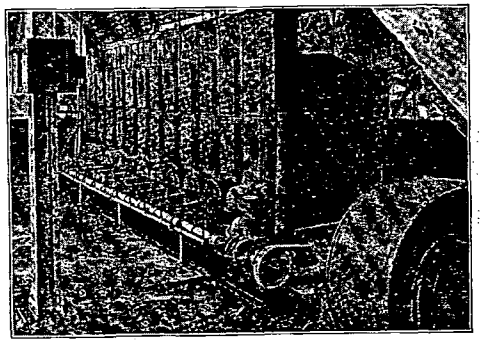
11 South Desplaines Street

CHICAGO-ILL.

Air Conditioning, Varnish Drying, High Temperature Baking Equipment and Heating Equipment.

WHILE the designing, manufacture and installation of drying systems is an essential part of our business, we should first be considered as engineers—specialists in problems involving drying, high temperature baking, processing, ventilating and air conditioning.

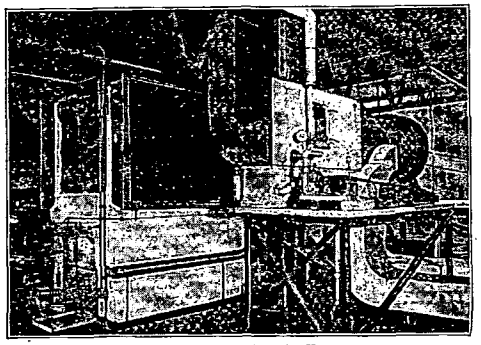
The accompanying photographs illustrate two types of Drying Systems, Inc., high temperature equipment which deliver air at temperatures ranging from 250 deg. to 700 deg. fahr. An air washer, or Phoenix Filter, is usually installed in connection with these heaters. This equipment, built in unit sections, is exceptionally economical, as well as entirely safe. It is being successfully applied for drying and baking decorative finishes in many diversified industries and for the processing of a number of different materials.



The Lawrence Heater

We manufacture an Induced Draft Heater, in which the working air is mixed with the products of combustion. This equipment is particularly adaptable for drying articles which are finished with a preservative coating, and for the drying of such materials as abrasives, insulating products and foundry cores.

Practically every drying or heating installation presents new conditions and different engineering problems. Our staff of experienced engineers, specialists in Air Conditioning, is available to analyze your individual requirements —without obligation. We invite correspondence and requests for literature covering any particular problem.



The Harrison Aertube Heater

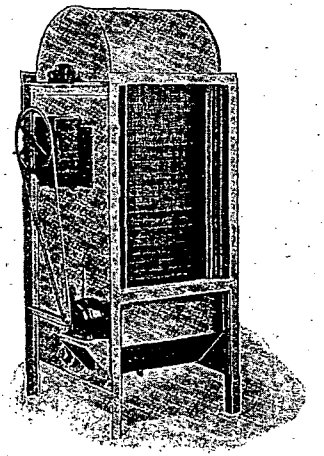


Typical Installation of Automatic Air Conditioning Equipment in Modern Bakery

The utilization of waste heat is a highly developed practice offering many opportunities for scientific waste heat equipment. Some unusual and very satisfactory installations of this equipment have been made in a number of different industries, practically eliminating hitherto material operating costs. Wherever hot, effluent gases are available, great economies can be effected by conserving this heat. In many cases such heat can be used advantageously for drying, baking and space heating, since the effluent gases are not mixed with the delivered air.

AIR CONDITIONING

By arrangement with the American Blower Company, manufacturers of Sirocco Equipment, and through the acquisition of a staff of specialists in this work, we are prepared to offer Air Conditioning Service in all its branches. Special installations for paper mills, bakeries, candy factories, public and manufacturing buildings have been conspicuously successful. Bulletins and information covering this subject will be forwarded on request. A consultation with our air conditioning specialists places you under no obligation.



The Phoenix Air Filter

The Phoenix Constant-Effect Air Filter is an advanced type of viscous film filter applicable for any service wherein clean air is required. This filter is automatic and comprises four important exclusive features, namely:

Unvarying Cleaning Efficiency
Constant Resistance
Self Cleaning
Minimum Operating Cost

The Phoenix Air Filter is built in sizes which are readily adaptable to any requirements—it is furnished in either single or double units, which range in capacity from 2,000 to 34,000 c.f.m. For larger air capacities, filters of three or four sections can be furnished. Bulletins covering this subject thoroughly and illustrating sizes and installations, will be sent upon request.

ESTABLISHED 1841

E. B. Badger & Sons Co.

Manufacturers of Expansion Joints for High and Low Pressure

OFFICE AND WORKS
63-75 Pitts Street, BOSTON, MASS.

SALES OFFICE
101 Park Avenue, NEW YORK

Badger Self-Equalizing Expansion Joints

The Badger Self-Equalizing Expansion Joints are made from special seamless copper tubing, fitted with cast iron or steel rings to control the expansion and provide equal distribution over each corrugation.

The joint is made in Standard and Extra Heavy patterns, and unless otherwise specified will be furnished with standard flanges for pressure up to 125 pounds and extra heavy flanges for all pressures from 125 pounds to 200 pounds.

Monel metal sleeves can be furnished fitting inside of the corrugations, for use with super-heated steam and other high temperature fluids, at additional cost.

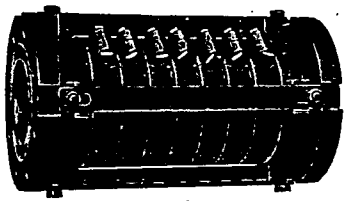


Fig. 1

This type of Joint is furnished in 4 in. and 5 in. sizes, with four and eight corrugations to take 1 in. and 2 in. of expansion. For smaller sizes, we furnish a 4-in. joint with companion flanges, bolts and gaskets, tapped for the size required.

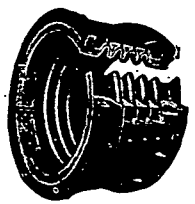


Fig. 2

This type of joint is made in sizes from 6 in. to 20 in. inclusive, with two, three, four or five corrugations, 2¼ in. deep, each corrugation taking ½ in. of expansion.

Specifications on Badger Expansion Joints

Fig. 1

Size Inches	FOUR-CORRUGATION			EIGHT-CORRUGATION			Add to List Prices for Extra Heavy Flanges
	Face to Face Inches	Finished Weight Pounds	Price Each	Face to Face Inches	Finished Weight Pounds	Price Each	
4	12⅜	65	$76.00	19⅜	95	$102.00	$4.60
5	12⅜	78	82.00	19⅜	110	110.00	5.35

For sizes up to 3½ in. inclusive, add $4.00 net to price of 4-in. joint for American Standard 125 pound companion flanges, bolts and gaskets; and $5.00 net for Extra Heavy American Standard flanges, bolts and gaskets, tapped to size required.

Fig. 2

Size Inches	Two Corrugation			Three Corrugation			Four Corrugation			Five Corrugation			Add to List Prices for Ex. Hy. Flanges
	F/F Inches	Fin. wt. Pound	Price Each	F/F Inches	Fin. wt. Pounds	Price Each	F/F Inches	Fin. wt. Pounds	Price Each	F/F Inches	Fin. wt. Pounds	Price Each	
6	12½	146	$126.00	16	200	$155.00	19	236	$187.00	22½	285	$216.00	$ 7.43
8	12½	187	156.00	16	250	188.00	19	293	211.00	22½	345	243.00	13.25
10	12½	258	182.00	16	325	219.00	19	395	254.00	22½	465	291.00	17.05
12	13	338	222.00	16½	410	262.00	19½	493	300.00	23	570	340.00	21.63
14	13½	404	252.00	17	490	296.00	20	576	337.00	23½	660	381.00	24.55
16	13½	476	285.00	17	570	334.00	20	672	382.00	23½	765	431.00	34.15
18	14	546	320.00	17½	645	374.00	21	760	428.00	24	851	483.00	53.84
20	15	669	388.00	18½	765	450.00	21½	911	511.00	24¼	1010	573.00	56.48

Sizes larger than 20 in. can be furnished on special order.

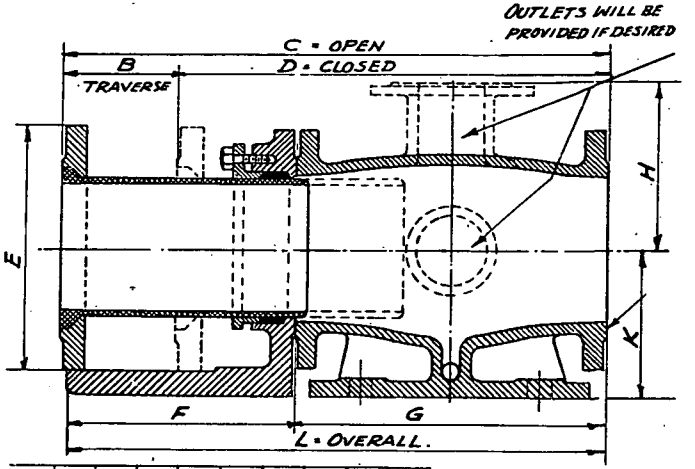
R. W. Sharon Co.

Offices 8060-61 Jenkins Arcade

PITTSBURGH :-: :-: :-: **PENNSYLVANIA**

SOLE MANUFACTURERS

We also manufacture the following articles under the Tyler Patents: Wall Brackets, Pipe Rests, Condensation Meters and Hot Water Meters



SIZE	B	C	D	E	F	G	H	K	L
1½									
2	2½	19⅝	17⅛	6¾	9⅜	10	5	5	19⅝
2½	2½	21⅛	18⅛	7¾	9⅜	11¼	5¼	5¼	21⅛
3	2¾	23⅜	20⅝	8½	9⅝	13½	6¼	5½	23⅛
3½	3	24⅛	21⅛	9¼	9⅜	14	7	6	23⅛
4	3¼	24⅛	21⅝	10¼	10⅜	14½	7¼	6⅜	24⅛
4½	3½	26⅜	23⅛	10¾	10⅛	16	7⅛	6⅝	26⅛
5	4	28⅜	24⅛	11⅛	10⅞	17	8½	6⅜	27⅛
6	5	30⅜	25⅛	12⅛	11⅜	18	9	8	29⅛
7	6	32⅜	26⅞	14¼	12⅜	19½	9¾	8½	32⅛
8	7	35⅝	28⅛	15⅛	13⅜	21°	10½	9⅛	34⅞
9	7	36⅜	29⅛	16½	13⅜	22	11	9¾	35⅛
10	7	37⅜	30⅞	17⅛	13⅜	23½	11¾	10½	37⅛
12	8	40⅞	32⅛	20⅛	14⅜	25½	12⅜	13⅜	40⅜
14	10	45⅜	35⅜	23¼	16⅜	28½	14⅛	13¾	45⅜
15	10	47⅜	37⅛	24⅛	16⅜	30	15	13¾	46⅜
16	10	48⅜	38⅜	25⅜	16⅜	31	15½	14½	47⅛
18	10	50⅜	40⅜	28½	16⅜	33	16½	15½	49⅜

Dimension Sheet for Style No. 1 Single Expansion Joint
All dimensions in inches

Specifications given in this Table for estimation purposes only. Working dimensions furnished on request.

Semi-steel construction for pressures up to 250 lbs.

Cast steel construction for pressures in excess of 250 lbs.

Sizes on single and double Expansion Joints larger than 18 in. and up to 36 in. can be furnished.

Tyler Joints never stick

Tyler Guided Single Expansion Joints

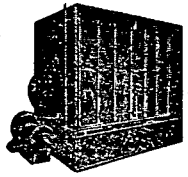
Type No. 102—Style No. 1

American Blower Company

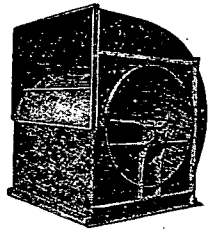
Detroit, Michigan

ATLANTA, GA., 614-615 Allen Bldg.
BALTIMORE, MD., 811 American Bldg.
BIRMINGHAM, ALA., 1308 American Trust Bldg.
BOSTON, MASS., 10 High Street
BUFFALO, N. Y., White Bldg.
CHARLOTTE, N. C., 208 Piedmont Bldg.
CHICAGO, ILL., 140 S. Dearborn Street
CINCINNATI, OHIO, 1109-11 Kieth Bldg.
CLEVELAND, OHIO, 526 Swetland Bldg.
COLUMBUS, OHIO, 321 First National Bank Bldg.
DALLAS, TEXAS, 1015 Mercantile Bank Bldg.
DAVENPORT, IOWA, 904 Kahl Bldg.
DETROIT, MICH., 2539 Woodward Ave.
DENVER, COLO., 1228 California Street
GRAND RAPIDS, MICH., 308 Shepard Bldg.
INDIANAPOLIS, IND., 819 Continental Bank Bldg.
KANSAS CITY, MO., 310-312 Mutual Bldg.
LOS ANGELES, CALIF., 405 Detwiler Bldg.
MILWAUKEE, WIS., 911 Majestic Bldg.
MINNEAPOLIS, MINN., 800-6 La Salle Ave.
NEWARK, N. J., 79 Ogden St.
NEW ORLEANS, LA., 521 Baronne Street
NEW YORK, N. Y., 50 Church Street
OMAHA, NEBR., 713 Peters Trust Bldg.
PHILADELPHIA, PA., Otis Bldg., 112 S. 16th Street
PITTSBURGH, PA., 2135-36 Oliver Bldg.
PORTLAND, ORE., 1006 Spaulding Bldg.
ROCHESTER, N. Y., 522 Cutler Bldg.
SALT LAKE CITY, UTAH, Dooly Bldg.
SAN FRANCISCO, CALIF., 737 Rialto Bldg.
SEATTLE, WASH., 605 Leary Bldg.
SCHENECTADY, N. Y., 147 Jay Street
ST. LOUIS, MO., 1221 Boatmen's Bank Bldg.
TACOMA, WASH., 1127-31 St. Paul Ave.

Manufacturers of Heating, Ventilating, Cooling, Purifying, Humidifying, Drying, Mechanical Draft, Conveying and Blast Equipment; Vertical Self-Oiling Steam Engines, Steam Traps; Fans and Blowers for All Purposes.



"Sirocco" System of Purifying, Cooling and Humidifying



For Purifying and Humidifying air in Schools, other Public and Semi-Public Buildings.

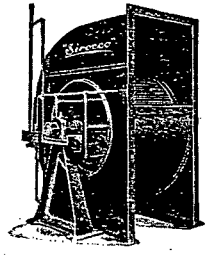
For Humidifying and Cooling Air in Textile Mills, Food and Confectionery Plants, Printing Houses, and other industrial Plants.

For Dehumidifying and Cooling in Candy Factories, Bakeries, Photo Film Drying Rooms, Blast Furnaces, Electric Generators, etc.

"Sirocco" Multiblade Fans and Blowers

For Heating, Ventilating and Cooling in Public, Office, Industrial and Educational Buildings.

For Drying and Mechanical Draft.

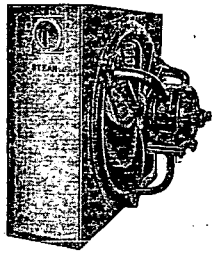


Several exclusive features make the "Sirocco" Fan the most efficient air-moving machine obtainable, for any of the many classes of service for which it is adapted. Its high efficiency is due to a design which, with large inlet, wheel without obstructions, specially curved blades and easy flowing lines, offers a minimum resistance to the passage of the air through the fan. These refinements in design are accompanied by a mechanical construction which is not only unusually rugged, but pleasing in appearance.

"ABC" Air Washing and Cooling Fan

The "ABC" Air Washing and Cooling Fan does the work of the centrifugal fan, the air washer and the pump required for circulating water in a separate washer, and does this with less power and with material reductions in installation, maintenance and operating costs. It is an automatic, highly effective and durable unit that adequately provides for purification, humidification and cooling.

The "ABC" Air Washing and Cooling Fan is used in Schools, Theatres, Clubs, Churches, Auditoriums, Stores and Industrial Buildings, where it insures good air conditions, conducive to comfort and increased working capacity. It requires a minimum of attention and occupies small floor space.



"Ventura" Disc Fans



"Ventura" Disc Fans deliver large volumes of air at low pressure or against low resistance. Cost of fan and installation is low and power consumption is insignificant. For ventilating rooms and buildings—pulley or motor driven—600 C. F. M. to 17,500 C. F. M.

"Venturafin" Unit Heaters

"Venturafin" Unit Heaters are light compact heating units of large capacity, adapted for heating many types of industrial buildings and for augmenting existing inadequate systems. Ranging in capacity from 125,000 to 650,000 B.t.u.

Bayley Manufacturing Co.

730 Greenbush Street **MILWAUKEE, WISCONSIN**

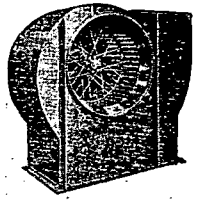
Branch Offices

NEW YORK CITY—Suite 503, 30 Church Street
CHICAGO, ILL.—1156 First National Bank Bldg.
CLEVELAND, OHIO—523 Penton Bldg.
DETROIT, MICH.—Purcell Stone Co., 2847 Grand River Ave.
ST. LOUIS, MO.—1928 Railway Exchange Bldg.
DES MOINES, IOWA—403 Observatory Bldg.
PITTSBURGH, PA.—Leiendecker Bros., Fulton Bldg.
SALT LAKE CITY, UTAH—P. W. Belcher, Dooly Block
INDIANAPOLIS, IND.—Geo. H. Jerge, 425 Board of Trade Bldg.

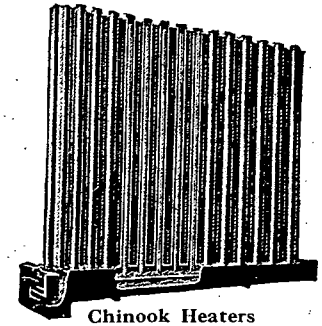
Heating, Ventilating, Air-Washing, Exhaust and Drying Equipment

Separate bulletins are issued on Air Washers, B.t.u. Heaters, Dryers, Chinook Heaters, Plexiform Fans, Exhaust Fans, Disc Fans. These will be furnished on request. The Company also furnishes engineering information in connection with the application of any of the products manufactured.

Plexiform Fans

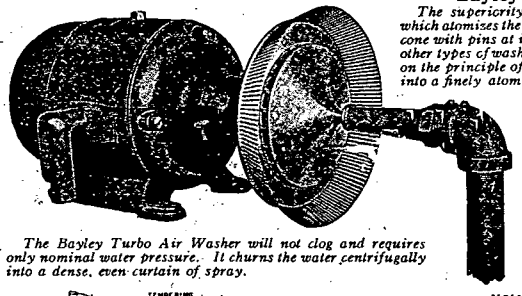


A well-balanced fan for ventilating public, office and industrial buildings, mines, tunnels, etc., and for heating, drying and air washing systems. Space and power economy are some of the advantages it offers. Complete information in Bulletin No. 26.



Chinook Heaters

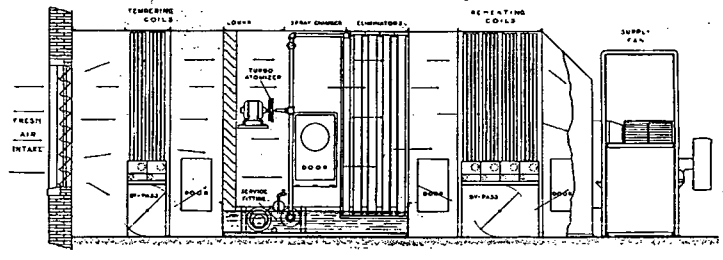
The Bayley Chinook Heater is a tube-within-a-tube radiator without return bends, elbows or nipples. Circulation is established from the steam chamber through the inner tube, and back through the outer tube to the return chamber. Used in connection with the Plexiform fan, also for indirect radiation, and for cooling water. Complete information in Bulletins Nos. 24 and 30.



The Bayley Turbo Air Washer will not clog and requires only nominal water pressure. It churns the water centrifugally into a dense, even curtain of spray.

Bayley Turbo-Air Washer

The superiority of this washer is in the atomizer which atomizes the liquid by means of a rapidly rotating cone with pins at its periphery. As distinct from all other types of washers, it will not clog because it operates on the principle of centrifugal force breaking the water into a finely atomized spray—the water is delivered to the revolving cone through a large orifice nozzle and at low pressure. This revolutionary non-clogging feature assures a steady, uniform spray with intimate contact between air and spray. No screen in pump intake requiring cleaning and no fine orifice nozzles to require attention because of clogging. The Bayley Atomizer fits any air washer. Washers made in various sizes for washing air or gases and for use in chemical plants. Complete information in Bulletin No. 25.



Buffalo Forge Company

Associated With

Carrier Air Conditioning Company of America

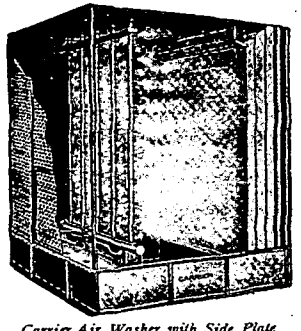
Buffalo, N. Y.

BRANCHES

New York, N. Y., 39-41 Cortlandt St.
Philadelphia, Pa., 1303 Land Title Bldg.
Boston, Mass., 177 State St.
Cleveland, O., Kirby Bldg.
Pittsburgh, Pa., 917 Union Arcade
Detroit, Mich., 1772 W. Lafayette Blvd.
Chicago, Ill., 562 W. Wash. Blvd.
Atlanta, Ga., Candler Bldg.
Washington, D. C., Washington Loan & Trust Bldg.
St. Louis, Mo., 515 Chemical Bldg.
Cincinnati, O., 606 Mercantile Library Bldg.
Minneapolis, Minn., 120 South Ninth St.
Denver, Colo., 1718 California St.
Los Angeles, Calif., 636 H. W. Hellman Bldg.
Indianapolis, Ind., 1016 Fletcher Trust Bldg.
San Francisco, Calif., Sharon Bldg.
Seattle, Wash., 905 Olympic Way

CANADIAN BRANCH

Canadian Blower and Forge Co., Kitchener, Ontario



Carrier Air Washer with Side Plate Removed. Note Spray in Operation

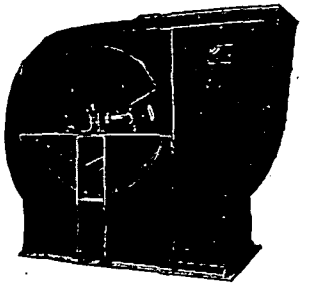
CARRIER AIR WASHERS

One-piece eliminators and scrubbers that are easily assembled in a few minutes and give greatest cleaning effect known. Spray nozzles prevented from clogging by tank-width screen. Original efficiency is maintained indefinitely by a few minutes flushing out each week.

Power Blowers and Exhausters have cast iron housings and are for belt or direct motor drive.

Mill Exhausters. Standard and slow speed, high efficiency, and single or double exhausters are furnished for handling refuse or dust. For belted or direct drive.

Buffalo Duplex Conoidal Fans, shown below, maintain even pressure and good efficiency over a greater range of air demand than is possible with any other construction. Best adapted to schools, public buildings, offices, etc. Moderate speed for direct connection to motor.



Send for Catalogue

Buffalo Niagara Conoidal Fans handle large quantities of air at high efficiency under big overloads in industrial plants. Low speed and great capacity well suited to belt drive.

Buffalo Disc Fans are very useful for removing steam, odors or foul air in shops, mills and factories. Belted or direct motor driven types.

Buffalo Stoker Fans have highest efficiency at normal load where it counts most, utmost proven reliability, and high speed for direct connection to turbine or motors. They completely protect motors.

Buffalo Products

Conoidal Multiblade Fans
Carrier Air Washers
Pipe Coil Heaters
Ventilating Sets
Disc Fans
Humidifiers
Generator Coolers
Gas Scrubbers
Stoker Fans
Induced Draft Fans
Planing Mill Exhaust Fans
Dust Collectors
Pressure Blowers
Drying Apparatus
Spray Nozzles
Forge Shop Equipment

Clarage Fan Company

Kalamazoo, Michigan

Boston, Chicago, Cleveland, Los Angeles, Minneapolis, St. Louis, Buffalo, Denver, New York, Philadelphia, Pittsburgh, Birmingham, Ala., Detroit, Omaha, Atlanta, Charlotte, N. C.

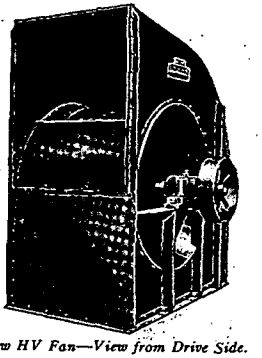
Consult Telephone Directory for Street Address of any of above Branch Offices

Products—Heating and Ventilating Fans and Allied Apparatus, Multiblade Fans, Air Washers, Exhaust Fans, Pressure Blowers, Mechanical Draft Equipment, Heaters, Vertical Steam Engines.

New Type HV Fan—Tested in accordance with the Standard Test Code, prepared by National Association of Fan Manufacturers and American Society of Heating and Ventilating Engineers. New HV Fan, single inlet, shows 77 per cent maximum efficiency. Average multiblade fans show approximately 63 per cent maximum efficiency. This higher efficiency allows saving of 15 to 20 per cent in power requirements to drive. Lower power requirement often allows use of smaller motor or engine, saving 10 to 15 per cent. Often HV Fan one size smaller will meet specifications, saving 15 to 20 per cent in first cost of fan equipment.

Built in complete range of sizes for heating and ventilating schools, offices, theatres, churches, factories etc. Capacities from 500 to 236,000 C. F. M. Constructed strong and sturdy for continuous duty with low upkeep. Furnished with babbitted, self-aligning, ring-oiling bearings, having special felt washer feature which keeps oil in and dirt out. Can be motor, engine or turbine driven by belt or direct connected.

Improved Type V Washer—Spray nozzles so perfected that dense mist screen is obtained with lower pump pressures, effecting marked saving in horse power for operating pump. Spray nozzles cannot clog. New construction of eliminator plates greatly simplifies erection. Suitable for all types of washed air installations. Performance fully guaranteed. Range of sizes to cover every requirement.



New HV Fan—View from Drive Side.

Cooperative Service—Our engineers have compiled elaborate data on every Clarage product. This data will prove valuable in selecting equipment. We will gladly cooperate in every way possible. Write for Clarage literature.

HV FAN CAPACITIES AT 1200′ OUTLET VELOCITY

Size of Fan	Volume of Air C. F. M.	¼″ S. P.		½″ S. P.		¾″ S. P.		1″ S. P.	
		R. P. M.	B. H. P.	R. P. M.	B. H. P.	R. P. M.	B. H. P.	R. P. M.	B. H. P.
1½	2,322	327	.22	402	.31	479	.43	549	.55
1¾	3,156	281	.29	345	.43	410	.58	471	.74
2	4,128	245	.38	301	.56	358	.76	411	.97
2¼	5,220	217	.48	267	.70	317	.96	364	1.22
2½	6,444	197	.59	242	.86	287	1.19	330	1.51
3	9,288	164	.85	201	1.24	239	1.71	275	2.17
3½	12,660	136	1.22	170	1.80	204	2.32	236	2.90
4	16,524	120	1.59	149	2.35	179	3.03	206	3.79
4½	20,880	106	2.00	132	2.96	158	3.83	183	4.79
5	25,800	96	2.47	119	3.65	143	4.74	165	5.92

HV FAN CAPACITIES AT 1800′ OUTLET VELOCITY

Size of Fan	Volume of Air C. F. M.	½″ S. P.		¾″ S. P.		1″ S. P.		1¼″ S. P.		1½″ S. P.		1¾″ S. P.		2″ S. P.	
		R. P. M.	B. H. P.	R. P. M.	B. H. P.	R. P. M.	B. H. P.	R. P. M.	B. H. P.	R. P. M.	B. H. P.	R. P. M.	B. H. P.	R. P. M.	B. H. P.
1½	3,482	480	.68	530	.83	579	.97	628	1.13	683	1.30	726	1.46	775	1.65
1¾	4,734	412	.93	454	1.12	497	1.32	538	1.53	585	1.77	622	1.98	665	2.24
2	6,192	360	1.21	397	1.47	433	1.73	470	2.00	512	2.31	544	2.59	580	2.93
2¼	7,830	319	1.53	351	1.85	384	2.18	417	2.53	453	2.92	481	3.26	514	3.70
2½	9,666	289	1.88	318	2.29	348	2.69	377	3.12	410	3.61	436	4.04	465	4.58
3	13,932	241	2.71	265	3.29	290	3.88	314	4.46	341	5.20	365	5.81	388	6.59
3½	18,990	199	3.70	223	4.44	244	5.07	265	6.01	286	6.77	309	7.65	332	8.70
4	24,786	175	4.83	195	5.80	214	6.62	232	7.86	250	8.82	270	10.0	290	11.4
4½	31,320	155	6.09	173	7.30	189	8.35	206	9.92	222	11.1	240	12.5	258	14.4
5	38,700	139	7.54	156	9.03	171	10.3	185	12.3	200	13.8	216	15.6	232	17.8

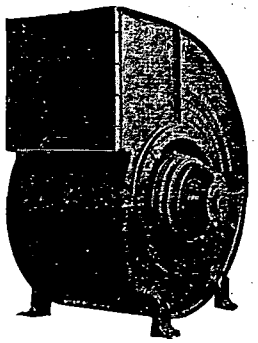
Range of Sizes include No. ¼ to No. 9 inclusive.

Ilg Electric Ventilating Company

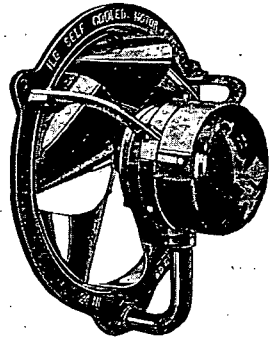
General Offices and Works:
2880 N. Crawford Avenue ∴ CHICAGO, ILL.

NEW YORK
13 Park Row
PHILADELPHIA
325 Commercial Trust Bldg.
BALTIMORE
Hearst Tower Bldg.
ST. LOUIS
1421 Syndicate Trust Bldg.
CLEVELAND
1314 Schofield Bldg.
PITTSBURGH
1024 Bessemer Bldg.
MINNEAPOLIS
442 Builders Exchange Bldg.
CINCINNATI
903 Union Central Bldg.
LOS ANGELES
600 Metropolitan Bldg.
DETROIT
204 Owen Bldg.
BOSTON
136 Federal St.
INDIANAPOLIS
514 Board of Trade Bldg.
ROCHESTER
941 Granite Bldg.

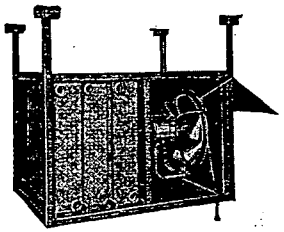
HIGH EFFICIENCY TRADE ILG MARK VENTILATING MACHINERY



Ilg Universal Blowers—Direct Connected and Belted—no bearings in inlet. Ball-bearing, grease lubricated motors. Sizes 10 in. to 100 in.



Ilg Self-Cooled Motor Propeller Fans, all sizes for any current or voltage, kept in stock 12 in. to 72 in.



Ilgair Unit Heaters with Patented Adjustable Deflector. For floor type or ceiling type. Lowest power consumption—easily connected to outside air.

CATALOGS

Complete Catalog, 200 Pages
Condensed Catalog, 48 Pages

BULLETINS

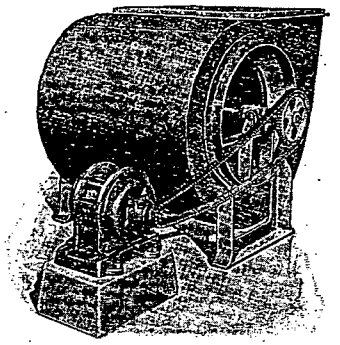
Unit Heaters
Garage Heating
Fog Reduction and Steam Removal
Restaurant Ventilation
Residence Ventilation
Store and Office Ventilation
Power Roof Ventilators
Farm Ventilation
Fans and Blowers for Railroads
Industrial Ventilation
Ilg Fans Everywhere

The New York Blower Company

CHICAGO, ILL. **LAPORTE, IND.**

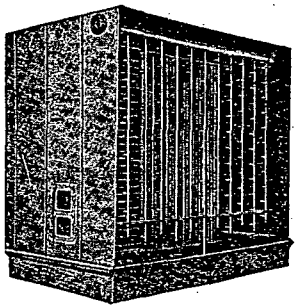
SALES OFFICES IN PRINCIPAL CITIES

Fans—Blowers—Heaters—Air Washers—Engines—Ventilators—Forges

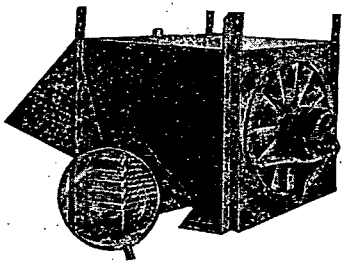


TYPE M. E. SERI-VANE Fans for the heating and ventilating of public buildings, schools, theatres, factories, mines, etc. Bulletin Number 100 has complete data. Fans for mechanical draft, conveying systems, foundries, gas plants, stokers, etc. Pulley driven or motor driven disc and propeller fans of wide range.

PEERLESS Air Washers for public and industrial buildings. Cooling systems for theatres, auditoriums, churches, department stores, etc.



Humidifiers and de-humidifiers for special processes and drying as paper, textiles, tobacco, glue, leather and wood.



COMET UNIT HEATERS for economical heating and ventilating where steam is used. Bulletin Number 85.

FAN FURNACES for churches, factories, schools, etc., requiring heat without any steam plant. Bulletin Number 90.

Special Unit Heaters for offices, libraries, and factories.

SPECIAL DESCRIPTIVE BULLETINS OF EACH PRODUCT WILL BE GLADLY SENT.

L. J. Wing Mfg. Co.

Branch Offices in Principal Cities — **663 Hudson St., NEW YORK** — PHONE: CHELSEA 0027-0030 — **Factory: NEWARK, N. J.**

Manufacturers of Wing Featherweight Unit Heaters, Wing Turbine and Motor Driven Blowers, Wing-Scruplex Fans and Exhausters

Wing Featherweight Unit Heaters

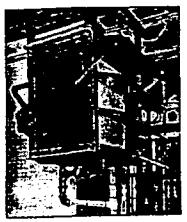
The outstanding features of Wing Featherweight unit heaters are their extreme light weight (about one-tenth that of the old style) and small dimensions, combined with the fact that driving motors are direct connected (no belts) and are out of the path of heated air.

These features open a much broader field of application for this system of heating—which is generally accepted by engineers and architects as the best system for industrial plants and other buildings of large open areas such as garages, armories, etc.

The features emphasized make possible suspending the units from ceiling or roof of any building, old or new, without necessitating additional strengthening of the structure; and the overhead installation makes it possible to run all steam and return lines overhead out of the way.

Wing Featherweight unit heaters heat the floor or working level first. Being placed near the roof or ceiling, they withdraw the heated air which tends to accumulate there and return it to the working level where it is needed. Considerable economy is effected by reducing the temperature directly under the roof where heat transmission is always the greatest.

Wing Featherweight unit heaters are made in four different designs: vertical, high ceiling, vertical medium ceiling, vertical low ceiling, and horizontal.



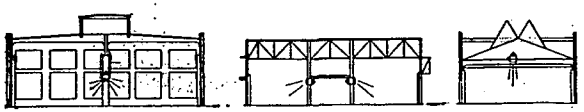
Horizontal Type

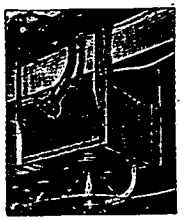
Methods of Installation

The cuts show three different methods of installation, the units in each case being located well above the head line, out of the way. The third illustration shows the high ceiling type heater installed thirty feet from the floor above a traveling crane. The column of heated air leaves the heater with sufficient velocity to strike the floor with considerable force from this point, but by the aid of adjustable diffusers the column is divided and directed so that no objectionable velocity is felt at the head line. The best and most economical installation of Wing Featherweight unit heaters is when they are placed close to the roof or ceiling.



Vertical High Ceiling Heater

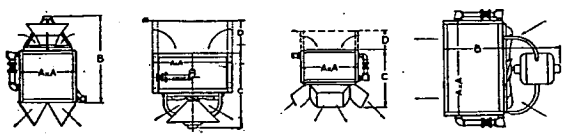




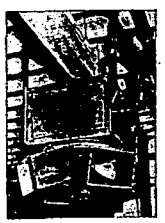
Vertical Medium Ceiling Heater

Condensed Table of Engineering Data

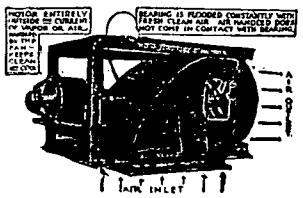
Size Unit	A x A In.	B In.	C In.	D In.	Air C. F. M.	Motor H. P.	Temperature Room	Temperature Leav.	B.t.u. per Hr. Available	Approx. Shipping Weight
17-3-12	23 x 23	24	24	6	1950	1/4	65	113	92,500	210
22-3-12	28 x 28	27	27	6	3200	1/3	65	115	157,000	270
22-4-12	28 x 28	27	27	6	2800	1/3	65	125	162,600	280
22-5-12	28 x 28	27	27	6	2600	1/3	65	135	173,200	290
25-4-12	33 x 33	27	27	7	4800	1/2	65	125	279,000	320
25-5-12	33 x 33	27	27	7	4500	1/2	65	135	300,000	330
30-4-85	35 x 35	33	33	8	6900	1	65	125	401,000	360
30-5-85	35 x 35	33	33	8	6500	1	65	135	433,000	360
36-4-85	41 x 41	39	39	8	9600	2	65	125	558,000	500
36-5-85	41 x 41	39	39	8	9000	2	65	135	599,400	530



Wing Featherweight Unit Heaters



Vertical Low Ceiling Heater



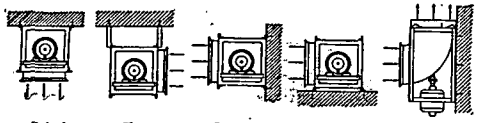
Wing-Scruplex Exhauster

WING-SCRUPLEX EXHAUSTERS

Wing Scruplex Exhausters consist of the highly efficient "screw propeller" fan and cased in appropriate manner with a motor on the outside where it is clean, cool and easy of access. They are used in duct work where the resistance is low and being designed in the form of an elbow fit snugly in any line. The accompanying diagrams show the methods of installation.

Proper Selection of Exhausters—Where particularly quiet operation is desired, as in offices, residences, hospital wards, churches theatres, etc., use lowest speeds in all sizes. For toilet rooms, laboratories, motion picture booths, stock-rooms, etc., use any speed in sizes 1 and 2; low and medium speeds in all other sizes. In industrial plants, hotel and restaurant kitchens, engine-rooms, workshops, etc., use any speeds.

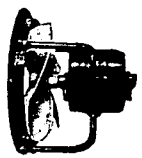
The accompanying table gives performances at static pressures up to ½ in. Complete table up to 1 in. static on request.



Bolted directly to Ceiling — *Hung from Ceiling* — *Bolted directly to Side Wall* — *Bolted to Floor or Foundation* — *Vertical Bolted to Side Wall*

"WING-SCRUPLEX" EXHAUSTERS

Size	Inlet Sq. In.	Outlet Round, In.	Speed R. p. m.	Free Air Cu. f. m.	Free Air Hp.	.15 in. Cu. f. m.	.15 in. Hp.	.25 in. Cu. f. m.	.25 in. Hp.	.40 in. Cu. f. m.	.40 in. Hp.	.50 in. Cu. f. m.	.50 in. Hp.
1-A	10	10½	1750	850	0.052	630	0.054	330	0.060	.....	.....	.....	.....
2-A	13½	14⅛	1150	1440	0.060	950	0.069	395	0.090	.....	.....	.....	.....
2-B	13½	14⅛	1750	2050	0.195	1895	0.208	1695	0.216	1155	0.248	750	0.285
3-S	16¼	17⅛	850	2130	0.090	1250	0.110	.....	.....	.....	.....	.....	.....
3-A	16¼	17⅛	1150	2700	0.180	2150	0.195	1550	0.221	.....	.....	.....	.....
3-C	16¼	17⅛	1750	4000	0.600	3720	0.635	3510	0.655	3150	0.700	2810	0.720
4-S	21	21¾	850	2850	0.100	2200	0.125	1610	0.150	.....	.....	.....	.....
4-A	21	21¾	1150	3575	0.170	3150	0.200	2775	0.220	1950	0.245	1550	0.280
4-C	21	21¾	1750	5400	0.540	5160	0.600	4990	0.650	4670	0.710	4440	0.750
5-A	25	25	1150	5200	0.330	4720	0.380	4250	0.440	3300	0.530	2610	0.600
5-B	25	25	1750	8000	1.330	7740	1.360	7540	1.400	7175	1.480	6900	1.540
6-A	30	30	600	5500	0.210	3725	0.250	2375	0.330	.....	.....	.....	.....
6-B	30	30	850	7400	0.550	6280	0.600	5450	0.740	4000	0.830	3400	0.960
6-C	30	30	1150	10250	1.500	9520	1.550	8950	1.570	8000	1.620	7340	1.760



Wing-Scruplex Fan

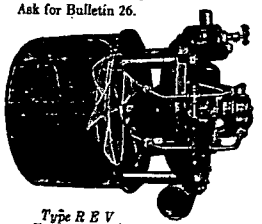
WING-SCRUPLEX FANS

Wing Scruplex Fans are built in the following sizes: 10 in., 13 in., 17 in., 22 in., 25 in., 30 in., 36 in., 42 in., 54 in., and 60 in. Capacities from 950 C. F. M. to 33,000 C. F. M. Up to 25 in. diameter, propellers are made of cast aluminum alloy while the larger sizes are of pressed steel.

WING FORCED DRAFT BLOWERS

The Wing Type E M blower makes the ideal forced draft for heating boilers. This small, compact propeller fan outfit is an integral unit, ready to install. No belting or coupling; the fan is right on the motor shaft. Where the base of the boiler is not high enough to accommodate the fan casing, the blower is provided with feet for mounting, placed a short distance away and connected to the boiler by means of a small piece of duct. E M units are furnished either in D. C., polyphase or single phase with speed regulation; or with squirrel cage motors and damper regulation.

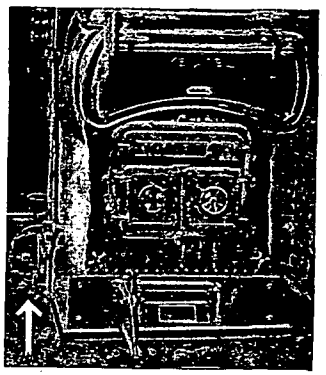
Ask for Bulletin 26.



Type R E V Turbine Driven

The Wing Turbine Blower, while long considered standard equipment for supplying forced draft to hand-fired boilers, has in more recent years become widely used for stokered boilers as well, a single blower delivering enough air to develop as high as 1000 h. p. Either manual or automatic operation may be had.

Ask for Bulletin 67.



Type E M Motor Driven

Atlanta, Ga.
Boston, Mass.
Buffalo, N. Y.
Camden, N. J.
Chicago, Ill.
Cincinnati, O.
Cleveland, O.
Dallas, Tex.
Denver, Colo.
Detroit, Mich.
Hartford, Conn.
Indianapolis, Ind.
Kansas City, Mo.

B. F. Sturtevant Co.

Hyde Park, Boston, Mass.

Sturtevant
PUTS AIR TO WORK

PLANTS LOCATED IN

CAMDEN, N. J. — HYDE PARK, MASS. — FRAMINGHAM, MASS.
STURTEVANT, WIS. — GALT, ONT. — BERKELEY, CALIF.

Los Angeles, Cal.
Minneapolis, Minn.
Montreal, P. Q.
New York, N. Y.
Pittsburgh, Pa.
Portland, Ore.
Rochester, N. Y.
St. Louis, Mo.
Salt Lake City, Utah
San Francisco, Cal.
Seattle, Wash.
Toronto, Ont.
Washington, D. C.

PRODUCTS

Heating and Ventilating Equipment

Multivane Volume Blowers and Exhausters; Propeller and Disc Type Volume Exhaust Fans; Heaters; Air Washers; Engines and D. C. Motors; Galvanized Duct Work; Portable Ventilating Sets; Autoforce Ventilators.

Power House Equipment

Fuel Economizers; Mechanical Draft Apparatus; Turbine and Steam Engine Generator Sets; Gasoline Electric Generator Sets; Generator Cooling; Steam Engines; Steam Turbines; Transmission Gears.

Industrial Equipment

High Pressure, Medium Pressure and Low Pressure Blowers; Volume Blowers; Planing Mill Exhausters; Cupola Blowers; Gas Blowers and Boosters; Gas Exhausters; Forges and Forge Blowers; Acid Proof Fans; Pneumatic Collecting and Conveying Systems; Steam Exhaust Heads.

Air Conditioning Equipment

Paper, Glue, Wood and Leather Drying, Vapor Absorption Systems; Air Washing, Humidifying and Dust Removing Systems; Dehumidifying Systems.

Vacuum Cleaning Equipment

Stationary Plants for Home and Industrial Use; Portable Vacuum Cleaners of all sizes for all work.

Engineering Service

As every installation presents certain factors which must be analyzed before the proper apparatus can be recommended intelligently, our engineering staff is trained to study each problem thoroughly. Consult them, they are at your service without obligation.

Publications

The STURTEVANT line is so varied that a comprehensive presentation in one publication is undesirable. We have, therefore, issued a special bulletin on each particular line, covering the mechanical details.

CATALOGS

Air Conditioning

No. 295 Air Washers.
25 Air Washers—Canadian
278 Air Conditioning.
246 Generator Cooling.
Climate Doctors.

Drying

No. 298 Sturtevant-Brownell Dryer.
299 Drying Systems.
243 Paper Drying.
1052 Vegetable Dryers.
314 High Humidity Lumber Dry Kilns.
289 Hosiery Dryer.
305 Poultry Manure Dryer.

Heating and Ventilating

No. 283 Autoforce Ventilators.
230 Heaters.
215 Heating and Ventilating Treatise.
1014 Heating and Ventilating Government Buildings.
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1013 Heating and Ventilating Public Buildings.
1012 Heating and Ventilating Schools.
279 Disc and Propeller Fans.
290 Silentvane Fans.
306 Hot Blast Heater.

Mechanical Draft

No. 236 Forced Draft Fans.
276 Turbo Undergrate Blowers, Design 3.
286 VD-7 Turboblower.
288 Forced and Induced Draft with Mechanical Stokers.

Pneumatic Collecting and Conveying Systems

No. 262 Granite Dust Removal Systems.
245 Cotton Fans, Design 7.
234 Steel Plate Blowers and Exhausters.
252 Steel Plate Fan Performance Charts
292 Pneumatic Collecting and Conveying Systems.

Power Apparatus

No. 222 Fuel Economizers in Paper Mills.
255 Gasoline Electric Generating Sets.
239 Steam Engine Generating Sets.
311 Steam Turbines.
311 Steam Turbine Generating Sets.
263 VS-7 and 8 Engines Instruction Book
307 Marine Engines.
309 Turbo Transmissions.
275 Gear Transmissions.
284 Polyphase Motors.
301 Cindervane Fans.

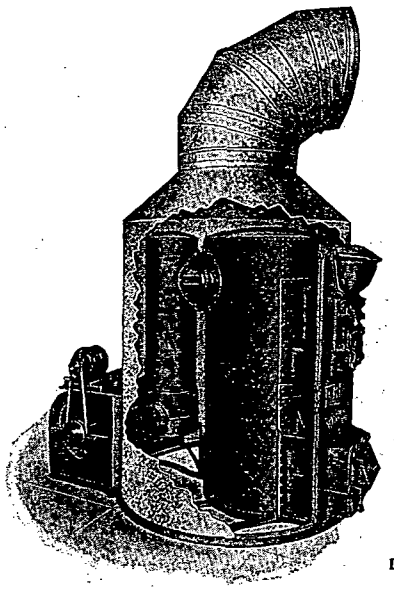
Langenberg Manufacturing Co.

4549 No. Euclid Ave. :: ST. LOUIS, MO.

FRONT RANK

TRADE NAME REGISTERED

Dealers in all parts of the United States



FRONT RANK
UNIT HEATER

Results speak for themselves.

Ample capacities, a wide flexibility and a most economical use of power used and energy created makes this system a most desirable one from a user's and architect's point of view.

Churches, Schools, Stores, Auditoriums, etc., are being successfully heated and ventilated by this modern system.

A most complete engineering staff and department is maintained by this Company for the designing of work that requires heating, ventilation and air conditioning.

We specialize in high class residential heating plants.

The following data is given complete for the use of Architects and Engineers.

Installations made anywhere in the United States and Canada.

DATA ON FRONT RANK UNIT HEATER

No. of Fan Units	Diam. Casing Inches	Diam. Drum Inches	Diam. Fire Pot Inches	Depth Fire Pot Inches	Area of Grate Sq. In.	Diam. of Rad. Inches	Height of Rad. Inches	Height of Drum Inches	Height of Unit Overall With One-Way Outlet	Diam. Smoke Pipe Inches
U-453	45	22	20	15	283	10	35	58	8'	9
U-513	51	26	23	15	380	11	35	59	8'	9
U-573	57	29	26	15	490	13	38	62	8'-9"	10
U-661	66	32	29	19	616	18	41	69	9'-6"	10
U-661-H	66	32	29	19	616	18	58	97	12'	10

Area of Outlet In Sq. In.	Size at Feed Door Openings Inches	Cu. Ft. Air per Minute Fan	Cu. Ft. Air per Minute Gravity Approximately	R. P. M. of Fan	Diam. of Fan Inches	H. P. Required	Approximate Shipping Weight Including Motor Lb.	B.t.u. Guaranteed at 9 lb. per sq. ft. (See Note)
452	12x13½	3500	1400	365	18	½	1350	180,576
616	12x13½	3900	1570	390	18	½	1550	252,396
707	12x13½	4400	1750	314	21	¾	1850	314,640
1018	12x13½	5900	2400	238	24	¾	2150	383,040
1018	12x13½	7000	2600	275	24	1	2250	406,980

NOTE:—When burning Illinois Coal producing about 12,000 B.t.u. as ordinarily burned. Other fuel will give different rating. Unless otherwise specified, furnace will be rated on 9 lb. of coal per sq. ft. of grate when estimated.

Moncrief Furnace Co.

Atlanta, Ga.

Henry Furnace & Foundry Co.

Cleveland, Ohio

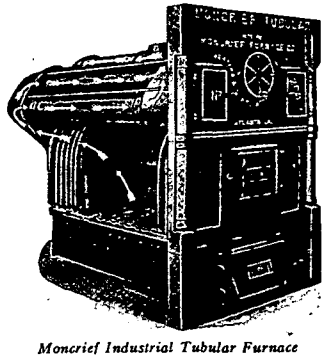
MONCRIEF INDUSTRIAL TUBULAR FURNACE

Cast Iron Construction

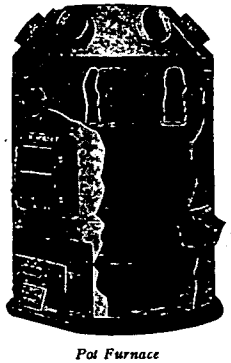
A heat generator of high efficiency for heating churches, schools and industrial plants with the fan blast system.

Weight 5000 lb., grate surface 7 sq. ft. Radiating surface 320 sq. ft. Capacity 780,000 B.t.u. per hour.

Installed singly or in batteries with steel or brick casing. Adapted for coal or oil burning.



Moncrief Industrial Tubular Furnace



Pot Furnace

MONCRIEF WARM AIR FURNACES

All Cast Top Return Flue

Moncrief No. 500A Series Pipe and Pipeless Furnaces are supplied with auxiliary wood burning grates. Equipment includes water pan, regulator and poker.

Grates are triangular, four in number and practically self-cleaning. Fire pots made in two pieces. Feed Section in one piece. Radiators, two piece, cast with smoke and cleanout collars, cast as part of radiator—not bolted on.

SPECIFICATIONS

Furnace No.	Diameter of Firepot in inches	Ratio of Heating Surface to Grate Surface	Diameter of Casing in inches	Free Area Through Casing in sq. in.	Leader Pipe Capacity in sq. in.	Grate Area in sq. ft.	B.t.u. Capacity Delivered at Register, 7½ lbs. per sq. ft. grate, per hour	Diameter of Smoke Pipe in inches
20-A	20	24 : 1	36	368	438	1.39	55,200	8
22-A	22	22 : 1	40	487	574	1.97	78,000	9
24-A	24	21 : 1	44	558	684	2.4	94,500	9
27-A	27	20 : 1	48	726	835	3.02	120,000	9
530-A	30	21 : 1	56	1044	1050	3.68	145,000	10

Leader Pipe Capacities Are Dependent Upon Pipe Sizes Being Figured In Accordance With The Standard Code.

The XXth Century Heating & Ventilating Co.

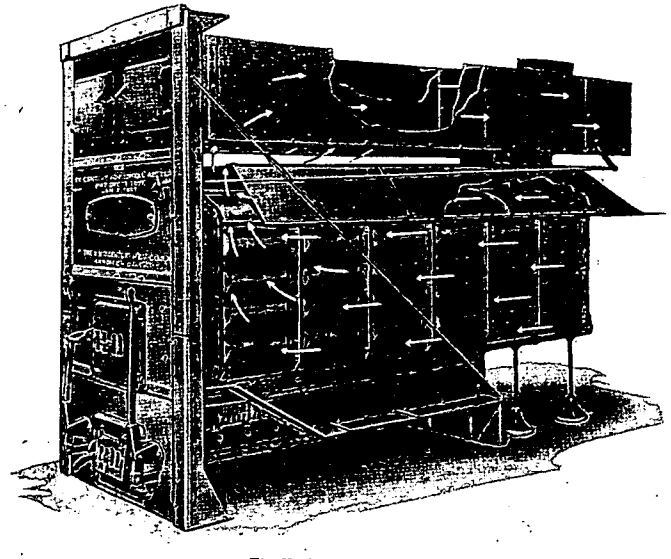
General Office and Factory

Akron, Ohio

Manufacturers of Warm Air Furnaces, Steam and Hot Water Boilers

The Horizontal Flow Heater is a new design in warm air furnace construction especially effective when used with fan system for heating schools, churches and large public buildings.

Manufactured in six sizes for ordinary service but can be installed in battery with as many units as may be required for special cases.



The Horizontal Flow Heater
Pat. Dec. 13, 1921—Jan. 23, 1923

We will furnish estimates on your requirements upon receipt of plans and specifications.

We also manufacture a full line of both hard and soft coal furnaces for residence heating.

Catalogs and descriptive matter will be gladly furnished upon application.

SKINNER BROTHERS MANUFACTURING COMPANY INC.

Main Office and Factories 1490 South Vandeventer Ave., St. Louis, Mo.
Eastern Office and Factories 170 Bayway, Elizabeth, N. J.

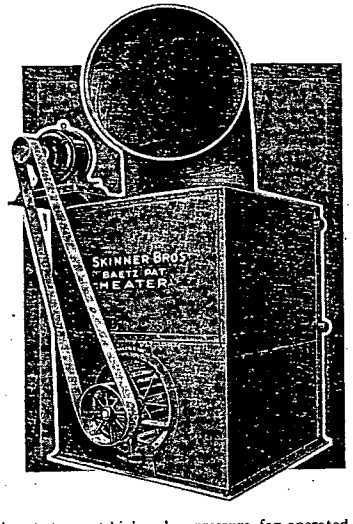
Sole and exclusive manufacturers of Skinner Bros Steam Coil Heater, Skinner Bros Direct Fired Heater, Skinner Bros Slow-Speed Dust-Collecting System, Skinner Bros Revolving Siphon Ventilator, Skinner Bros Patented Fan Blast Dryer Outfit, Exhaust Heads, Exhaust and Blow Piping, Slow-Speed Fans, Buffing and Emery Wheel Systems.

Direct Factory Branches in the Following Cities

BALTIMORE, MD.	2 E. Lexington Street	MINNEAPOLIS, MINN.	802 Met. Life Bldg.
BOSTON, MASS.	445 Little Bldg.	NEW YORK, N. Y.	1702 Flatiron Bldg.
BUFFALO, N. Y.	702 Morgan Bldg.	PHILADELPHIA, PA.	1711 Sansom Street
CHICAGO, ILL.	1703 Fisher Bldg.	PITTSBURGH, PA.	715 Magee Street
CLEVELAND, OHIO	612 Marshall Bldg.	SAN FRANCISCO, CALIF.	
DETROIT, MICH.	308 Scherer Bldg.	SPOKANE, WASH.	409 First Ave.
INDIANAPOLIS, IND.		WASHINGTON, D. C.	714 Evans Bldg.

Sales Offices in All Principal Cities

SKINNER BROS STEAM COIL HEATER



Skinner Heater excels through scientific construction and simplicity of operation, it responds immediately, performs constantly and at lowest cost. This heater will continually maintain a uniform comfortable temperature, at all times, permeating the remotest corners and recesses of the open spaces in a plant or factory, multi-story building, one or more floors of any type of building or size of space to be heated, regardless of weather conditions or temperature fluctuations.

Skinner Bros Steam Coil Heater is a single enclosed unit which contains a series of steam coils compactly mounted over a powerful multivane fan wheel. No outside pipes or ducts are used for air distribution. Humidity is properly controlled at all times. This ductless heater is the pioneer and the originator of the ductless system for heating, ventilating and air conditioning of multi-story buildings, one or more floors in factories, industrial plants, mills and building, of every type and size where steam is available.

When operated as a heater, cold air near the floor level or from outside is drawn into the unit and after being thoroughly warmed during its passage upward and around the steam coils, it is gently diffused through outlet hood to all parts of the building. Every part of the open building space is kept at a uniform, comfortable working temperature, even in the coldest weather.

Skinner Heater is constructed in the floor type and the inverted type for overhead suspension. Use live or exhaust steam at high or low pressure, fan operated by any power available. Most economical heating equipment possible to obtain and maintained at a cost that is exceedingly low. Completely assembled before shipment. Heaters are portable, require no special foundation, can be easily moved and relocated by common labor, ready for operation without delay.

Skinner Heater will also dry textiles, soaps, fruits, vegetables, candies and all similar products. They are particularly adapted for steam and vapor removal in packing plants, creameries, laundries, paper mill machine and beater rooms, textile and woolen mills, drying and cleaning establishments in which their installation guarantees the prevention of condensation, drippage and excessive moisture, and are recommended for controlling humidity in printing plants. Skinner Heaters are positively guaranteed to give satisfactory performance under all conditions when the heaters are installed as directed by our engineers.

Skinner Bros Steam Coil Heater is built in eight (8) standard sizes and three (3) models, delivering 50,000 to 3,000,000 B. T. U.'s and Skinner Bros Direct Fired Heater is built in three (3) standard sizes and two (2) designs, with B. T. U. deliveries from 150,000 to 1,500,000.

Complete information concerning the size units in which Skinner Bros Steam Coil Heaters are manufactured, with the size motor required, and their equivalent of direct radiation, will be cheerfully given on request.



SKINNER BROS DIRECT FIRED HEATER

Designed for use in plants, factories, mills, foundries, machine and railway shops, roundhouses, single floor, monitor and multi-story buildings of every type and size, where steam is not available. Constructed on correct mechanical and scientific principles. Supplies proper distribution of heat units and holds a uniform, fixed temperature under all conditions. The pioneer ductless system of heating, ventilating and air conditioning which insures the greatest economy. Simplicity of operation, low cost of installation and maintenance, securing maximum amount of heat with minimum amount of fuel, requiring very limited floor space, are compelling features of a Skinner Heater.

Skinner Bros Direct Fired Heater burns coal, coke, wood, gas or oil. Skinner Heaters equipped with oil burning attachments are ideal. Wherever used these installations have received the highest endorsement. Heaters are sturdily built and tested to stand the constant intense heat generated by oil burners. Skinner Heaters do not create drafts or air blasts. Every part of the building is thoroughly and uniformly heated. Heaters are portable, can be easily moved, quickly relocated, ready to use.

Brief Description of Skinner Bros Direct Fired Heater

All internal parts consisting of fire pot, combustion chamber, ash chamber and doors are made of heavy cast iron. Heater is solidly built throughout. Grate bars are triangular with diamond-shaped edges, close fitting with extended shaker rod, and removable shaker bar. Ample air space is provided for to obtain perfection combustion. Fan is of the improved multivane type, acknowledged to be the best for air distribution, and rigidly built. It delivers a maximum amount of air with a minimum expenditure of power. Fan is operated by any power available. The Fan Housing is so constructed that the wheel can be removed from either side. The air inlet at the bottom of the heater is so constructed that air may be drawn into the heater from out of doors if desired.

Provides More Heat at Less Cost

No distributing ducts are required to maintain an even temperature in the largest space with this heater. The fan draws in the cold air at the bottom, passes it over the heated surface and out at the top of the heater, establishing a steady movement of air throughout the room and away from the heater at the top and back but towards the fan at the floor. The forced draft damper gives a wide range for intensifying the fire and an accurate control of fuel consumption. With this damper, the air force created by the operation of the fan can be directed through the grates to the burning fuel to whatever extent desired, keeping the fire at all time under perfect control.

Skinner Heaters Will Cool and Ventilate Your Plant in the Summertime

Skinner Bros Direct Fired Heater is not only an unexcelled heater but it serves as an air conditioner and cooling system in hot weather. When acting as such it is operated without firing, the powerful multivane fan drawing cold air from the floor level or from out of doors and gently casting it through the overhead hood over the entire space in the building. With the steam supply shut off, Skinner Bros Steam Coil Heater functions in warm weather in the same manner.

Skinner Heater is built in various units and for each particular requirement. The size heater and most desirable location for it will be recommended upon receipt of a floor plan or a rough sketch of the building in which the heater is to be installed. Skinner Heaters of both types are fully guaranteed, when installed as directed by our engineers, to keep every part of the building at a comfortable working temperature, at all times, regardless of weather conditions.

Complete information concerning the size units in which Skinner Bros Direct Fired Heaters are manufactured, with the size motor required, will be cheerfully given on request.

The Herman Nelson Corporation

Moline, Illinois

BRANCH SALES AND SERVICE STATIONS

Belfast, Me.	Philadelphia	Cleveland	Des Moines	Emporia	Spokane
Boston	Scranton	Columbus	Milwaukee	Omaha	Portland
New Haven	Pittsburgh	Toledo	Minneapolis	Kansas City	Seattle
New York City	Grand Rapids	Indianapolis	St. Louis	Denver	Vancouver
Syracuse	Detroit	Chicago		Salt Lake City	Toronto

Product: UNIVENT System of Ventilation.

Univent: The UNIVENT, which is electrically operated draws fresh air through the wall or window, cleans it, warms it to a comfortable temperature and diffuses this fresh air to every nook and corner of the room.

There are six UNIVENT models: "S," "S-D," "R," "O," "W" and "W-R."

Each of these models are made in various sizes and capacities to meet most problems in ventilation.

Cabinet: All models are 38 in. high. Model "S" and "S-D" 12½ in. deep, model "R," "O," "W" and "W-R" are 16 in. deep. The width of the various models vary according to their capacity.

The UNIVENT cabinet is built of high grade furniture steel, properly re-inforced to insure utmost rigidity and durability.

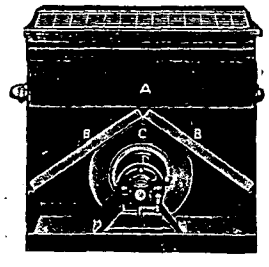
The light front panel is easily removed making all parts accessible for cleaning and inspection. The cabinet is regularly finished with two coats of olive green enamel, baked on.

Radiator: The radiator is made of pure copper plates securely and tightly pressed to core of special silumin metal. Silumin metal is non-corrosive. This is a leak-proof, high capacity, last-forever radiator, with low temperature surface.

It heats air from 40 deg. below zero to 70 deg. or from zero to 110 deg. when the UNIVENT is in operation.

Univent Fan and Motor: A single aluminum low speed fan is used. No housing is necessary for this fan.

All models of UNIVENT can be equipped with direct or 60 cycle alternating current motors, and are recommended in the following order: Direct-current, poly-phase, alternating current, single-phase alternating current.



Open View of UNIVENT Illustrating
A—Copper radiator without a single joint, absolutely leak-proof.
B—Air filter easily removable for cleaning.
C—Cone type fan specially insulated for quiet operation.

UNIVENT
(TRADE MARK)

Ventilation

Filter: Filters for removing dirt, dust, soot and sand from the air can be installed in the UNIVENT if desired. No nuts, bolts or screws are necessary for installation.

Automatic Temperature Control: Any well known system of temperature control may be used with the UNIVENT System.

Capacities: Four sizes of each model with capacities varying from 500 to 1500 cu. ft. of air per minute can be furnished.

Service Stations—Information: Representatives and Service men are located in each of the cities listed above.

Catalogs containing complete engineering data can be furnished on request to our main office at Moline, Illinois.

John J. Nesbitt, Inc.

ESTABLISHED 1894

Manufacturers of

The Universal Unit Ventilation System

EXECUTIVE OFFICE AND FACTORY

213 N. Vermont Avenue

Atlantic City, New Jersey

Branch Offices and Representatives

ST. PAUL, MINN.

PORTLAND, ORE.
POWER EQUIPMENT CO.,
816-17 Lewis Bldg.

SEATTLE, WASH.
POWER EQUIPMENT CO.,
1347 Dexter-Horton Bldg.

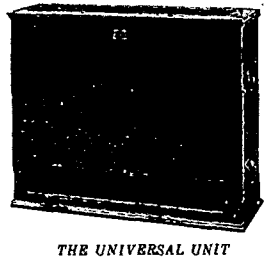
Branch Offices and Representatives

NEW YORK CITY.
JOHN J. NESBITT, INC.,
405 Lexington Ave.

DENVER, COLO.
HENRIED & BOLTHOFF
MFG. AND SUPPLY CO.,
1621 Seventeenth St.

MINNEAPOLIS, MINN.

DULUTH, MINN.



THE UNIVERSAL UNIT
The Standard by Which All Other Makes are Measured
Trade Mark Reg. U. S. Pat. Office

Products

Manufacturers of the UNIVERSAL combined heating and ventilating Units. (Portable Unit ventilators). Also UNIVERSAL exhaust fans and UNIVERSAL air filters.

Universal Unit System of Heating and Ventilating

A mechanical system of ventilation for supplying fresh warm air directly from outdoors for use wherever good ventilation is required and particularly suitable for school house ventilation.

Universal Combined Heating and Ventilating Units

The cabinet of the UNIVERSAL UNIT is constructed of No. 14 gage cold rolled, stretched leveled, pickled and oiled first quality furniture stock steel. All parts of the UNIVERSAL UNIT are finished in olive green, sprayed and baked to a smooth hard finish.

Fans

UNIVERSAL Fans are of the multi-blade low speed double inlet type, designed to operate at 800 r. p. m., plus or minus 5 per cent. The fans are rigidly constructed of aluminum with special care given to balance. Fans are mounted on double extended ends of the motor shaft.

Motor

Motor of UNIVERSAL UNIT can be supplied to operate on any voltage of direct current or any cycle or voltage of polyphase alternating current. Where single phase current is available, it is necessary to install a motor generator set to convert that character of current to 110-volt direct current.

Three-Point Lead Mounting

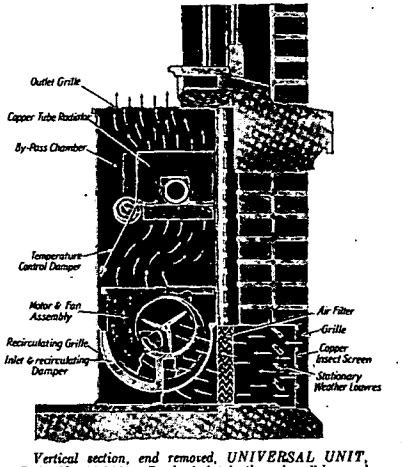
The motor and fan, assembly of the UNIVERSAL UNIT is mounted in the cabinet on three steel ball points. These points rest on lead liners, supported by angles from the side of the casing. This three-point lead mounting has made possible the use of polyphase alternating current motors with a permanent and rigid supporting device.

Universal Unit Radiator

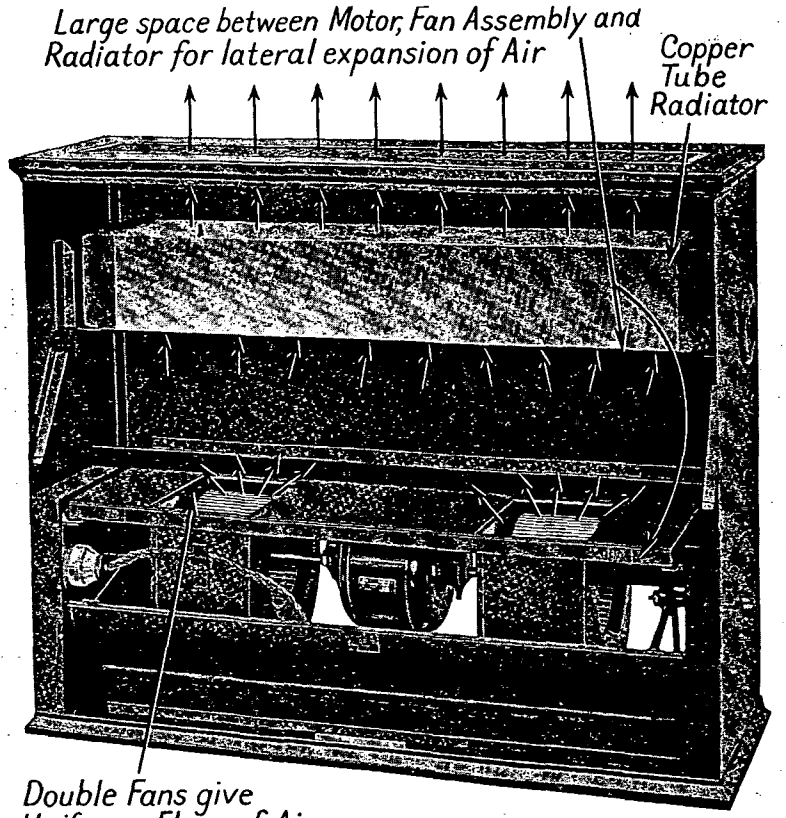
Standard UNIVERSAL UNITS are provided with 106.25 sq. ft. of prime surface extruded copper tube radiation. The radiator weighs only 61 lbs. complete. This radiator is composed of a plurality of individual, thin walled, seamless copper tubes the ends of which are hexagonal and assembled resemble a true honey-comb in appearance. The steam is free to flow between the tubes in both a vertical and horizontal direction. The air flows through the tubes, so that the tubes are entirely surrounded by steam on one side and swept by air on the other side, which means 100 per cent prime surface.

Temperature Control Damper

The UNIVERSAL UNIT is provided with a temperature control damper, which can be manually or thermostatically operated to regulate the temperature of air from Unit.



Vertical section, end removed, UNIVERSAL UNIT, Series No. 14-3643. Fresh air intake through wall box and grille near bottom of Unit. This Unit can be recessed to depth of 4 in. as shown, recess must be 60 in. long by 36 in. high, or can be recessed 2 in. in 43 in. long recess 36 in. high. Standard practice places the Unit flush with the inside wall.



UNIVERSAL UNIT Series No. 14-3643 one piece front and by-pass division plates removed, showing radiator and motor fan assembly in place. Entire operation of removing and replacing front and by-pass requires less than three minutes

Inlet and Recirculating Damper

Each UNIVERSAL UNIT is arranged so that air can be brought from outdoors, warm, if desired, and circulated in the room, or can be recirculated and reheated within the room, as desired. This is accomplished by means of a circular roll damper of aluminum. This damper can be manually controlled at the cabinet, or pneumatically controlled from some remote point.

Universal Air Filters

The use of air filters is especially recommended for buildings located in congested manufacturing districts, or where the air is heavily laden with dust or soot. UNIVERSAL air filters are of the adhesive impingement type, designed to fit in the fresh air intake of the UNIVERSAL UNIT. In this location the velocity of air over the entire surface of the filter is uniform with the result that an equal amount of work is imposed throughout its entire area. Combined with this ideal location is a set arrangement, which provides ease and simplicity of removal and replacement, when cleaning is necessary.

Catalog and Engineers' Data Book

A copy of our "*Catalog and Engineers' Data Book*," containing complete engineering data, specifications, etc. on UNIVERSAL UNIT Ventilation System, will be furnished upon request to our executive office.

TABLE OF CAPACITIES
Final Temperatures and Condensations

STEAM—218 DEG. 2 LBS. GAUGE

Temp. Entering Air Deg. F.	1500 Cu. Ft. of Air per Minute or 90,000 Cu. Ft. of Air per Hour—Universal Unit Series No. 14-3643-15 and 18-3643-15					1200 Cu. Ft. of Air per Minute or 72,000 Cu. Ft. of Air per Hour—Universal Unit Series No. 14-3643-12 and 18-3643-12				
	Final Temp. of Air	British Thermal Units	Sq. Feet Surface in Radiator	Condensation per Sq. Ft. in Rad.	Total Condensation in Radiator	Final Temp. of Air	British Thermal Units	Sq. Feet Surface in Radiator	Condensation per Sq. Ft. in Rad.	Total Condensation in Radiator
−10	100.31	210115	106.25	2.06	218.87	103.1	175440	106.25	1.72	182.75
0	106.63	201955	106.25	1.98	210.37	109.4	168297	106.25	1.65	175.31
10	112.65	192777	106.25	1.89	200.81	115.73	161155	106.25	1.58	167.87
20	119.28	183600	106.25	1.80	191.25	122.04	154012	106.25	1.51	160.43
30	125.63	175440	106.25	1.72	182.75	128.35	145852	106.25	1.43	151.93
40	131.93	166252	106.25	1.63	173.18	134.67	138720	106.25	1.36	144.50
50	138.23	157075	106.25	1.54	163.62	140.97	131577	106.25	1.29	137.06
60	144.43	148915	106.25	1.46	155.12	147.37	123417	106.25	1.21	128.56
70	150.83	139737	106.25	1.37	145.56	153.67	116275	106.25	1.14	121.12
Current Consumed Watts Hour	A. C. 146 Watts			D. C. 143 Watts		A. C. 118 Watts			D. C. 102 Watts	

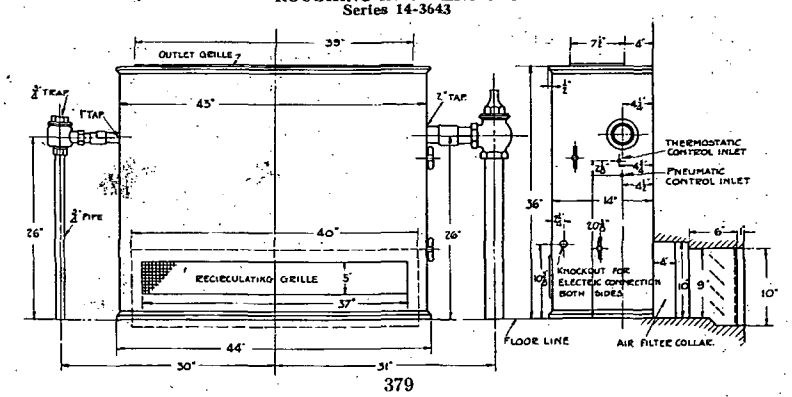
Temp. Entering Air Deg. F.	900 Cu. Ft. of Air per Minute or 54,000 Cu. Ft. of Air per Hour—Universal Unit Series No. 14-3643-9 and 18-3643-9					600 Cu. Ft. of Air per Minute or 36,000 Cu. Ft. of Air per Hour—Universal Unit Series No. 14-3643-6 and 18-3643-6				
	Final Temp. of Air	British Thermal Units	Sq. Feet Surface in Radiator	Condensation per Sq. Ft. in Rad.	Total Condensation in Radiator	Final Temp. of Air	British Thermal Units	Sq. Feet Surface in Radiator	Condensation per Sq. Ft. in Rad.	Total Condensation in Radiator
−10	112.96	139737	106.25	1.37	145.56	123.18	103017	106.25	1.01	107.31
0	119.3	133612	106.25	1.31	139.18	130.6	98937	106.25	0.97	103.06
10	125.64	128515	106.25	1.26	133.87	137.02	93840	106.25	0.92	97.75
20	131.98	122400	106.25	1.20	127.5	143.42	89760	106.25	0.88	93.50
30	138.23	116275	106.25	1.14	121.12	149.79	85680	106.25	0.84	89.25
40	144.68	110160	106.25	1.08	114.75	156.29	83635	106.25	0.82	87.12
50	150.98	105052	106.26	1.03	109.43	.....	.....	.....	.....	.....
Current Consumed Watts Hour	A. C. 90 Watts			D. C. 90 Watts		A. C. 80 Watts			D. C. 83 Watts	

When a fine adjustment is desired for obtaining either a smaller or larger volume of air than a given set of fans discharge from a given line voltage, air volume regulators will be furnished.

The air volume regulators consist of curved plates, which may be readily adjusted to further open or close the fan discharge opening.

The adjustment of these plates for a smaller air delivery reduces the amount of current consumed.

ROUGHING-IN DIMENSIONS
Series 14-3643

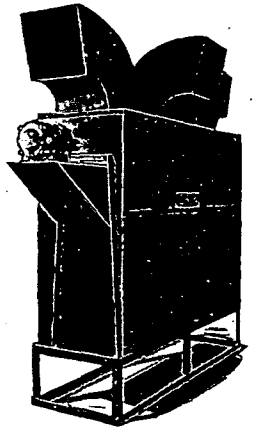


York Heating and Ventilating Corp.

1502 Locust Street :: PHILADELPHIA

Unit Heaters—Unit Fans—Rotary Ventilators—Stationary Ventilators—Cyclone Dust Collectors—Damper Quadrants—Blast Gates—Drying Trays—Radiator Brackets—Sheet Metal Work and Light Structural Iron Fabrication.

YORK "WELDED COIL" UNIT HEATER



GENERAL ADVANTAGES

1—Low Power Consumption, balanced fan running on ball bearings, combined with straight path of air thru unit reduces power requirements to a minimum. The total cost of electric power over an entire heating season is negligible.

2—By removing a few bolts at each end of the unit, the entire housing, outlets, motor, shaft, coupling and fans, all assembled together, may be removed and the coils left bare as shown by the photo on the right.

3—Base of the unit is open on all four sides, hence air is drawn from the floor, where it is naturally coldest. This simplifies connection to outside air when same is desired, for it can easily be made by a rectangular duct from any one side.

4—Units can be arranged for suspension from ceiling or roof truss, or they can be mounted on special supports allowing headroom underneath.

SPECIAL FEATURES

1—Standard Unit is direct connected to motor, by means of a flexible coupling. This costs no more than a belt driven unit. Standard motor speeds are used—see capacity table on next page.

2—Balanced Double Inlet Fan of centrifugal type, with volute housing, distributes air over desired areas.

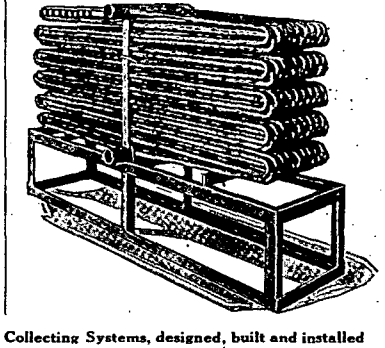
3—Welded Pipe Coils, no joints to leak, therefore, no maintenance. Pipe coils are staggered, insuring efficient warming of air. Coils are tested to 300 lb. pressure and are good for 150 lb.

4—Operates equally well on vacuum, low or high pressure steam.

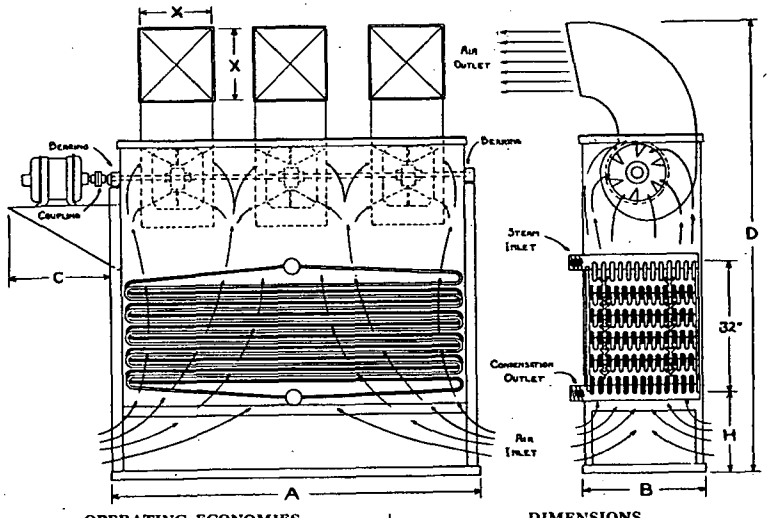
5—Ball Bearings, self aligning, dustproof type, mounted outside the housing. Bearing maintenance is thus avoided and lubrication made easy.

6—Unit Stands on Floor hence no overheating of upper part of building before lower part is heated. Heat zone is within ten feet of floor.

7—Ventilation—Unit will heat and ventilate simultaneously, if desired.



Complete Heating, Ventilating, Drying and Dust Collecting Systems, designed, built and installed



OPERATING ECONOMIES

It is unnecessary to run York Unit Heaters continuously to obtain an appreciable amount of heat, as is the case with horizontal unit heaters or a blower system. In the morning the units can be run for a short time to bring the room up to the proper temperature and to start the air in circulation. The power can then be shut off and the circulation thus started will continue (although at a slower rate) due to the air motion set up and to the stack or aspirating effect caused by the height of the unit.

OPERATION

Air enters the unit at the base from all four sides, passes upward around the welded pipe coils, through the fan and then distributed by the outlets in any direction desired. Unit may be automatically controlled by a thermostatic switch.

DIMENSIONS

No. of Unit	A	B	C	D	X	H	No. of Outlets
25	47	17	13	85	11⅜	13¼	2
35	88	17	17	85	11⅜	13¼	4
45	11	21	19	110	19½	19¼	2
55	11	29	22	110	19½	19¼	3
60	11	29	23	110	19½	19¼	3
65	11	44	24½	110	24	19¼	3
75	11	58	24½	118	24	23¼	3

CAPACITIES

Size Unit	R. P. M.	A. P. M.	H. P. Motor	Recirculating Air at 60° F. Entering Unit 5 lbs. Steam Pressure			Sq. Ft. Heating Surface	Equiv. Sq. Ft. Direct Radiation	Weight With Motor	No. of Steam Conn.
				B.t.u.*	Final Temp.	Lbs. Cond. Per. Hr.				
25	1750 1160	3000 2000	¾ ¼	200,000 141,000	128° 135°	208 147	140	800	1150	1
35	1750 1160	6050 4000	1¼ ½	439,000 320,000	135° 144°	456 333	280	1800	1900	1
45	1160 870	8300 6000	3 1	620,000 470,000	136° 141°	645 489	360	2500	2450	1
55	1160 870	11700 8700	3 1	920,000 740,000	143° 149°	958 770	520	3700	3300	1
60	1160 870	13300 9700	5 2	1,020,000 815,000	141° 148°	1062 848	520	4000	3500	1
65	1160 870	18300 13900	7½ 3	1,420,000 1,160,000	141° 147°	1478 1208	800	6000	6000	1
75	870 690	21800 17700	7½ 3	1,700,000 1,400,000	146° 152°	1770 1460	1040	7000	7000	2

*Note—To get BASIC Rating (i. e., 0 entering and 5 lb. pressure), multiply B.t.u. given by 1.35. See Guide 1925-26, page 223, for B.t.u. Constants.

AEROFIN CORPORATION

750 Frelinghuysen Avenue
Newark, N.J.
L. C. SOULE, Sec'y and Chief Engineer

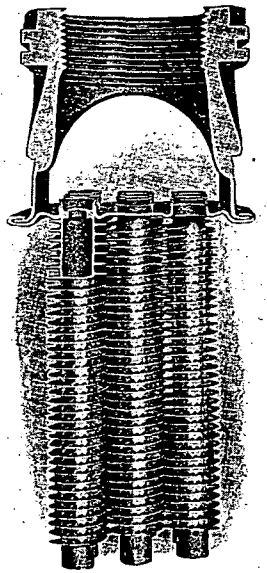
Manufacturers of

AEROFIN

Fan System Heating and Cooling Surface

Type of Heater

AEROFIN Standard Units (except for the galvanized casings) are constructed entirely of brass and copper. The seamless copper tubes (5/8 in. O. D.) are wound with a helical crimped brass fin which is mechanically soldered to the tube while the fin is held tightly in place, so that a perfect metallic union is effected providing an excellent conducting medium for the heat. The fin surface is 80 per cent of the total surface, thereby effecting remarkable lightness in weight and great compactness.



Section through Header, Tapping Hub, Tube Plate, Orifice Ring and Tubes, showing construction of AEROFIN

Construction Advantages

The superiority of AEROFIN is demonstrated by its light-weight, non-corrosive features, unit construction, space saving, and because it comes to the job already encased and ready for steam connections. AEROFIN is furnished in various sizes of standard units which may be bolted together to make batteries of any number of units high, wide or deep (in the direction of air flow).

Our catalogue will be gladly sent on request to any architect, engineer, or contractor desiring same for the purpose of specifying exact sizes of AEROFIN UNITS or for obtaining complete information regarding the construction and installation of these units.

Weight

AEROFIN weighs from 9 to 16 per cent of equivalent cast-iron heaters and from 12 to 25 per cent of equivalent pipe coil heaters.

Two men can easily handle any of these AEROFIN Units.

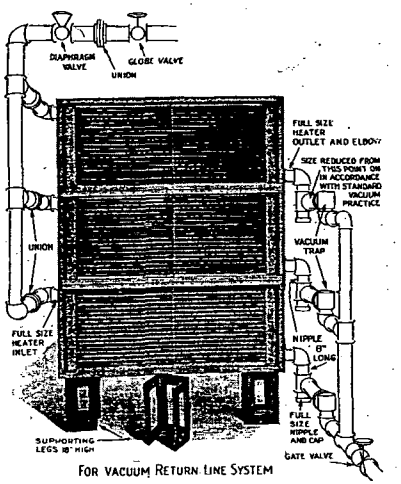
Compactness

Several units may be assembled together like a sectional bookcase by simply bolting through the template-punched flanges.

AEROFIN Units are furnished in tube lengths ranging from 2 ft. to 12 ft. and with either one, two or three rows of tubes deep in each unit. There is only one standard size of header which makes the width of the units 29 in. over the casing flanges. The length of the casing is the tube length plus 8½ in.

AEROFIN batteries have about the same face area as is required by other blast heaters, but a great deal of space is saved in the direction of air flow. The 3-row units occupy only ¼ the depth of that required by other heaters, 2-row units save ⅓ the depth and the single row units have the same 10 in. depth as is required for other types of heaters.

The galvanized steel casing with its template-punched flanges provides a means for direct attachment of the duct work or for the fastening of another set of batteries onto the back or front of the first battery, by simply bolting through the flanges.



FOR VACUUM RETURN LINE SYSTEM

Comparative Installation Costs

The first cost of AEROFIN (completely encased) sometimes appears higher than the cost of other heaters (quoted without casing) but when the saving in erection and freight is considered, the installed cost for AEROFIN is generally less than that for other types of heaters.

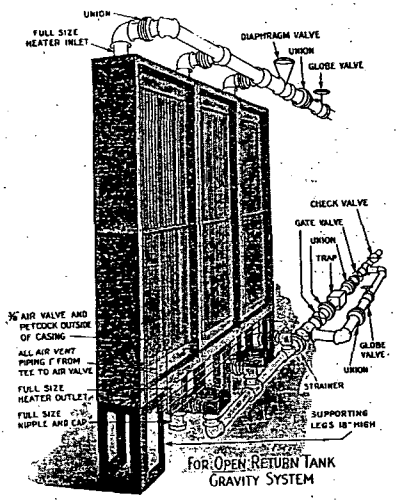
In figuring installation costs, add to the price of cast-iron heaters and pipe coils an additional 6 or 7 cents per sq. ft. of heating surface for the galvanized steel casing. AEROFIN has its galvanized steel casing as an integral part of the unit. The average *labor cost* of installing cast-iron heaters and pipe coils is 10 to 12 cents *more* per sq. ft. of heating surface, than the cost of installing AEROFIN. Remember that all sizes of AEROFIN UNITS can be handled by two men, without block and tackle.

Erection

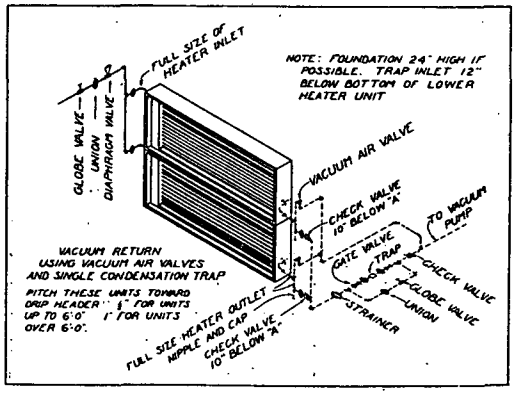
AEROFIN is so light and sturdily encased that it can easily be supported on steel legs which are furnished as a standard accessory at a small charge.

No extra reinforcement of the building construction required with AEROFIN—may be suspended from ceiling with small angles and rods, without expensive platforms — may be handled with only ordinary care and assembled without using any block and tackle or scaffolding.

AEROFIN can be erected in the same number of HOURS as would be required in DAYS to erect the heavy heaters.



FOR OPEN RETURN TANK GRAVITY SYSTEM



Figuring Capacities

The performance tables and physical data tables cannot be published here on account of the great amount of space required, but these data are contained in our catalogue which will be gladly sent on request.

In our catalogue it will be noted that *face* velocities and net *face* areas are published instead of the usual free area velocities and the corresponding free areas. In case of AEROFIN the net *face* area is just double the free area and the *face* velocity is correspondingly ½ the free area velocity. The net *face* area of any unit equals the tube length times 2 ft., which is the width across the tubes between the inner surfaces of the casing. Hence to find the net *face* area, simply multiply the tube length by 2 ft.

The single row units have 18 tubes wide, two-row units 35 tubes (18 and 17), and the three-row units 53 tubes (18, 17 and 18). The two-row and three-row units have *staggered* rows of tubes.

Specifications

When ordering AEROFIN, specify number of units, number of rows of tubes in each unit, length of tubes, and assembly, i.e., whether units will be installed with tubes horizontal or vertical or laid flat, number of sections high or wide. Specify whether steam or water is to be used and what will be the initial pressure. Specify number of steel supporting legs desired. If you also specify C. F. M., temperature range and steam pressure or water temperature, we will check your selection, which is double protection.

If AEROFIN Units are to be laid flat or face down with tubes on a plane parallel with the floor, three-inch drip tappings are required and must not be bushed. This must be clearly specified. Such units must be installed with a pitch toward the drip header.

If AEROFIN Units are to be used with water, all outlet tappings, in all sizes must be same size as inlet tappings, and this must be clearly specified.

Installation Features

Foundations

It is very necessary with AEROFIN to have foundations sufficiently high to allow the water of condensation to run quickly out of the units and into drip lines or traps. AEROFIN foundations should be from 18 to 24 in. high.

A foundation 24 in. high will be required in cases where a single large trap handles all the condensation from an entire battery of AEROFIN Units. This trap itself will probably be 12 to 14 in. high with the inlet near the top of the trap—and this trap inlet should be 10 to 12 in. below the bottom of the lower AEROFIN Unit.

A foundation 18 in. high will be sufficient in cases where an individual trap is installed on each unit, or where gravity return connections are taken out of these units and run down a considerable distance into a receiver. This will allow the condensation to drop out of each unit at least 10 in. before passing through traps, check valves or horizontal gravity return drip pipes. It is very important to have about 10 in. drop out of the units for the condensation so as to free the units of water quickly.

Traps

We recommend the use of one heavy duty float trap for taking care of several AEROFIN Units in a battery. This arrangement is less subject to errors of installation. The use of an individual thermostatic return line trap for each AEROFIN Unit is entirely satisfactory when the installation is made in accordance with our instructions and diagrams. This arrangement, however, is not preferred for the larger sizes of AEROFIN Units because, in many cases, a single unit might require two thermostatic return line traps, and the piping connections would be too complicated and expensive. Generally speaking, we would recommend, therefore, individual return line thermostatic traps for the small sizes of AEROFIN Units and the heavy duty float traps for large sizes and batteries of AEROFIN Units.

Great care should be observed in selecting the proper sizes of traps for AEROFIN Units. Sizes should be figured on the basis of the volume of air being handled, velocities through the AEROFIN, entering air temperature and steam pressure. The rate of condensation in pounds per linear foot per hour can then be looked up in the tables in catalogue, and this figure multiplied by the number of linear feet in each unit gives the total pounds of condensate which must be handled by the trap, and this amount, at the steam pressure being used, determines the trap size.

Check Valves

In cases where an individual trap can be installed on each unit or battery deep (in direction of air flow), no check valves are necessary. When one large trap is used to handle the condensation from two or more units or batteries deep (in the direction of air flow), horizontal swing (45 deg.) check valves must be installed on the horizontal drip pipe taken out of the water leg, at least 10 in. below the bottom of the lower AEROFIN UNIT.

Avoidance of Installation Errors

The Installation of AEROFIN with Vertical Tubes is recommended for the reason that this arrangement is less subject to errors of installation and operation. The Horizontal Tube arrangement is entirely satisfactory, however, when installed in accordance with our instructions and diagrams. Either Vertical or Horizontal Tubes may be used with either Gravity Return System or Vacuum Return Line System.

AEROFIN Units set up with tubes vertical, are less subject to installation errors than units set with tubes horizontal, due to the fact that the condensate can remain longer in the bottom header chamber without causing trouble. Installations of AEROFIN with horizontal tubes, with the units set upright, have given perfect satisfaction, but in this case the engineer and contractor must specify and install the units with at least level tubes and preferably with a slight pitch of the units toward the drip tapping. If such a pitch is used the supply end should be set up ½ in. higher than the return end for all units up to 6 ft. in length, and 1 in. higher for all units from 7 ft. to 12 ft. in length. Furthermore, all of the diagrams in the catalogue and on the printed slip pasted on the return end of each unit, indicate a positive recommendation that full size drip nipple be taken out of each unit into a tee or ell and a full size water leg taken out of the bottom of this tee or ell. This is to allow the condensate to flow quickly out of the unit. The trap connection or gravity return connection (10 in. below bottom of lower AEROFIN UNIT) should then be taken horizontally out of the side of this water leg. Installations have caused trouble where the drip tapping has been bushed or reduced and where traps have been installed on a direct line out of the drip tapping from the unit, and such arrangements are absolute contrary to instructions contained in our catalogue.

AEROFIN Used as a Tempering Coil

Special attention is directed to AEROFIN used as a tempering coil. When an air washer is not used and there is sufficient height for a by-pass underneath the units, the installation may be made according to Fig. 19, Page 34 of the catalogue where a louvre damper is installed covering the entire face of the AEROFIN heater and connected up directly with the by-pass damper, both being operated by a single diaphragm motor controlled by a thermostat located in the discharge duct from the fan. In this case the steam supply valve to the AEROFIN Heater is hand operated.

For other installations, with or without an air washer, the outside battery of AEROFIN should be a single-row unit receiving the freezing air, with hand control or else with control by a thermostat located in the fresh air chamber, and arranged to turn steam on this single-row battery at 35 to 40 deg. above zero and to keep steam on this outside single-row battery at all times when the outside temperate is colder than 35 or 40 deg. above zero. The additional coils required may be arranged as shown in Figs. 20 to 28 in the catalogue.

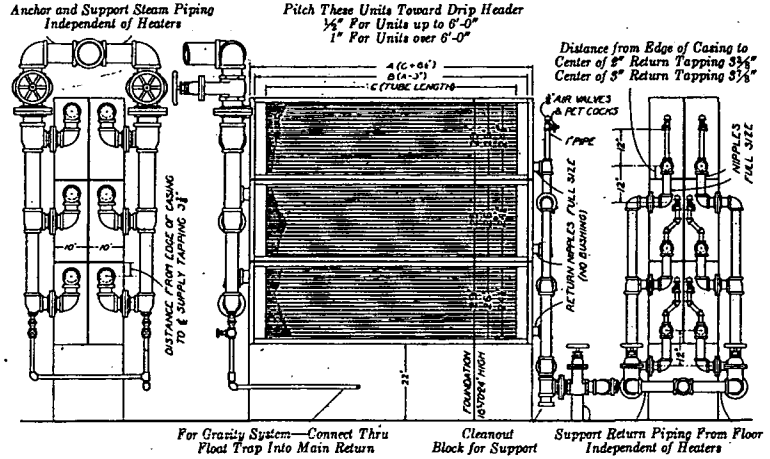
SPECIAL WARNING is given against the installing of AEROFIN with a 2-row or 3-row battery with duct-thermostat control, to receive freezing air. The off and on control in this case, regulated from the duct thermostat, would probably result in freezing the condensate within the AEROFIN Units and this method of installation is obviously incorrect.

If engineers and contractors will carefully observe instructions and diagrams contained and shown in our catalogue, the operation of AEROFIN will be found eminently satisfactory in all cases.

Write for catalogue, instruction leaflet and service details.

Sales

AEROFIN is sold only by Manufacturers of Nationally Advertised Blower Heating Apparatus.



Lyon Products Company, Inc.

EXECUTIVE AND SALES OFFICES
708 Union Trust Building
CHICAGO, ILL.

Factory
312 Union Park Court

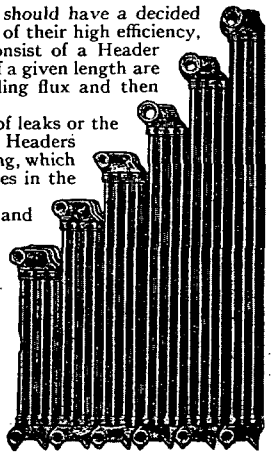
Lyon Interlocking Heaters are built in sections and should have a decided appeal to engineers, architects and contractors because of their high efficiency, durability and space and labor saving fixtures. They consist of a Header and Base of Semi-Steel into which eight one-inch pipes of a given length are forced, the pipe ends being first coated with an expanding flux and then pressed home by Hydraulic Pressure.

No threads are used, thus avoiding any possibility of leaks or the weakening of the ends of the pipes, where they enter the Headers and Bases. The Headers and Bases are made interlocking, which allows for close assembling and the staggering of all pipes in the completed Heater.

The sections are put together with extra heavy right and left Cast Iron Nipples threaded to make up the full number of threads. All of the sections are tested to 125 lbs. Hydraulic Pressure before shipping, and are guaranteed for 100 lbs. working pressure.

We have had several thousand square feet of these Heaters installed for over five years, some on low pressure and others on pressures up to 100 lbs. per square inch, all of which have proven the correctness of their design and construction.

All of these Heaters can be furnished with four different lengths of Nipples to make up on either 4¼ in., 4⅝ in., 5 in. or 5⅜ in. centers, therefore it is only necessary to select the proper length of sections to get the amount of heating surface required without decking or piling the sections on top of each other. (See *Typical Table.*)

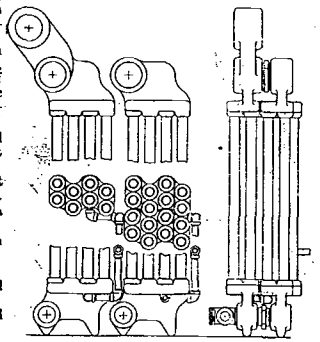


Lyon Interlocking Heaters Made In 11 Sizes, 40 to 140 in. in Height

With the use of our Special Center Feed Section we are able to furnish Heaters of any size, presenting an unbroken front from end to end. This is an exclusive feature of the Lyon's Interlocking Heater.

It will be found that there are a great many advantages in using these Heaters, among which are the great saving in freight, cartage and handling, owing to their light weight and ease of assembling. The saving in the cost of Steam-fitting where the decking of the Heaters is avoided is a very large and important item.

1. Where Heaters are used in upper stories of buildings or where special supports have to be provided, there would be a material saving on account of their lightness.
2. Where Heaters can be used for high pressures there would be a great saving in the size of the Heaters, depending upon the pressure available.
3. The pipes in each section are spaced on 2⅛ in. centers, giving a maximum heating surface in a minimum space.
4. Being made in small units they are easily handled and can be taken through a very small opening.
5. They remove all danger of cracked or broken sections.
6. The heating surface is all prime surface, giving a greater thermal efficiency.
7. Special full weight and strength Spellerized pipe, virtually rust and corrosion proof, is used in these Heaters.



RATING OF LYON INTERLOCKING HEATERS AND WEIGHTS

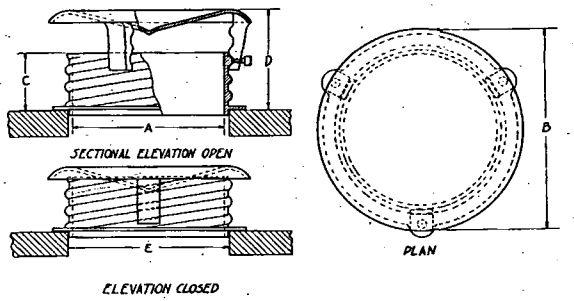
Trade No. of Section	40″	50″	60″	70″	80″	90″	100″	110″	120″	130″	140″
Heating Surface, Sq. Ft.	10.6	12.9	15.2	17.5	19.8	22.1	24.4	25.7	29.0	31.3	33.6
Free Area, Sq. Ft., 4¼ in. Center	0.45	0.58	0.69	0.80	0.91	1.03	1.14	1.26	1.38	1.49	1.60
4⅝ in. Center	0.53	0.67	0.81	0.95	1.09	1.24	1.38	1.52	1.66	1.80	1.94
5 in. Center	0.60	0.77	0.93	1.10	1.27	1.44	1.61	1.77	1.94	2.11	2.28
5⅜ in. Center	0.67	0.86	1.06	1.25	1.45	1.65	1.84	2.04	2.23	2.43	2.62
Weight per Section, Pounds	64	75	86	97	108	119	130	141	152	163	174

TYPICAL ENGINEERING DATA FOR LYON INTERLOCKING HEATERS

FINAL TEMPERATURES IN DEG. FAHR. = F. T. CONDENSATION IN LBS. PER SQ. FT. OF H. S. = C.

Rows of Sections Deep	Velocity of Air in Ft. per M.	GAGE PRESSURE 0 F.T.	0 C.	5 F.T.	5 C.	10 F.T.	10 C.	15 F.T.	15 C.	20 F.T.	20 C.	30 F.T.	30 C.	40 F.T.	40 C.	50 F.T.	50 C.	60 F.T.	60 C.	80 F.T.	80 C.	100 F.T.	100 C.	120 F.T.	120 C.
2	600	65	1.55	73	1.72	80	1.88	86	2.02	90	2.14	98	2.37	104	2.56	110	2.72	116	2.84	124	3.05	131	3.14	134	3.12
	800	61	1.82	69	2.06	75	2.24	81	2.39	85	2.53	92	2.78	99	2.99	104	3.18	109	3.34	117	3.59	123	3.73	127	3.77
	1000	.....	.....	65	2.37	71	2.59	76	2.76	80	2.92	87	3.20	93	3.44	98	3.65	103	3.84	111	4.14	116	4.23	120	4.44
	1200	.....	.....	61	2.70	67	2.94	72	3.13	75	3.30	82	3.60	88	3.86	92	4.10	97	4.32	103	4.68	109	4.94	112	5.11
	1400	.....	.....	.....	.....	62	3.29	66	3.50	70	3.68	76	4.01	82	4.30	87	4.57	91	4.81	97	5.22	102	5.54	104	5.79
	1600	.....	.....	.....	.....	.....	.....	62	3.82	65	4.07	71	4.43	76	4.74	81	5.03	85	5.30	90	5.77	95	6.15	97	6.46
	1800	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	66	4.83	71	5.17	75	5.49	78	5.79	84	6.32	87	6.76	89	7.11
	2000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	65	5.62	69	5.96	73	6.30	77	6.87	80	7.36	82	7.78
4	600	105	1.19	117	1.32	125	1.42	132	1.51	138	1.59	148	1.72	158	1.85	166	1.95	173	2.05	185	2.19	194	2.25	202	2.27
	800	101	1.44	112	1.61	120	1.73	127	1.84	132	1.93	142	2.09	151	2.22	159	2.37	166	2.48	178	2.66	187	2.77	194	2.82
	1000	.....	.....	107	1.90	115	2.05	122	2.16	127	2.27	136	2.46	145	2.63	152	2.78	159	2.92	170	3.14	178	3.29	186	3.38
	1200	.....	.....	103	2.19	110	2.37	116	2.50	121	2.62	130	2.84	138	3.04	145	3.20	152	3.36	163	3.63	171	3.82	178	3.95
	1400	.....	.....	.....	.....	105	2.68	111	2.84	116	2.97	124	3.20	132	3.42	138	3.61	145	3.80	155	4.10	163	4.23	169	4.52
	1600	.....	.....	.....	.....	.....	.....	105	3.16	110	3.31	117	3.56	125	3.82	131	4.03	137	4.23	147	4.58	155	4.88	161	5.09
	1800	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	111	3.94	118	4.21	124	4.45	130	4.68	139	5.07	147	5.39	153	5.64
	2000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	106	4.60	117	4.88	123	5.11	131	5.54	139	5.91	145	6.21
6	600	130	0.96	143	1.06	152	1.14	160	1.20	167	1.25	179	1.36	189	1.46	198	1.55	207	1.61	220	1.72	231	1.78	240	1.80
	800	126	1.19	138	1.32	147	1.41	155	1.51	161	1.57	173	1.70	183	1.81	191	1.91	200	2.00	213	2.13	223	2.23	232	2.27
	1000	.....	.....	133	1.57	143	1.70	150	1.80	157	1.89	168	2.04	177	2.16	186	2.29	194	2.39	207	2.57	216	2.68	224	2.74
	1200	.....	.....	130	1.84	138	1.98	145	2.10	151	2.21	162	2.37	172	2.53	180	2.65	187	2.78	199	2.99	209	3.12	216	3.22
	1400	.....	.....	.....	.....	133	2.26	140	2.40	147	2.52	157	2.70	166	2.88	174	3.04	180	3.16	192	3.40	202	3.57	208	3.68
	1600	.....	.....	.....	.....	.....	.....	135	2.70	141	2.82	151	3.04	160	3.22	168	3.40	175	3.56	186	3.82	194	4.03	201	4.16
	1800	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	145	3.38	154	3.58	161	3.78	168	3.94	179	4.24	187	4.46	193	4.62
	2000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	148	3.93	156	4.14	162	4.33	173	4.67	180	4.91	185	5.09

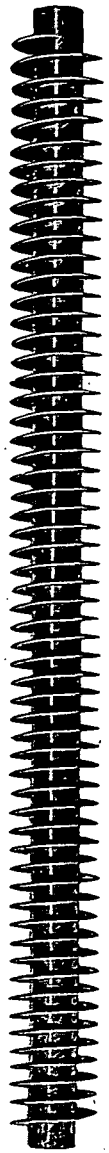
NOTE—For complete engineering information on the entire range of Intake Temperatures, Steam Pressures, Condensation, Velocities, engineers, architects and contractors should request the Lyon Heater Data Book.



The Lyon Toadstool Vent Cap has several exclusive features and many special advantages for ventilating theatres, auditoriums, assembly halls and similar buildings. It is sturdy, efficient and economical. Has free unobstructed throat and cap is supported solidly and directly by the circumference wall of toadstool. Has wide range of adjustment and one complete turn gives range of completely open to completely closed.

LYON TOADSTOOL VENT CAPS—Capacities and Velocities

Size	Area Sq. In.	Area Sq. Ft.	Diameter Floor Opening	Capacity Cubic Feet Air per Minute at Different Velocities 100 ft.	150 ft.	200 ft.	250 ft.	300 ft.	350 ft.	400 ft.	500 ft.
4″	12.57	.0873	4½″	8.73	13.1	17.5	21.8	26.2	30.6	35.0	43.6
5″	19.63	.1364	5½″	13.64	20.5	27.3	34.2	41.0	47.7	54.6	68.4
6″	28.27	.1964	6½″	19.64	29.5	39.3	49.1	59.0	68.7	78.6	98.2
7″	38.48	.2673	7½″	26.73	40.0	53.5	66.8	80.0	93.5	107.0	133.6
8″	50.27	.3491	8½″	34.91	52.4	69.8	87.3	104.8	122.2	139.6	174.6
9″	63.62	.4418	9½″	44.18	66.3	88.4	110.4	132.6	154.6	176.8	220.8
10″	78.54	.5454	10½″	54.54	81.8	109.0	136.3	163.6	190.8	218.0	272.6



The Rome-Turney Radiator Co.

Rome, N. Y.

Exclusive Manufacturers of
HELICAL TUBE
High Efficiency Extended Surface Radiation

Radiators, Heaters, Condensers, Coolers, Etc.

Rome Seamless Copper HELICAL TUBE is a tried and proven successful product, which has given years of service on all types of heavy duty equipment requiring the dissipation of heat.

HELICAL TUBE is manufactured of heavy gauge seamless cold drawn brass or copper tube. This tube is fitted with a continuous flat copper radiating fin, free of corrugations, which is formed under power around the tube.

Sizes—HELICAL TUBE has been developed for a great variety of uses. It is manufactured of nearly all sizes of tube ranging from $\frac{5}{16}$ in. OD to $1\frac{1}{4}$ in. OD and with several widths of radiating fin.

HELICAL TUBE radiators are built up by a new process which offers to the heating and ventilating trade an unusually strong and most durable construction.

Sales—HELICAL TUBE Radiators are supplied to nationally known manufacturers of fan type heating and ventilating apparatus. Specifications calling for HELICAL TUBE Radiators and Heater Units will assure your securing the most modern equipment.

Data concerning HELICAL TUBE and HELICAL TUBE Radiators and Heater Units now in course of preparation.

Specify
ROME-TURNEY COPPER RADIATION
No corrosion - - - - Good forever

ROME TURNEY
RADIATOR SPECIALISTS

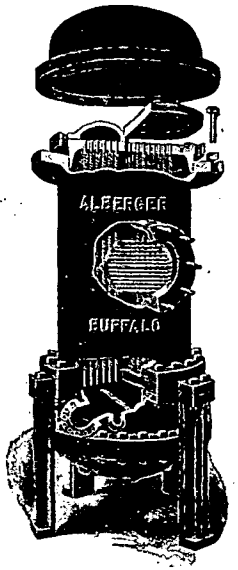
Good Radiators since 1905

Alberger Heater Company

HOWARD IRON WORKS
218 Chicago St. :-: :-: :-: BUFFALO, N. Y.
REPRESENTATIVES IN PRINCIPAL CITIES

Heaters — Condensers — Coolers — Economizers — Expansion Joints

ALBERGER heaters are of five distinct types each having outstanding characteristics to insure a high heat transfer, economical operating and insignificant maintenance costs. The Multi-Head Instantaneous heater for domestic and feed water purposes is made in types H, horizontal and V, vertical. Type A is a special 3 pass heater for light service, and low temperature differences. Type S is a storage water heater for use where steam supply is intermittent and hot water requirements periodical. Type AB is a special designed heater for swimming pools, also for use in connection with air washers in heating and ventilating systems.



Multi-Head Instantaneous Heater

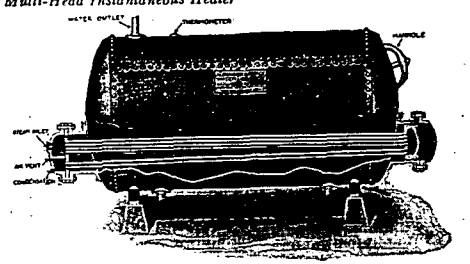
SIZES OF TYPE "S" HEATER FOR TEMPERATURE RANGE 50 to 180 deg.—Steam at 212 deg. fahr.

Gal. per Hr.	CAPACITY OF STORAGE TANK IN GALLONS										
	142 24x72	258 30x84	318 36x72	425 36x96	500 42x84	650 42x108	754 48x96	942 48x120	1190 54x120	1473 60x120	1757 60x144
200	AY-5	BY-4	CY-5	DY-4	EY-4	FY-3	GY-4	HY-3	JY-3	KY-3	LY-3
300	AY-7	BY-6	CY-7	DY-6	EY-6	FY-5	GY-5	HY-5	JY-4	KY-4	LY-4
400	AA-9	BY-8	CA-9	DY-7	EY-8	FY-6	GY-7	HY-6	JY-6	KY-6	LY-5
500	AA-11	BA-10	CA-11	DA-9	EA-10	FY-8	GY-8	HY-7	JY-7	KY-7	LY-6
600	AA-14	BA-12	CA-13	DA-11	EA-12	FA-9	GA-10	HA- 9	JY-8	KY-8	LY-7
700	AB-16	BA-14	CB-15	DA-12	EA-13	FA-11	GA-12	HA-10	JA-10	KA-10	LY-8
800	AB-18	BB-16	CB-17	DA-14	EA-15	FA-12	GA-13	HA-11	JA-11	KA-11	LA-9
900	AB-20	BB-18	CB-20	DB-16	EB-17	FA-14	GA-15	HA-13	JA-12	KA-12	LA-11
1000	AB-22	BB-20	CB-22	DB-17	EB-19	FB-15	GB-17	HA-14	JA-14	KA-13	LA-12
1100	.....	BB-22	CD-25	DB-19	EB-21	FB-17	GB-18	HB-15	JA-15	KA-15	LA-13
1200	.....	BB-24	CD-27	DB-21	EB-23	FB-19	GB-20	HB-17	JB-17	KB-16	LA-14
1300	.....	BD-25	CD-29	DB-22	ED-25	FB-20	GB-22	HB-18	JB-18	KB-18	LA-15
1400	.....	BD-27	CD-31	DB-24	ED-26	FB-21	GB-23	HB-20	JB-19	KB-19	LB-16
1500	.....	BD-29	CD-34	DD-26	ED-29	FB-23	GD-25	HB-21	JB-21	KB-20	LB-18
1600	.....	BD-31	.....	DD-28	ED-30	FD-25	GD-27	HB-22	JB-22	KB-21	LB-19
1700	.....	BD-33	.....	DD-29	ED-32	FD-26	GD-28	HB-24	JB-23	KB-23	LB-20
1800	.....	.....	.....	DD-31	ED-34	FD-28	GD-30	HD-25	JD-25	KB-24	LB-21
1900	.....	.....	.....	DD-33	ED-35	FD-29	GD-32	HD-27	JD-26	KD-26	LB-22
2000	.....	.....	.....	DD-34	EF-37	FD-31	GD-33	HD-28	JD-27	KD-27	LB-23
3000	.....	.....	.....	.....	.....	FF-46	GF-49	HF-42	JF-41	KF-40	LD-35
4000	.....	.....	.....	.....	.....	.....	GH-67	HH-56	JH-54	KH-54	LF-46
5000	.....	.....	.....	.....	.....	.....	.....	.....	JH-68	KH-67	LH-58
6000	.....	.....	.....	.....	.....	.....	.....	.....	JI-81	KI-81	LH-69
7000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	LI-80
8000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	LI-92

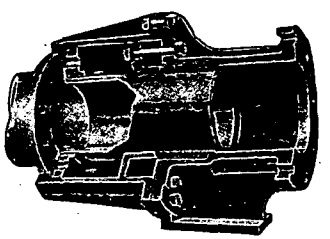
Howard Expansion Joints are extensively used in high and low pressure piping systems for all classes of service. They are a reliable means for accommodating expansion in such lines and are specified for all important work.

To {ARCHITECTS / ENGINEERS / CONTRACTORS} EVERYWHERE

If you have not received a copy of the Alberger Engineers Heater Data Book describing all types and giving dimensions, service and installation data please send in your name immediately. Also remember that our experience in designing and building special heaters and coolers is available to prospective clients.



Type S Storage Heater

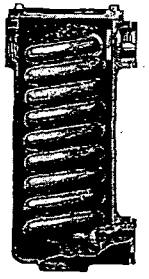


Howard Expansion Joint

Excelso Specialty Works, Inc.

119 Clinton St., BUFFALO, N. Y.

Excelso Indirect Water Heaters, Phaeton Heaters, Fire Pot Generators, Rotary Hack Saw Tools



Connect below water line of any Steam or Vapor Boiler, or use with live steam. Boiling water in the shell heats water circulating through copper coil.

EXCELSO INDIRECT WATER HEATERS

Dimensions—Price List—Capacities

	Single Coil						Double Coil				Triple Coil	
Size	Jr.	11	12	13	14	15	25	26	27	28	35	36
Length...In.	8½	10½	14	11½	15	19½	12½	15	19	23¼	21	25
Diameter...In.	5	5	5	6½	6½	6½	9	9	9	9	13¾	13¾
Shell Open'gs. In.	1	1	1	1½	1½	1½	2	2	2	2	3	3
Coil Open'gs. In.	¾	¾	¾	1	1	1	1½	1½	1½	1½	2½	2½
Weight Crated...Lbs.	11	13	16	29	37	42	65	73	88	106	185	210
List Price	$12.50	$30	$40	$50	$60	$70	$120	$150	$180	$210	$310	$400

Heating Water Below Water Line of Steam or Vapor Boilers

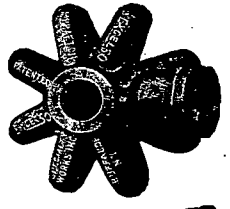
Size	Jr.	11	12	13	14	15	25	26	27	28	35	36
Tank Capacity	30	30	45	60	90	120	160	200	300	400	600	800

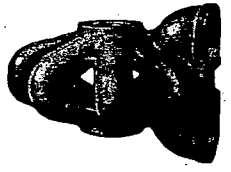
Temperature rise 100 deg. in 3 hours.

Heating Water With Live Steam

Size	Jr.	11	12	13	14	15	25	26	27	28	35	36
Tank Capacity	45	50	75	100	150	200	250	300	450	600	900	1200

Temperature rise 100 deg. in 3 hours at 5 lb. pressure.



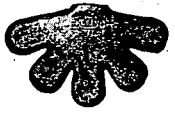


THE EXCELSO PHAETON HEATER

Dimensions—Price List—Capacities

Diameter...In.	6	8	10	12	15	18
Height...In.	3½	4½	5¼	6	7	8
Tappings...In.	1	1	1½	2	2½	3
Center to Center of Outlets...In.	2½	2½	3	3½	4½	5½
Capacity...Gals.	30	45	80	100	150	250
Sq. Ft. Direct Water Radiation...Ft.	40	75	100	150	250	400
Shipping Weight..Lb.	6	11	18	30	60	85
List Price...Iron	$7.50	$12.00	$20.00	$24.00	$50.00	$70.00
List Price...Brass	$15.00	$28.00	$45.00	$54.00	$115.00	$160.00

The highly efficient firepot heater, suitable for hot water supply or auxiliary radiation, transfers 80 per cent of heat to water.





Excelso Firepot Generator

Generator fits any type of hot water boiler or hot air furnace. Made in both cast iron and brass.

Size No. 1, up to 40 gals. capacity.

Size No. 2, over 40 gals. capacity.





Excelso Rotary Hack Saw Tool

Boilers may be quickly and easily tapped by means of the Excelso Rotary Hack Saw Tool. Each tool cuts three sizes: 1 in., 1½ in. and 2 in. Pipe Tap size.

Price $7.50 net, with six blades; two of each size.

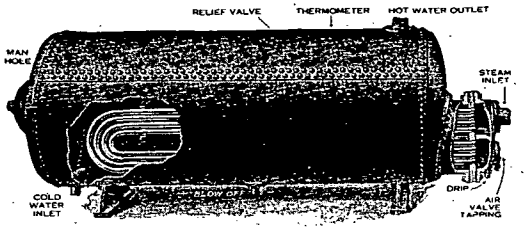
The Patterson-Kelley Co.

101 Park Avenue - New York City

Hot Water Heaters for all purposes. Pool Heaters and Converters. Preheaters, Heat Exchangers, Heaters for Chemicals, Gases, Oils. Coolers for Brine, Chemicals, Gases, Oil and Water.

The Patterson Combined Hot Water Service and Storage Heater, Type B, is for any service where requirements for hot water are not constant, or where a large volume must be stored for sudden heavy demands.

We guarantee to furnish heaters that will deliver the quantity of hot water called for. Without obligation our Engineering Department will be glad to give engineers the benefit of our 45 years' experience.



General Specifications

Constructed like a high grade boiler—of heavy steel plate. Steam inlet and outlet chamber is a heavy, grey iron casting. Tube head is a heavy, steel forging into which both ends of each tube are expanded. Tubes are of pure, cold drawn seamless copper and '∩' shaped to provide against contraction and expansion strains. Heater is for any service and in any required size per tables below. Write us for engineering advice.

STORAGE CAPACITIES

No.	Dimensions in Inches	Capacity in Gals.	Approx. Wt. in Lbs.	No.	Dimensions in Inches	Capacity in Gals.	Approx. Wt. in Lbs.
1 S	24 x 48	94	650	21 S	42 x 144	860	2450
2 S	24 x 60	118	750	22 S	42 x 168	1000	2800
3 S	24 x 72	141	850	23 S	42 x 192	1155	3100
4 S	24 x 84	164	950	24 S	48 x 96	750	2600
5 S	30 x 60	180	875	25 S	48 x 120	940	2925
6 S	30 x 72	215	1000	26 S	48 x 144	1125	3350
7 S	30 x 84	255	1150	27 S	48 x 168	1300	3840
8 S	30 x 96	285	1300	28 S	48 x 192	1500	4200
9 S	30 x 120	360	1500	29 S	54 x 120	1190	3500
10 S	36 x 72	310	1250	30 S	54 x 144	1425	3900
11 S	36 x 84	365	1400	31 S	54 x 168	1665	4300
12 S	36 x 96	415	1550	32 S	54 x 192	1900	4700
13 S	36 x 108	475	1700	33 S	60 x 120	1400	4300
14 S	36 x 120	500	1850	34 S	60 x 144	1700	4950
15 S	36 x 144	640	2100	35 S	60 x 168	2000	5600
16 S	42 x 72	430	1500	36 S	60 x 192	2240	6200
17 S	42 x 84	500	1650	37 S	72 x 174	3000	7000
18 S	42 x 96	575	1800	38 S	84 x 168	4000	8700
19 S	42 x 108	650	1950	39 S	96 x 168	5200	10000
20 S	42 x 120	720	2200	40 S	96 x 192	6000	11000

HEATING CAPACITIES—40° F. to 180° F.—Steam at Atmospheric Pressure

No.	Gallons per Hour	Approx. Wt. in Lbs.	No.	Gallons per Hour	Approx. Wt. in Lbs.
1 H	100	200	15 H	2000	700
2 H	150	215	16 H	2500	800
3 H	200	235	17 H	3000	900
4 H	250	255	18 H	3500	1050
5 H	300	285	19 H	4000	1200
6 H	400	315	20 H	4500	1350
7 H	500	350	21 H	5000	1500
8 H	600	370	22 H	6000	1750
9 H	700	400	23 H	7500	2000
10 H	800	425	24 H	10000	3200
11 H	1000	450	25 H	12500	3800
12 H	1250	500	26 H	15000	4500
13 H	1500	550	27 H	20000	5100
14 H	1750	600	28 H	25000	5800

NOTE.—To specify Type B. Heaters, combine the numbers of the required storage and heating capacities. For example, "One Patterson Type B. Heater with No. 22 S. and No. 17 H." has 1000 gallons storage with 3000 gallons hourly heating capacity.

O. E. Frank Heater and Engineering Co., Inc.

Associated with FARRAR & TREFTS, Inc.

BUFFALO, N. Y.

Branch Offices

New York — Baltimore
Philadelphia — Kansas City
Detroit — Charlotte, N. C.
St. Louis — Richmond, Va.

Branch Offices

Boston Mass. — Los Angeles
Chicago — San Francisco
Pittsburgh — Washington
Cleveland — Harrisburg, Pa.
Minneapolis — Roanoke, Va.

O. E. F. products consist of a complete line of heaters for every hot water need. Storage Heaters for hot water service in either U-tube or Straight tube type. Instantaneous Heaters for hot water service, heating systems, power plants. Complete information on materials, construction, service and our guarantee on request.

Large stocks of tanks, castings and tubes insure prompt shipments.

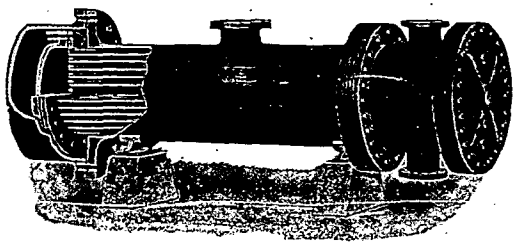
Capacities and General Dimensions O. E. F. Instantaneous Heaters, Heating Water from 50 to 180° F. with Steam at 212° F.

Gals. per Hr.	Size	Approx. Overall Dimensions: Width	Length Hor. Type	Height Ver. Type	Max. Steam	Max. Water	Drain	Gals. per Hr.	Size	Approx. Overall Dimensions: Width	Length Hor. Type	Height Ver. Type	Max. Steam	Max. Water	Drain
200	IH-7	15¼"	7'-5"	8'-1½"	3"	3"	1"	2000	IH-60	21¾"	8'-8¾"	9'-8¾"	4"	5"	1½"
300	IH-11	15¼"	7'-5"	8'-1½"	3"	3"	1"	2500	IH-76	25¾"	8'-11"	9'-10"	6"	6"	2"
400	IH-14	15¼"	7'-5"	8'-1½"	3"	3"	1"	3000	IH-90	25¾"	8'-11"	9'-10"	6"	6"	2"
500	IH-15	18"	8'-7"	9'-8"	3"	4"	1½"	4000	IH-120	26½"	9'-1½"	10'-4¼"	8"	8"	3"
600	IH-18	18"	8'-7"	9'-8"	3"	4"	1½"	5000	IH-150	26½"	9'-1½"	10'-4¼"	8"	8"	3"
800	IH-24	18"	8'-7"	9'-8"	3"	4"	1½"	6000	IH-162	26½"	9'-1½"	10'-4¼"	8"	8"	3"
1000	IH-30	18"	8'-7"	9'-8"	3"	4"	1½"	7000	IH-189	30¼"	10'-3½"	11'-4¼"	10"	8"	3"
1250	IH-38	18"	8'-7"	9'-8"	3"	4"	1½"	8000	IH-216	30¼"	10'-3½"	11'-4¼"	10"	8"	3"
1500	IH-45	21¾"	8'-8¾"	9'-8¾"	4"	5"	1½"	9000	IH-243	30¼"	10'-3½"	11'-4¼"	10"	8"	3"
1800	IH-54	21¾"	8'-8¾"	9'-8¾"	4"	5"	1½"	10000	IH-270	30¼"	10'-3½"	11'-4¼"	10"	8"	3"

Capacities and General Dimensions O. E. F. Feed Water Heaters, Heating Feed Water from 50 to 200° F. with Steam at 212° F.

Horse Power	Size	Lbs. per Hour	Approximate Overall Dimensions: Width	Length Horiz. Type	Height Vertical Type	Maximum Steam	Maximum Water	Drain
50	FW-9	1500	15¼"	7'-5"	8'-1½"	3"	3"	1"
75	FW-13	2250	15¼"	7'-5"	8'-1½"	3"	3"	1"
100	FW-17	3000	15¾"	7'-5"	8'-1½"	3"	3"	1"
150	FW-26	4500	18"	8'-7"	9'-8"	3"	4"	1½"
200	FW-35	6000	18"	8'-7"	9'-8"	3"	4"	1½"
250	FW-43	7500	21¾"	8'-8¾"	9'-8¾"	4"	5"	1½"
300	FW-52	9000	21¾"	8'-8¾"	9'-8¾"	4"	5"	1½"
350	FW-61	10500	21¾"	8'-8¾"	9'-8¾"	4"	5"	1½"
400	FW-69	12000	21¾"	8'-8¾"	9'-8¾"	4"	5"	1½"
450	FW-78	13500	25¼"	8'-11"	9'-10"	6"	6"	2"
500	FW-87	15000	25¼"	8'-11"	9'-10"	6"	6"	2"
600	FW-104	18000	25¼"	8'-11"	9'-10"	6"	6"	2"
700	FW-121	21000	26½"	9'-1¾"	10'-4¼"	8"	8"	2"
800	FW-136	24000	26½"	9'-1¾"	10'-4¼"	8"	8"	2"
900	FW-156	27000	26½"	9'-1¾"	10'-4¼"	8"	8"	2"
1000	FW-160	30000	26½"	10'-1¾"	11'-4¼"	8"	8"	2"
1100	FW-165	33000	26½"	10'-1¾"	11'-4¼"	8"	8"	2"
1200	FW-180	36000	26½"	10'-1¾"	11'-4¼"	8"	8"	2"
1300	FW-195	39000	30¼"	10'-3½"	11'-8¼"	10"	8"	3"
1400	FW-210	42000	30¼"	10'-3½"	11'-8¼"	10"	8"	3"
1500	FW-225	45000	30¼"	10'-3½"	11'-8¼"	10"	8"	3"
1800	FW-270	54000	30¼"	10'-3½"	11'-8¼"	10"	8"	3"
2000	FW-300	60000	34¼"	11'-0¼"	12'-0¼"	10"	10"	3"
2500	FW-375	75000	34¼"	11'-0¼"	12'-0¼"	10"	10"	3"
3000	FW-450	90000	39¼"	11'-6¼"	12'-6¼"	10"	12"	3"
4000	FW-600	12000	39¼"	11'-6¼"	12'-6¼"	10"	12"	3"

O. E. F. Feed Water Heaters and Instantaneous Heaters are designed for a maximum working pressure of 125 lbs. on the water spaces and 50 lbs. on the steam spaces.



O. E. F. Instantaneous Heaters are constructed of heavy close grain castings with rolled steel tube sheets and eighteen gage Admiralty Metal tubes. Admiralty Metal tubes are unexcelled for feed-water service. Write us about them.

O. E. F. Instantaneous Heater for General Hot Water Service, Feed Water, Bleeder Turbines and Forced and Gravity Hot Water Heating Systems. Also Vertical Type. Steam opening may be located on top or either side of shell to suit requirements.

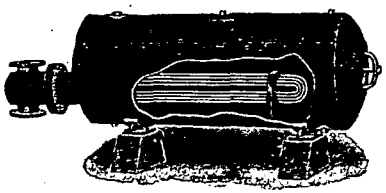


Fig. 1. O. E. F. U-Tube Storage Heater

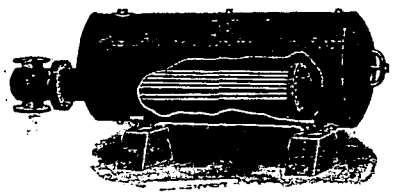


Fig. 7. O. E. F. Straight Tube Storage Heater

O. E. F. Storage Heaters are made of best quality flange steel, have rolled steel tube sheets, and sixteen gage copper tubes. Chemical analysis and physical test of all steel used furnished on request. O. E. F. Heaters are doubly guaranteed by O. E. Frank Heater & Engineering Company and Farrar & Trefts, Inc.

O. E. F. Storage Heaters are furnished in either the U-bend Pattern, per Fig. 1 or the Straight Tube type, per Fig. 7. The shells are of best quality steel plate, the smaller sizes welded and the larger sizes riveted construction. The heating surface consists of 1¼ in. OD seamless drawn copper tubes No. 16 or 18 SWG as required. They are properly supported with a cast iron tube supporting plate to prevent wear of the tubes due to sagging and rubbing together. The tube sheets are steel, eliminating any possibility of cracks and leaks, which so commonly occur with cast iron tube sheets. The tube nests or bundles are removable from the tank for cleaning or repairing.

Where it is necessary to use both low and high pressure steam, the steam chamber and tubes may be arranged without the necessity of installing a separate tube bundle.

Openings of ample size are provided, and we call your attention to the arrangement of the steam inlet and outlet, making it possible to remove the tube bundle by simply unbolting the flanges and avoiding the necessity of breaking any length of pipe.

All storage heaters, unless otherwise specified, will be furnished for a working pressure of 100 pounds per square inch gage pressure, on both the steam and water spaces.

Storage heaters furnished for higher pressures.

CAPACITIES—O. E. F. U-Tube and Straight Tube Storage Heaters—Heating Given Quantities of Water from 50-180 Deg. Fahr., with Steam at 212 Deg. Fahr.

Storage Capacity	80	93	141	164	188	220	257	294	330	370	423	476	529	576	648	720	792	864	732	846	940
Tank Size	18x72	18x84	24x72	24x84	24x96	30x72	30x84	30x96	30x108	36x84	36x96	36x108	36x120	42x96	42x108	42x120	42x132	42x144	48x96	48x108	48x120
Gallons per Hour																					
100	A5	B5	C5	D5	E5	F5	G5	H5	J5	K5	L5	M5	N5	O5	P5	Q5	R5	S5	T5	V5	W5
200	A11	B11	C11	D11	E11	F11	G11	H11	J11	K11	L11	M11	N11	O11	P11	Q11	R11	S11	T11	V11	W11
300	.....	B16	C16	D16	E16	F16	G16	H16	J16	K16	L16	M16	N16	O16	P16	Q16	R16	S16	T16	V16	W16
400	.....	.....	C22	D22	E22	F22	G22	H22	J22	K22	L22	M22	N22	O22	P22	Q22	R22	S22	T22	V22	W22
500	.....	.....	C27	D27	E27	F27	G27	H27	J27	K27	L27	M27	N27	O27	P27	Q27	R27	S27	T27	V27	W27
600	.....	.....	C32	D32	E32	F32	G32	H32	J32	K32	L32	M32	N32	O32	P32	Q32	R32	S32	T32	V32	W32
700	.....	.....	C38	D38	E38	F38	G38	H38	J38	K38	L38	M38	N38	O38	P38	Q38	R38	S38	T38	V38	W38
800	.....	.....	.....	D43	E43	F43	G43	H43	J43	K43	L43	M43	N43	O43	P43	Q43	R43	S43	T43	V43	W43
900	.....	.....	.....	D47	E47	F47	G47	H47	J47	K47	L47	M47	N47	O47	P47	Q47	R47	S47	T47	V47	W47
1000	.....	.....	.....	.....	E54	F54	G54	H54	J54	K54	L54	M54	N54	O54	P54	Q54	R45	S54	T54	V54	W54
1500	.....	.....	.....	.....	.....	F81	G81	H81	J81	K81	L81	M81	N81	O81	P81	Q81	R81	S81	T81	V81	W81
2000	.....	.....	.....	.....	.....	.....	G108	H108	J108	K108	L108	M108	N108	O108	P108	Q108	R108	S108	T108	V108	W108
2500	.....	.....	.....	.....	.....	.....	.....	.....	J134	.....	.....	M134	N134	O134	P134	Q134	R134	S134	T134	V134	W134
3000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	N162	O162	P162	Q162	R162	S162	T162	V162	W162
4000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	P215	Q215	R215	S215	T188	V188	W188
5000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	R269	S269	.....	V215	W215

Storage Cap.	1034	1128	1204	1325	1445	1574	1666	1469	1616	1763	1909	2056	2115	2327	2538	2750	2961	3173
Tank Size	48x132	48x144	54x120	54x132	54x144	54x156	54x168	60x120	60x132	60x144	60x156	60x168	72x120	72x132	72x144	72x156	72x168	72x180
Gals. per Hr.																		
100	X5	Y5	AX5	BX5	CX5	DX5	FX5	GX5	HX5	KX5	LX5	MX5	NX5	OX5	PX5	QX5	RX5	TX5
200	X11	Y11	AX11	BX11	CX11	DX11	FX11	GX11	HX11	KX11	LX11	MX11	NX11	OX11	PX11	QX11	RX11	TX11
300	X16	Y16	AX16	BX16	CX16	DX16	FX16	GX16	HX16	KX16	LX16	MX16	NX16	OX16	PX16	QX16	RX16	TX16
400	X22	Y22	AX22	BX22	CX22	DX22	FX22	GX22	HX22	KX22	LX22	MX22	NX22	OX22	PX22	QX22	RX22	TX22
500	X27	Y27	AX27	BX27	CX27	DX27	FX27	GX27	HX27	KX27	LX27	MX27	NX27	OX27	PX27	QX27	RX27	TX27
600	X32	Y32	AX32	BX32	CX32	DX32	FX32	GX32	HX32	KX32	LX32	MX32	NX32	OX32	PX32	QX32	RX32	TX32
700	X38	Y38	AX38	BX38	CX38	DX38	FX38	GX38	HX38	KX38	LX38	MX38	NX38	OX38	PX38	QX38	RX38	TX38
800	X43	Y43	AX43	BX43	CX43	DX43	FX43	GX43	HX43	KX43	LX43	MX43	NX43	OX43	PX43	QX43	RX43	TX43
900	X47	Y47	AX47	BX47	CX47	DX47	FX47	GX47	HX47	KX47	LX47	MX47	NX47	OX47	PX47	QX47	RX47	TX47
1000	X54	Y54	AX54	BX54	CX54	DX54	FX54	GX54	HX54	KX54	LX54	MX54	NX54	OX54	PX54	QX54	RX54	TX54
1500	X81	Y81	AX81	BX81	CX81	DX81	FX81	GX81	HX81	KX81	LX81	MX81	NX81	OX81	PX81	QX81	RX81	TX81
2000	X108	Y108	AX108	BX108	CX108	DX108	FX108	GX108	HX108	KX108	LX108	MX108	NX108	OX108	PX108	QX108	RX108	TX108
2500	X134	Y134	AX134	BX134	CX134	DX134	FX134	GX134	HX134	KX134	LX134	MX134	NX134	OX134	PX134	QX134	RX134	TX134
3000	X162	Y162	AX162	BX162	CX162	DX162	FX162	GX162	HX162	KX162	LX162	MX162	NX162	OX162	PX162	QX162	RX162	TX162
3500	X188	Y188	AX188	BX188	CX188	DX188	FX188	GX188	HX188	KX188	LX188	MX188	NX188	OX188	PX188	QX188	RX188	TX188
4000	X215	Y215	AX215	BX215	CX215	DX215	FX215	GX215	HX215	KX215	LX215	MX215	NX215	OX215	PX215	QX215	RX215	TX215
4500	X243	Y243	AX243	BX243	CX243	DX243	FX243	GX243	HX243	KX243	LX243	MX243	NX243	OX243	PX243	QX243	RX243	TX243
5000	X269	Y269	.....	BX269	CX269	DX269	FX269	.....	HX269	KX269	LX269	MX269	.....	OX269	PX269	QX269	RX269	TX269
6000	.....	.....	.....	.....	.....	DX323	FX323	.....	.....	.....	LX323	MX323	.....	.....	.....	QX323	RX323	TX323
7000	.....	.....	.....	.....	.....	.....	FX377	.....	.....	.....	.....	MX377	.....	.....	.....	.....	RX377	TX377

Note.—The letter given in the above table of sizes indicates the size of the tank and the numerals the square feet of heating surface. Example.—A C5 heater consists of a 24" x 72" storage tank (length not including dished heads) and contains 5 sq. ft. of heating surface.

The Whitlock Coil Pipe Company

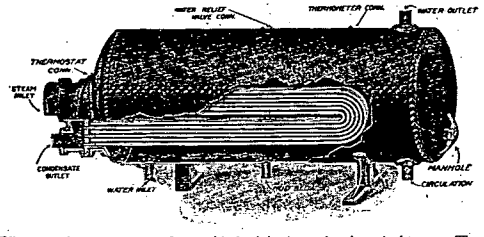
Manufacturers and Engineers

HARTFORD, CONN.

Baltimore, Md.	Dallas, Tex.		New Orleans, La.	San Francisco, Calif.
Boston, Mass.	Denver, Colo.		New York, N. Y.	Seattle, Wash.
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Chicago, Ill.	Houston, Tex.	**PRODUCTS**	Pittsburgh, Pa.	Tacoma, Wash.
Cincinnati, O.	Indianapolis, Ind.		Portland, Ore.	Toledo, O.
Cleveland, O.	Kansas City, Mo.		Rochester, N. Y.	Troy, New York
Columbus, O.	Memphis, Tenn.		San Antonio, Tex.	Tulsa, Okla.

Darling Bros. Montreal, Manufacturers of Whitlock Heaters in Canada

See Telephone Directory for Local Address



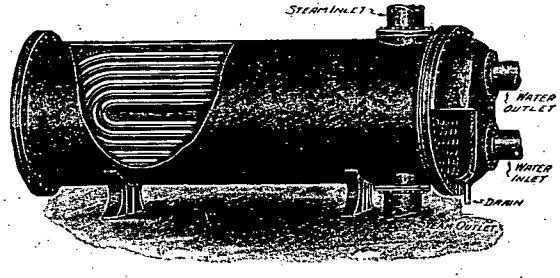
Whitlock type "K" storage heaters are manufactured in both horizontal and vertical types. The table shows sizes of the horizontal heaters only. We will gladly furnish dimensions of horizontal heaters and vertical heaters upon request. That this type of heater is of particularly sturdy construction is evidenced by the increasing number of prominent engineers and architects who are specifying their use in all types of buildings, including many of the largest and finest buildings constructed.

Whitlock Type K Storage Heaters, Horizontal

SHELLS — To be used with Type K Heating Section. Shell Prices include Cradle. Manhole 11"x15"							HEATING SECTIONS — Capacity based on Heating from 40° to 180° with Steam at 0 lbs. pressure. For other temperatures and Steam Pressures see Bulletin No. 27				
Number	Gallons One Filling	Diameter of Shell	Length of Shell	Thickness of Shell	Thickness of Head	Weight of Shell	Number	Gallons per Hour	Maximum Size Steam Pipe Inches	Smallest Shell into which Section will Fit Inches	Weight of Entire Heating Section Lbs.
1	65	18	60	1/4	3/8	400	H 0	100	2	18x 48	75
2	80	18	72	1/4	3/8	450	H 1	150	2	18x 60	80
3	118	24	60	1/4	3/8	600	H 2	200	2	18x 72	90
4	141	24	72	1/4	3/8	700	H 3	250	3 1/2	18x 48	175
5	164	24	84	1/4	3/8	800	H 4	300	3 1/2	18x 48	185
6	185	30	60	1/4	3/8	750	H 5	350	3 1/2	18x 60	190
7	220	30	72	1/4	3/8	850	H 6	400	3 1/2	18x 60	200
8	255	30	84	1/4	3/8	950	H 7	500	3 1/2	18x 72	210
9	290	30	96	1/4	3/8	1050	H 8	550	3 1/2	18x 72	215
10	365	36	84	5/16	1/2	1300	H 9	600	3 1/2	18x 84	220
11	420	36	96	5/16	1/2	1450	H10	700	5	24x 60	300
12	475	36	108	5/16	1/2	1600	H11	800	3 1/2	18x 96	260
13	525	36	120	5/16	1/2	1800	H12	900	3 1/2	18x108	270
14	575	42	96	5/16	1/2	1850	H13	1000	3 1/2	18x120	285
15	720	42	120	1/2	1/2	2150	H14	1250	5	24x 84	370
16	860	42	144	1/2	1/2	2500	H15	1500	5	24x108	425
17	1000	42	168	1/2	1/2	2900	H16	1750	5	24x120	450
18	950	48	120	3/8	1/2	2850	H17	2000	6	30x 96	570
19	1140	48	144	3/8	1/2	3250	H18	2400	6	30x120	620
20	1310	48	168	3/8	1/2	3700	H19	2800	6	30x132	670
21	1480	48	192	3/8	1/2	4100	H20	3200	8	36x 96	860
22	1190	54	120	3/8	1/2	3250	H21	3600	8	36x108	920
23	1430	54	144	3/8	1/2	3700	H22	4000	8	36x120	950
24	1670	54	168	3/8	1/2	4200	H23	4400	8	36x132	1020
25	1900	54	192	3/8	1/2	4700	H24	4800	10	36x 96	1200
26	1420	60	120	7/16	5/8	4300	H25	5400	10	36x108	1300
27	1710	60	144	7/16	5/8	4900	H26	6000	10	36x120	1380
28	2000	60	168	7/16	5/8	5600	H27	7000	12	42x 96	1950
29	2300	60	192	7/16	5/8	6200	H28	8000	12	42x 96	2000
30	2460	72	144	7/16	5/8	5700	H29	9000	12	42x108	2300
31	2880	72	168	7/16	5/8	6400	H30	10000	12	42x108	2460

DIRECTIONS FOR USE—Select the size storage you require and combine its designating number with the number which designates the desired hourly output. Assuming a required storage of 1000 gallons (No. 17 shell 42 x 168) and a required hourly output of 1750 gallons (No. H16 Heating unit) you would specify a Whitlock Type K, No. 17H16.

WHITLOCK TYPE R INSTANTANEOUS HEATERS



This type of heater is used extensively as an instantaneous heater in connection with a separate storage tank, as a swimming pool heater, as a hot water converter for use with a heating system as well as for various special conditions.

Standard sizes of the 2 and 4 pass heaters are shown in the table. Dimensions on multi-pass heater will be furnished on request.

Standard Sizes, Capacities, Dimensions and Weights

Size No.	2 PASS, TEMP. RANGE 40° F. to 80° F. Capacity Gallons per Hour	Over-all Length	Diameter of Shell	Size Water Connections	Size Steam Connections	Weight	4 PASS, TEMP. RANGE 40° F. to 120° F. Capacity Gallons per Hour	Over-all Length	Diameter of Shell	Size Water Connections	Size Steam Connections	Weight
0	150	11 5/8	7	3/4	1 1/4	70	80	11 5/8	7	3/4	1	70
1	350	14 5/8	7	1 1/4	1 1/2	80	150	16 5/8	7	3/4	1 1/4	85
2	650	19 5/8	7	1 1/2	1 1/2	100	300	21 5/8	7	1	2	100
3	1100	23 5/8	7	2	2	110	480	26 5/8	7	1	2	115
4	1600	29 5/8	7	2	2 1/2	125	650	31 5/8	7	1 1/4	2 1/2	130
5	1900	34 5/8	7	2	3	160	800	38 5/8	7	1 1/4	2 1/2	150
6	2550	24 1/4	9 1/2	2 1/2	3	210	960	24 1/4	9 1/2	1 1/2	3	190
7	3200	30 1/4	9 1/2	2 1/2	3 1/2	240	1350	30 1/4	9 1/2	2	3	230
8	3800	35 1/4	9 1/2	2 1/2	4	300	1600	35 1/4	9 1/2	2	3 1/2	255
9	5100	43 1/4	9 1/2	3	5	320	2100	43 1/4	9 1/2	2	4	300
10	6350	55 1/4	9 1/2	3	5	380	2600	55 1/4	9 1/2	2 1/2	5	370
11	7950	45	12	4	6	565	3300	52	12	2 1/2	5	555
12	9550	52	12	4	6	625	4000	61	12	3	6	625
13	12700	67	12	4	8	760	5300	79	12	3	6	775
14	15900	51 7/8	15	5	8	810	6600	55 5/8	15	3 1/2	8	790
15	19100	59 5/8	15	5	8	900	8000	65 5/8	15	4	8	885
16	25600	59	17	6	10	1240	10500	71	17	5	10	1250
17	31700	71	17	6	10	1390	13300	83	17	5	10	1420
18	38200	61 7/8	20	8	12	1800	16000	72 5/8	20	5	10	1800
18 1/2	44400	70 5/8	20	8	12	1940	18500	82 5/8	20	5	12	2000
19	50700	78 5/8	20	8	12	2100	21000	92 5/8	20	6	12	2165
19 1/2	57100	59 5/8	26	10	14	2660	24000	62 5/8	26	6	12	2625
20	63450	64 5/8	26	10	14	2860	26700	67 5/8	26	6	12	2820
21	79300	76 5/8	26	10	16	3300	33300	82 5/8	26	6	14	3285
22	95100	66	30	12	18	4250	40000	73	30	8	14	3960
23	126900	83	30	12	20	4980	53300	92	30	8	16	4600
24	158400	78	36	14	24	6550	66700	83	36	10	20	5980
25	191000	89	36	14	24	7060	80000	95	36	10	22	6820
	Sizes 0 to 10 inclusive, have 3/4" O. D. No. 18 B. W. G. Copper Tubes. Remainder have 1" O. D. No. 17 B. W. G. Copper Tubes.						Sizes 0 to 10 inclusive, have 3/4" O. D. No. 18 B. W. G. Copper Tubes. Remainder have 1" O. D. No. 17 B. W. G. Copper Tubes.					

Whitlock Heat Transfer Products include the following types of apparatus in addition to the Storage and Instantaneous Heaters shown above: Feed Water Heaters; Heat Exchangers; Fuel Oil Heaters; Superheaters; Condensers and Coolers for all kinds of liquids; Also pipe coils of any kind of pipe or tubing and Air and Ammonia Receivers.

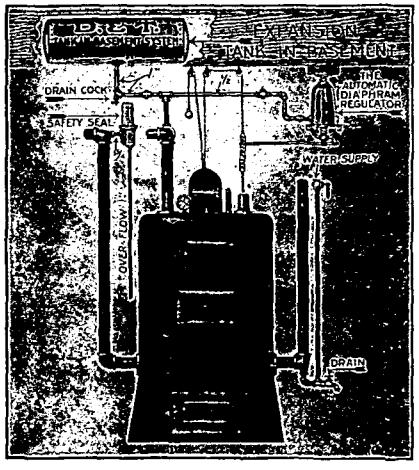
Additional information and list prices concerning any of this apparatus will be gladly furnished upon request.

D. & T. Manufacturing Company

3001 La Salle Street

St. Louis, Mo.

ORIGINAL TANK IN BASEMENT SYSTEM



Placing the expansion tank in the basement on hot water installations is destined to become the one general method. WHY NOT GET INTO THE GAME?

Eleven years' experience and upwards of 100,000 D. & T. Tank-in-the-Basement Systems in successful operation throughout the United States and Canada, should be sufficient proof of the success of this system to the most skeptical heating engineer or contractor.

The D. & T. System is efficient, simple and foolproof.

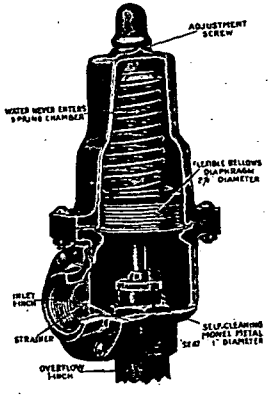
Send for booklet entitled, "Progress in Hot Water Heating."

The Superior Air Sealed Pressure Controller is absolutely dependable, opening freely after long periods of inactivity. There is no danger of the controller failing to relieve.

This Air Sealed Pressure Controller is different from all other relief devices. As you will note, by reference to the sectional view, the opening of the valve is effected by the pressure on the diaphragm.

This diaphragm being the well-known flexible type, has sufficient flexibility to allow the disc to raise up off the seat a full inch. This insures positive relief when the predetermined point is reached.

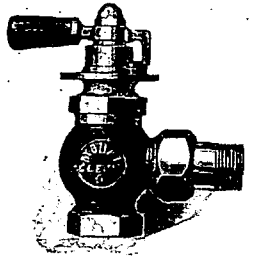
This disc is made of a composition which will stand a temperature of 300 deg. fahr. The seat is made of the well-known non-corrosion Monel metal, which is self-cleaning and assures proper action at all times. The disc is 1 in. in diameter and the bellows which lifts the disc from the seat is 2½ in. in diameter, thereby giving a lifting power 6¼ times greater than the area of the disc.

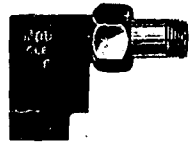


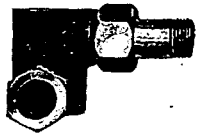
The Mouat Vapor Heating Co.

1246 W. Fourth Street ∴ CLEVELAND, OHIO

The Mouat System of heating is 2-pipe gravity vapor, operating at from 1 to 2 oz. pressure, resulting in positive and successful hand control of the supply of heat at the radiators. It has no pumps, thermostatic valves, return traps or mechanically operated parts of any kind.







RADIATOR RETURN FITTINGS

The Mouat Radiator Return Fitting is a specially designed water seal, with a by-pass for air. It also has provision for drainage to prevent freezing.

NOTE—All of the Mouat Specialties have been designed to work in conjunction with one another; therefore, these specialties are not sold separately, but only complete for each installation.

A detailed working plan and specification prepared by experienced engineers is furnished for each building in which the Mouat System is used.

PACKLESS FRACTIONAL RADIATOR SUPPLY VALVES

Has Jenkins Disc and is substantially made. Easily adjusted, when installed, to suit the size or working conditions of the radiator to which it is connected.



AIR RELIEF VALVES

The Mouat Air Relief Valve or Main Vent is provided with a properly proportioned venting area.

It has no thermostatic, mechanically operated or float parts.

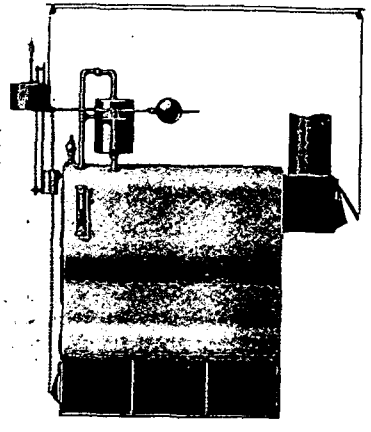


VAPOR PRESSURE GAUGES

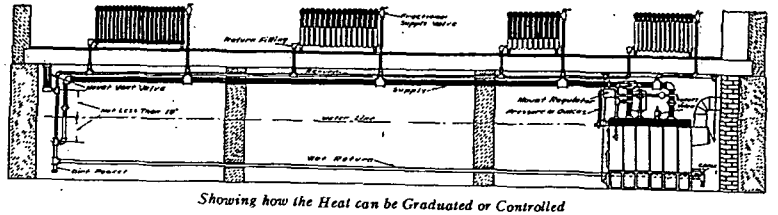
The Mouat Vapor Pressure Gauge indicates ounces of pressure by water elevation in a glass tube.

DAMPER REGULATORS

This regulator is controlled by the pressure in the boiler and automatically regulates the drafts. It will maintain a pressure of from one to two ounces, and is sufficiently sensitive to operate at a variation of less than one ounce. The working parts are connected above the water line of the boiler and are not affected by a high or low water line or the variations of an unsteady water line. No water can be forced out of the boiler through the regulator.



This regulator can also be used to reduce steam pressure to vapor pressure on central station heating plants.



Showing how the Heat can be Graduated or Controlled

MUELLER CO.

Decatur, Ill.

BRANCHES

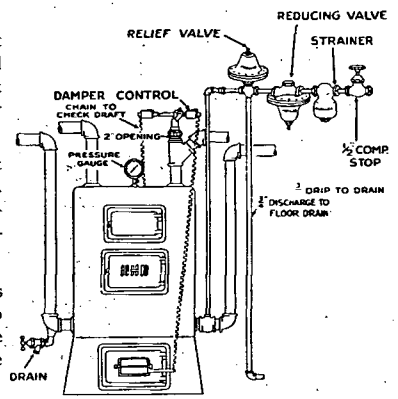
145-149 W. 30th St., New York 1072-76 Howard St., San Francisco 2468 Hunter St., Los Angeles

PRODUCTS

Mueller Automatic System of Hot Water Heat Control

Reducing and Regulating Valves for water.
Reducing and Regulating Valves for steam.
Relief Valves. Water Strainers.

Complete line of High Grade Plumbing Brass Goods



Mueller Automatic System of Hot Water Heat Control—This is a closed system operating automatically without an expansion tank. It can be quickly installed on either new or old jobs.

The water in the system is always kept fresh. This promotes good circulation. Just enough water is admitted by the reducing valve to supply the amount released by the relief valve.

When air is released from a radiator it is not necessary to go to the basement to turn water into the system as is the case with other systems. The reducing valve takes care of this.

A very considerable saving in fuel is effected due to the automatic control of dampers and rapid circulation.

Perfectly safe as both reducing valve and relief valve are operated by the pressure of the water in the system. These valves are especially constructed and tested for use on this system.

The reducing and relief valves are positive in action and durable, the working parts being made of bronze with phosphor bronze diaphragms.

Boiling point of water raised to higher point than with open system.

The damper regulator is a very important part of this system as it is not only a fuel saver but also is a safety feature, checking the fire when the desired temperature is reached.

Reducing and Regulating Valves—For steam, water, air, gas, oil, etc., and relief valves that are absolutely dependable. They will not stick after long periods of disuse.

Brass Goods—Everything in the line of brass faucets, stops, etc., for lavatory and bath room, and also complete line of laboratory faucets adopted and approved by leading universities such as the Massachusetts Tech.

Mueller Co. has been in business from 1857 and has an acknowledged reputation for quality goods.

Specific information regarding any Mueller product will be cheerfully given upon request.

Reading Heater & Supply Co.

Incorporated

GENERAL OFFICES

Woodward and Church Streets

Reading, Pa.

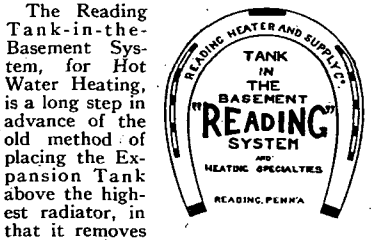
Manufacturers and Distributors of

The Reading Tank-in-the-Basement Systems for Hot Water Heating and The Reading All-Metal Temperature Regulator for Hot Water Heaters, Domestic Heaters and Storage Tanks, Wholesale Dealers in Boilers, Radiators and Heating Specialties.

The Reading Tank-in-the-Basement System, for Hot Water Heating, is a long step in advance of the old method of placing the Expansion Tank above the highest radiator, in that it removes the tank to the basement, obviating many objectionable features and removing the liability of fracture by freezing of the expansion line or overflow.

The Reading Tank is proportioned according to the amount of radiating surface on the job, and provides ample air space to allow for expansion. The gauge glass enables the operator to detect any air leakage and to maintain a sufficient air space.

The Reading Relief Valve permits a slight pressure on the system, even when the water is cold. This means increased efficiency and prevents the accumulation of air in the upper radiators. The increased pressure will not cause leaks as the air cushion prevents undue strains. We furnish complete instructions for installation.



Capacities and Prices

(Subject to trade discount)

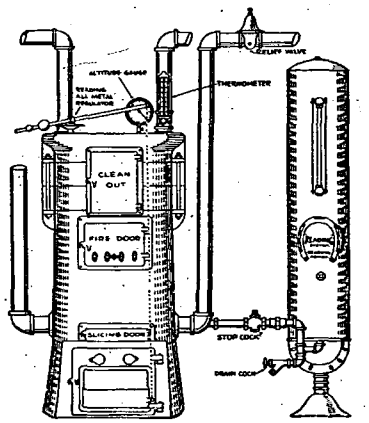
No. 1.	300 to 500 ft. of Radiation	$38
No. 2.	500 to 800 ft. of Radiation	40
No. 3.	800 to 1,000 ft. of Radiation	41
No. 4.	1,000 to 1,300 ft. of Radiation	45
No. 5.	1,300 to 1,800 ft. of Radiation	50
No. 6.	1,800 to 2,600 ft. of Radiation	56

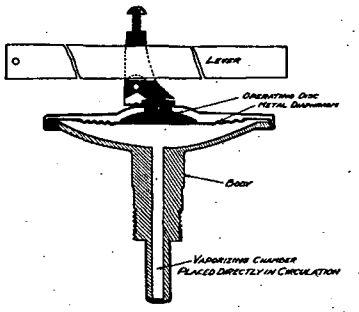
In ordering Reading Tank-in-the-Basement Systems the following information is required: Amount of radiation on job, *square feet; number of stories to be heated.*

The Reading All-Metal Regulator can be used to control water temperature in any system, regardless of pressure carried. The Regulator is easily applied and the action is sensitive and reliable.

We will be glad to send a catalog describing our complete line of Specialties, upon request. Our Engineering Department will welcome the opportunity to assist the trade in difficult problems pertaining to our line, and we invite such inquiries.

We carry a large stock of boilers of all capacities, Round or Sectional, and can make prompt shipments.





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READING ALL METAL TEMPERATURE REGULATOR

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Cooperative Engineering and Contracting Service on Heating Systems—Seventy years experience in piping installation puts Grinnell Company, Inc., in an especially advantageous position to render service of the highest order to heating engineers and their clients. This not only includes a cooperative advisory service which is frequently used by engineers who desire authoritative practical information when working on problems more or less out of the ordinary, but also a complete and expert contracting service as well.

Close contact with power and industrial piping enables Grinnell Engineers to approach questions of heating with full realization of their relationship to other factors. Information supplied by members of the Grinnell Staff regarding the utilization of waste heat through the agency of hot water systems, the utilization of exhaust steam, etc., has proved of invaluable assistance in working out more efficient heating.

Grinnell Engineering or Contracting Service is equally satisfactory on the remodeling of old heating systems—a type of work with which the Company is thoroughly familiar.

Power and Industrial Piping—The advantages of placing contracts for all necessary piping with one reputable company are obvious. Responsibility is centralized and a saving in cost is often effected. Grinnell Company, Inc. is prepared to submit bids and render expert, personally supervised construction service on all types of Power Plant and Industrial Piping including Automatic Sprinkler Systems, piping for Acids, Alkalis, etc., Compressed Air Cleaning Systems, Humidifying Systems, Drying Machinery. A contract placed with Grinnell Company is carried out to the satisfaction of all concerned. Materials of the highest quality are used. Grinnell Adjustable Hangers and Grinnell Fittings, for instance, save work in installation and make for

cleaner, more satisfactory finished jobs and lower maintenance costs.

Pipe Bends, Welds, Etc.—Grinnell facilities for making Pipe Bends, Welds and Lap Joints are second to none. Three plants—Providence, R. I., Auburn, O., Atlanta, Ga.,—equipped with special modern machinery and operated by the most skillful workmen make possible unusually prompt and efficient service on this important work.

Humidifying Systems—Through our affiliations with American Moistening Company, we are in a position to design and install complete humidifying systems, using devices long standard in this work. An especially reliable and sensitive control is a feature of all American Moistening Company equipments, which include, in addition to its new Simplex Humidifier, sectional, fan type, high duty and ventilating humidifiers; atomizer or compressed air systems, air conditioning room equipment, etc.

Grinnell Textile Drying Machinery—Grinnell Company manufacture a complete line of textile drying machinery which has been developed on one basic underlying principle—*Lower Temperatures and Greater Air Volume with a Defined Air Movement.*

This principle has been incorporated into a warp drying machine about which one user says: "When with the use of cylinder dryers there was required about thirty hours for splitting, quilling, etc., we think nothing of doing the job in six hours." Another user of this warp dryer reduced his splitting, quilling and winding costs fifty per cent.

This same principle has been incorporated also into a slasher dryer and a yarn dryer with equally astonishing results.

In view of this experience we believe we can successfully adapt this new Grinnell principle to the solution of any drying problem. Without any cost or obligation to those who will frankly tell us what their drying problems are, we are willing to investigate to see if this principle of low temperatures and large air volume in a predetermined way may be the remedy.

Grinnell Fittings—After years of buying cast iron fittings on the open market Grinnell Company concluded that the best way to obtain clean accurate fittings of uniformly high quality was to cast them in Grinnell Foundries. Grinnell Cast Iron Flat Band Fittings made to conform to the American standard adopted by the Manufacturers Committee on Standardization of Fittings and by the N. F. P. A. can now be obtained by other users. Impartial purchasers agree that accuracy of threading, freedom from sand holes, and smoothness of core speed up installations and reduce replacements wherever Grinnell Fittings are specified.

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Heating, Industrial and Power Plant Piping, Fittings, Hangers, Valves, Pipe Bending, Welding, Piping Supplies, Etc.

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Heating, Industrial and Power Plant Piping, Fittings, Hangers, Valves, Pipe Bending, Welding, Piping Supplies, Etc.

Grinnell Adjustable Hangers

ONE of the chief advantages of Grinnell Adjustable Hangers is that they permit adjustment of pipe lines after installation, thus obviating the necessity of turn buckles or the removal of hangers. And their time and trouble-saving qualities during installation are equally exceptional. On this and the two following pages are shown a few Grinnell Hangers of particular interest to heating engineers. The Grinnell Hanger Blue Book, however, illustrates and describes the complete line and carries mechanical drawings and dimensional tables on practically every hanger shown. This feature alone makes the Grinnell Hanger Blue Book invaluable to Engineers, Architects and Draftsmen. As many copies as you require will be sent on request.

Adjustable Swivel Ring—Solid Ring Type

(Patented October 4, 1921)



Fig. No. 101

THIS Malleable Iron Adjustable Swivel Ring can be used with Coach Screw Rod or Machine Threaded Rod in connection with practically any type of Ceiling Flange, Expansion Case, Insert, etc.

The unusual feature of this ring is the Swivel Shank. An adjustment of at least 1½ in. is secured by simply turning the nut on the shank. No temporary support of the pipe line is necessary while making adjustments.

By means of a unique locking device the Swivel Shank can be locked to prevent loosening due to vibration in the pipe line.

Adjustable Swivel Ring—Split Ring Type

(Patented October 4, 1921)



Fig. No. 104

THE Split Ring Type of the Adjustable Swivel Ring was also designed for use with Coach Screw Rod or with Machine Threaded Rod. The Swivel Shank feature allows the same adjustment as in Fig. No. 101 and the off-center hinging of the ring, by providing sufficient seating to hold pipe securely, permits adjustments before the Ring is closed. The closing of the hinged section of this Ring securely locks the Swivel Shank.

Side I-Beam Clamp

(Patented April 6, 1915)

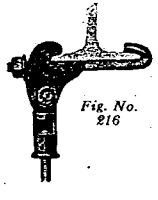


Fig. No. 216

ADAPTABLE to many uses, this Side I-Beam Clamp has ample strength for hanging ¾ to 12 in. pipe from I-Beams. This Clamp in different sizes will fit all sizes of Standard and Bethlehem I-Beams, and most sizes of Bethlehem Girder Beams.

Under conditions requiring vertical adjustment of the pipe line, this Side I-Beam Clamp is used with the Extension Piece. This Extension Piece allows 1 in. adjustment at the top of the hanger rod, and a full swing of the rod itself.

Channel Iron Clamp

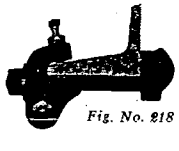


Fig. No. 218

DUE to the adjustability of the Grinnell Channell Iron Clamp, three sizes of these clamps, with varying lengths of clamp rods, each with a simple hex-nut, will meet most of the conditions encountered in practical installation work in connection with channels. We know of nothing else on the market which will obviate the necessity for the making of specials for Channel Iron work.

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Adjustable Wall Radiator Brackets



Fig. No. 190

THE Grinnell Adjustable Wall Radiator Brackets shown here were designed to support either a single tier of radiation or two tiers—one in front of the other. Fig. No. 190 shows bracket with single foot for supporting one tier—Fig. 191 shows bracket with double foot, long screw and double collar, for holding two sections in place.

Only one bolt is necessary to securely fasten these brackets to the wall. This means low installation cost as it cuts drilling holes down to a minimum. Cost of installation can be further reduced by spacing these hangers farther apart than ordinary type of weaker construction, especially where hook bolts are set in the wall.

When hook bolt is used it can be set without extremely accurate measurements due to the liberal range of vertical adjustment and as only three points of the bracket touch the wall, the difficulty so often experienced with rough brick work is practically eliminated.

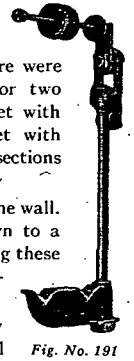


Fig. No. 191

Adjustable Wall Coil Hangers

(Patented May 20, 1923)

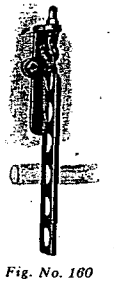


Fig. No. 160

THE Adjustable Wall Coil Hanger can be furnished with four separate brackets—two for single coils and two for double coils. The brackets locate the center of the coils 2¼ or 6¼ in. from back of bracket. Where double coils are used the second hangs 3½ in. in front of the first.

Besides the adjustable advantages of these hangers which permit the hanger plate to be raised or lowered to secure perfect pipe alignment, it is only necessary to fasten the individual bracket in place by two bolts. This saves labor.

Saddle Hangers—Standard Type

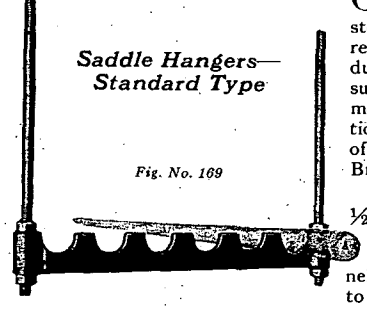


Fig. No. 169

GRINNELL Saddle Hangers are unique inasmuch as the hanger bar is of steel instead of cast iron. This Feature not only reduces the weight of the hanger but also reduces its cost. Hex-nuts at bottom of rods support the hanger and allow liberal adjustment. These Saddle Hangers are exceptionally strong and will not sag. Labor cost of installation is considerably less than with Branch Rolls and Rods.

The Saddle Hanger is used in connection with ½ in. rods and hex-nuts on 2 to 8 branch hangers —⅝ in. rods and hex-nuts on 9 to 12 branch hangers—and with Expansion Cases, Grinnell Hanger Flanges, or with Side I-Beam Clamps to steel work, for supporting overhead coils.

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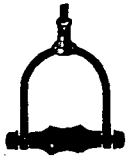


Fig. No. 174

Adjustable Swivel Pipe Roll

(Patented October 4, 1921)

THE Adjustable Swivel Pipe Roll supplies the need for any adjustable type of pipe roll hanger with single hanger rod. It is unique inasmuch as vertical adjustment can be made by use of the swivel shank at the top of the hanger.

Branch Pipe Rolls

GRINNELL Pipe Rolls are especially designed to take care of expansion and contraction. The rolls are made hollow so that only a small surface is in contact with the rod whereas the surface in contact with the pipe is made as large as possible. This allows the roll to take care of expansion and contraction properly.

Through a specially designed socket, vertical adjustment is allowed at the bottom of each vertical rod as well as at the Ceiling Flange. Furthermore, the nut at the bottom of the hanger rod fits into a recess of the socket preventing loosening or turning from vibration.



Fig. No. 172

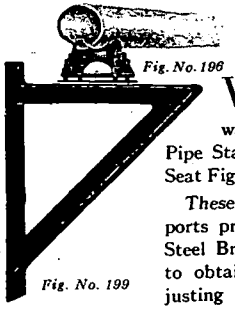


Fig. No. 196

Fig. No. 199

Adjustable Pipe Stand—Anchor Chair—Pipe Seat—used with Welded Steel Bracket

WELDED Steel Bracket Fig. No. 199 is light in weight as compared with the usual cast iron brackets. It was designed primarily for use with the Grinnell Adjustable Pipe Stand Fig. No. 196, Anchor Chair Fig. No. 197 and Pipe Seat Fig. No. 198, here illustrated.

These combine the strongest type of brackets and pipe supports procurable. The Adjustable Pipe Stand as used with the Steel Bracket has excellent adjustment features, it being possible to obtain vertical adjustment by simply adjusting bolts on the roll stand. A lateral adjustment or movement is possible with the Adjustable Pipe Stand and Pipe Seat by sliding the Stand or Seat on the bracket. With the Anchor Chair, lateral adjustment is also possible if Chair is moved before the nuts on the anchor yoke are tightened.



Fig. No. 197



Fig. No. 198

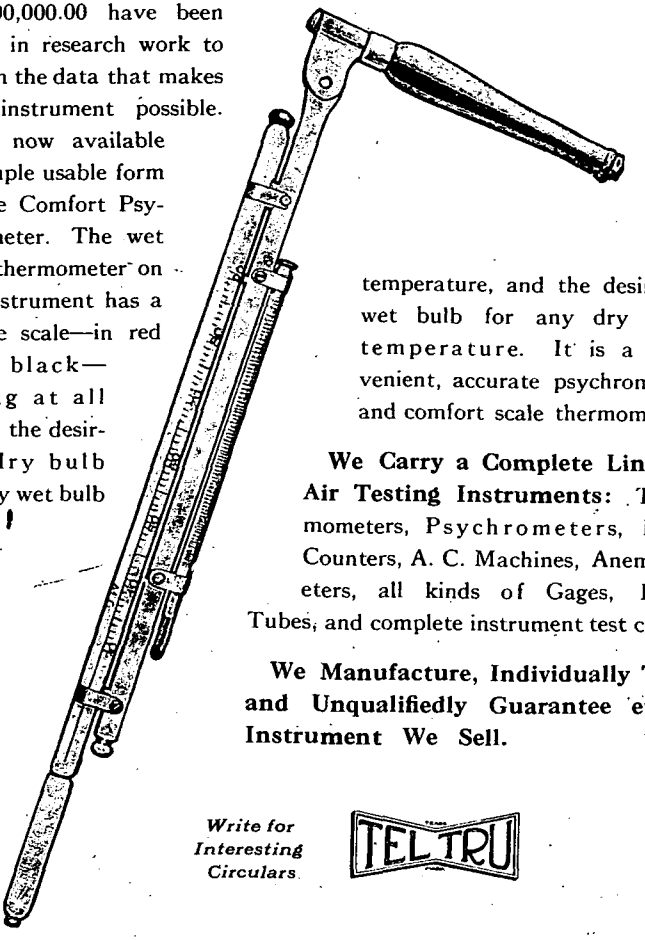
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Designed for Air Ducts are extremely sensitive and are used extensively by heating and ventilating engineers.

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Used to record air duct temperatures. The self-contained type (not illustrated) is used to record room temperatures—Clock furnished with 7 day charts.

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A convenient method of obtaining relative humidity records. Equipped with blowers to keep air moving over bulbs at uniform velocities.

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Type P is supplied with flange connections for air ducts, air washers, and room conditioners, etc.

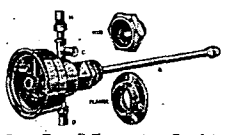
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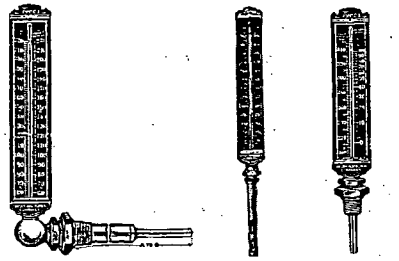
For registering velocity of air currents.

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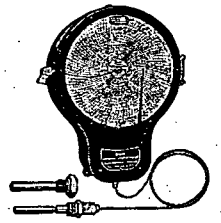
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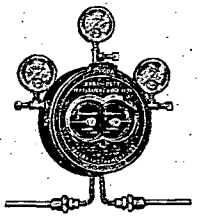
Tycos Type P Temperature Regulator



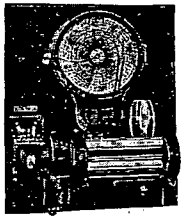
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Ric-wiL Interlocking Conduit—RIC-WIL Conduit is first quality, standard weight, vitrified salt glazed tile of the bell and spigot type. It is shipped on the job in full round sections and split into top and bottom halves as used. When installed bell and side joints are sealed with Portland cement. The top half has an overhanging lip that interlocks with the bottom half, providing extra cementing surface and protecting the side joints of tile against water. Top and bottom halves are numbered in pairs so that companion pieces may be kept together. Sections all in 2-ft. lengths, sizes from 4 to 24 in. inside diameter. Every sixth section of conduit has an opening in the bottom half through which a pipe support of the roller type projects to carry the steam, hot water or oil pipes thus making the pipe supports independent of the conduit itself—a desirable feature for this class of work.

Ric-wiL Interlocking Base Drain—RIC-WIL Base Drain is first quality vitrified salt glazed tile of such design that it is both a base for supporting and lining up the conduit, and drain for carrying away any water which might otherwise accumulate around the conduit. The base drain also provides two points of support for conduit, adding 35 per cent to the ground load which the conduit will carry safely as compared to the same conduit placed on flat ground or broken stone. The top of the base drain has a slot in it into which the bell of conduit fits thus making sections of conduit and base drain stagger with each other so that a strong interlocking construction results. No concrete foundation is necessary in solid ground. Free drainage area of the base drain is large and ample for every practical condition. Three sizes are made: No. 1 for 4 and 6 in. conduits, No. 2 for 8 to 15 in. inclusive, and No. 3 for larger sizes. We will furnish ordinary drain tile instead of base drain if desired but the base drain will save more than its extra cost in labor and makes a far better job.

Ric-wiL Pipe Supports—The pipe supports are planned to carry from one to five or more pipes and are ordinarily spaced 12 ft. apart. They are strong, made of cast iron, rust proofed, and interlocked with the base drain, imposing no load on the conduit itself. Once in place, no movement of the pipes can disturb them.

Ric-wiL Conduit Systems for All Uses—RIC-WIL Conduit is of four types to meet varying service requirements.

Type SPC System for steam heating and power pipes and for superheated steam. The tile itself is not lined with insulation as in types *DA* and *DF* but the insulation is applied to pipes direct and consists of any standard make of sectional pipe covering, the *kind* and *thickness* depending upon the service to be rendered. Double drainage is provided in this type.

Type F System for steam heating and power pipes. A lower priced type than the others, consisting of unlined RIC-WIL Conduit with filler packed around the pipes. Filler is the same as described in Type *DF* System.

Type DA System for hot water, fuel oil, and condensation returns. Tile and insulation in one, the latter moulded inside the tile and keyed in. Consists of a diatomaceous earth (Sil-O-Cel) mixture, light in weight and of high insulating quality; will not deteriorate. This type insulates the pipes from surrounding ground but not from each other, making it specially adapted to house oil and steam pipes together for fuel oil transmission. Exceptionally easy to install.

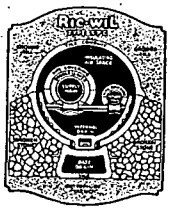
Type DF System for steam heating and power pipes. This is type *DA* with the addition of RIC-WIL Conduit Filler to be packed around the pipes at approximately 15 lb. per cu. ft. The filler is a good non-conductor which will not corrode the pipes nor shrink.

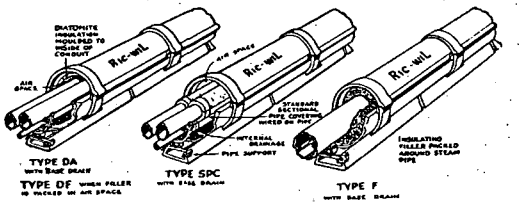
Inquiries—Inquiries should state the size of pipe or pipes to be covered and the services to be carried by them—whether steam, condensation return, hot water or fuel oil. If steam, give pressure. Catalog and Price List on request.

Engineering—An engineering service is maintained for the convenience of customers.

Maximum Capacity of Conduits With Standard Equipment—Approximate

In. Diameter	4	6	8	10	12	15	18	20	22	24
1 Pipe	1½	3	4½	6	8	10	12	14	16	18
2 Pipes	½-½	¾-¾	1¼-1¼	2-2	3-3	4-4	5-5	6-6	7-7	8-8
3 Pipes	None	None	1¼-1¼-1	2-2-1¼	3-3-1½	4-4-2	5-5-2½	6-6-3	7-7-3½	8-8-4





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Steam Pressure or Condition	Temperature Deg. Fahr.	Thickness of Insulation		
		Pipes Larger than 4 in.	Pipes 2 in. to 4 in.	Pipes Smaller than 2 in.
25 to 100 lbs.	267 to 338	1½"	Std.	Std.
100 to 200 lbs.	338 to 388	2"	1½"	Std.
Low Superheat	388 to 500	Dbl. Std.	2"	1½"
Superheat	500 to 600	3"	Dbl. Std.	1½"

Superheated Steam Piping (Temperatures above 600 deg. fahr.)—All superheated steam piping shall be insulated with Johns-Manville High Temperature Combination Insulation of thicknesses shown below:

Steam Condition	Temperature Deg. Fahr.	Thickness of Insulation		
		Pipes Larger than 4 in.	Pipes 2 in. to 4 in.	Pipes Smaller than 2 in.
High Superheat	600 to 700	3½"	3"	1½"
High Superheat	700 to 800	4"	3½"	2"

Low Pressure and Exhaust Steam and Feed Water Piping—All low pressure, exhaust steam and feed water piping shall be insulated with 4-ply Johns-Manville Improved Asbestocel Sectional Insulation.

Steam Heating Supply and Return Mains, Risers and Radiator Branches—All steam heating supply and return mains and branches, and all risers, shall be insulated with 4-ply Johns-Manville Improved Asbestocel Insulation. All concealed radiator branches shall be insulated with 3-ply Johns-Manville Improved Asbestocel Insulation.

High Pressure Steam Lines In Manufacturing Buildings—All high pressure steam piping and high pressure drip piping used in connection with distribution of steam for manufacturing purposes shall be insulated with Asbesto-Sponge Felted Sectional Insulation of the following thicknesses:

Steam Pressure.	Temperature Deg. Fahr.	Thickness of Insulation		
		Pipes Larger than 4 in.	Pipes 2 in. to 4 in.	Pipes Smaller than 2 in.
25 to 100	267 to 338	1½"	1½"	1"
100 to 200	338 to 388	2"	1½"	1"

Fittings, Valves and Flanges—All pipe fittings, valves and flanges shall be insulated with block and plastic insulation to the same thickness as the adjacent pipe insulation. Block insulation shall be of the same material as the adjacent pipe insulation and plastic material used shall be hard finish Asbestos Cement. Block insulation may be omitted on pipe sizes smaller than 4 in., or where total thickness of insulation is less than 1½ in. and the entire thickness of insulation in such cases may be made up of hard finish Asbestos Cement.

Cold Water Piping—All cold service water piping, including risers and concealed fixture connections or exposed soil or waste lines, shall be insulated with Anti-Sweat Insulation 1 in. thick applied in two layers with all joints broken, fittings with Hair Felt and hard finish Asbestos Cement to the same thickness.

Finish of Insulation—All insulation on pipes, fittings, valves and flanges which is exposed to view shall be enclosed in an extra jacket of 8-oz. canvas applied over rosin sized paper.

Where insulation is concealed the light canvas furnished in manufacture is to be pasted down over the joints and the insulation additionally secured by means of brass lacquered bands applied at least two to a section.

Warm Air Ducts—All warm air ducts, flues, heater casings and fan housings in the ventilating system shall be insulated with 4-ply Improved Asbestocel sheet insulation finished with hard finish Asbestos Cement ⅛ inch thick, applied over hexagonal wire reinforcement. The cement finish shall be troweled to a smooth and uniform surface. Where this insulation is exposed to view it shall be finished with a jacket of 8-oz. canvas, glued to the insulation and sewed in place.

Painting—All insulation exposed to view and enclosed in a jacket of 8-oz. canvas is to be painted with one coat of glue-sizing and two coats of first quality lead and oil paint of a color selected by the architect.

Underground Lines—All high and low pressure steam lines and hot water lines running under ground outside of buildings shall be installed in Johns-Manville System of Underground Insulation. This system shall be installed in accordance with the manufacturer's specifications.

All of the above insulation is to be furnished and applied by the manufacturer of the materials used, or by his approved contractor, in accordance with the manufacturer's standard specifications.

Johns-Manville is prepared to furnish detailed standard specifications on any of the above items, as well as on the following and many others:

Boilers,
Boiler Settings,
Tube Doors,
Breechings and Smoke Flues,
Stack Lining, Stack Insulation,
Feed Water Heaters,
Pump Cylinders,
Hot Water Piping,
Ice Water Piping,
Refrigeration Piping,
Pipes Exposed to Freezing.

JOHNS-MANVILLE IMPROVED ASBESTOCEL INSULATION

For insulating pipes conveying hot water or steam at medium and low pressure.

EFFICIENCIES

Pipe Sizes Inches	Ply		Temperature Difference Between Pipe and Surrounding Air, Deg. Fahr. 100°	150°	200°	250°	300°
			Temperature of Pipe, Deg. Fahr. (Temperature of Surrounding Air, 75 Deg.) 175°	225°	275°	325°	375°
			Heat losses per linear foot of bare pipe per hour and efficiencies of insulation				
1		Bare Pipe Loss, B.t.u.	74.0	123.8	183.4	253.7	337.4
	2-ply	Efficiency %	57.8	59.8	61.6	63.2	64.8
	3-ply	" %	62.9	64.8	66.6	68.2	69.7
	4-ply	" %	66.4	68.1	69.7	71.2	72.6
2		Bare Pipe Loss, B.t.u.	133.9	223.9	331.5	458.7	608.3
	2-ply	Efficiency %	64.5	66.1	67.6	68.9	70.1
	3-ply	" %	69.7	71.3	72.6	73.9	75.1
	4-ply	" %	73.0	74.5	75.7	76.9	78.0
3		Bare Pipe Loss, B.t.u.	197.3	330.1	488.8	676.3	896.8
	2-ply	Efficiency %	67.2	68.7	70.0	71.2	72.3
	3-ply	" %	72.6	74.0	75.3	76.4	77.4
	4-ply	" %	75.9	77.2	78.3	79.4	80.3
4		Bare Pipe Loss, B.t.u.	253.5	424.2	627.9	868.8	1152.1
	2-ply	Efficiency %	68.6	70.0	71.3	72.4	73.4
	3-ply	" %	74.0	75.3	76.5	77.6	78.6
	4-ply	" %	77.4	78.5	79.6	80.6	81.5
6		Bare Pipe Loss, B.t.u.	371.9	623.9	923.7	1278.1	1694.9
	2-ply	Efficiency %	70.0	71.4	72.6	73.7	74.7
	3-ply	" %	75.6	76.8	77.9	79.0	79.9
	4-ply	" %	79.0	80.1	81.1	82.0	82.8
8		Bare Pipe Loss, B.t.u.	485.7	812.5	1203.0	1664.5	2207.3
	2-ply	Efficiency %	70.9	72.2	73.3	74.4	75.3
	3-ply	" %	76.4	77.6	78.6	79.6	80.5
	4-ply	" %	79.8	80.9	81.8	82.7	83.5

Space limitations do not permit the insertion of complete efficiency tables, pipe sizes, insulation thickness, etc. If you do not find the size you want, write to the nearest Johns-Manville Division sales office.

JOHNS-MANVILLE 85 PER CENT MAGNESIA INSULATION

An efficient insulation for steam lines to 600 deg. fahr.

EFFICIENCIES

Pipe Size Inches	Nominal Insulation Thickness Inches		Temperature Difference Between Pipe and Surrounding Air, Deg. Fahr. 100° / 200° / 300° / 400° / 500° — Temperature of Pipe, Deg. Fahr. (Temperature of Surrounding Air, 75 Deg.) 175° / 275° / 375° / 475° / 575° — Heat losses per linear foot of bare pipe per hour and Efficiencies of insulation				
1	0	Bare Pipe Loss, B.t.u.	74.0	183.4	337.4	555.2	891.0
	Std.	Efficiency %	68.7	73.7	77.7	81.1	84.0
	2	" %	78.4	82.0	84.8	87.3	89.5
	3	" %	81.4	84.6	87.0	89.1	90.9
2	0	Bare Pipe Loss, B.t.u.	133.9	331.5	608.3	1003.9	1611.0
	Std.	Efficiency %	76.7	80.5	83.3	85.7	88.2
	2	" %	83.3	85.9	88.2	90.2	91.7
	3	" %	86.2	88.5	90.2	91.9	93.3
3	0	Bare Pipe Loss, B.t.u.	197.3	488.8	896.8	1480.0	2375.0
	Std.	Efficiency %	78.8	82.3	84.8	87.1	89.3
	2	" %	85.2	87.7	89.6	91.4	92.9
	3	" %	88.2	90.2	91.7	93.0	94.2
4	0	Bare Pipe Loss, B.t.u.	253.5	627.9	1152.1	1901.3	3051.0
	Std.	Efficiency %	81.7	84.5	86.9	89.1	90.8
	2	" %	86.4	88.7	90.5	92.1	93.4
	3	" %	89.3	91.1	92.4	93.7	94.8
6	0	Bare Pipe Loss, B.t.u.	371.9	923.7	1694.9	2797.1	4488.5
	Std.	Efficiency %	82.7	85.4	87.6	89.7	91.3
	2	" %	87.8	89.8	91.3	92.8	94.0
	3	" %	90.4	92.1	93.3	94.4	95.3
8	0	Bare Pipe Loss, B.t.u.	485.7	1203.0	2207.3	3642.8	5845.6
	Std.	Efficiency %	83.7	86.2	88.4	90.2	91.9
	2	" %	88.4	90.3	91.8	93.1	94.3
	3	" %	91.1	92.7	93.7	94.8	95.6
	0	(Bare Surface) B.t.u.	215.2	533.0	978.0	1614.0	2590.0
	1	Efficiency %	82.36	85.25	87.60	89.64	91.48
	2	" %	90.16	91.85	93.12	94.27	95.31
	3	" %	93.22	94.37	95.25	96.06	96.75

JOHNS-MANVILLE ASBESTO-SPONGE FELTED INSULATION

For insulating high pressure and superheated steam lines to 750 deg. fahr.

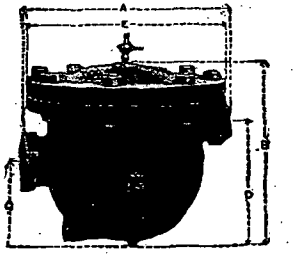
EFFICIENCIES

Pipe Size Inches	Nominal Insulation Thickness Inches		Temperature Difference Between Pipe and Surrounding Air, Deg. Fahr. 100° / 200° / 300° / 400° / 500° — Temperature of Pipe, Deg. Fahr. (Temperature of Surrounding Air, 75 Deg.) 175° / 275° / 375° / 475° / 575° — Heat losses per linear foot of bare pipe per hour and Efficiencies of insulation				
1	0	Bare Pipe Loss, B.t.u.	74.0	183.4	337.4	555.2	891.0
	1	Efficiency %	76.5	79.9	82.6	85.2	87.4
	2	" %	80.7	83.6	85.8	87.8	90.0
	3	" %	83.5	86.1	88.0	89.8	91.5
2	0	Bare Pipe Loss, B.t.u.	133.9	331.5	608.3	1003.9	1611.0
	1	Efficiency %	80.4	83.3	85.5	87.6	89.3
	2	" %	85.1	87.2	89.0	90.6	92.1
	3	" %	87.7	89.6	91.0	92.4	93.7
3	0	Bare Pipe Loss, B.t.u.	197.3	488.8	896.8	1480.0	2375.0
	1	Efficiency %	82.2	84.9	86.8	88.8	90.3
	2	" %	86.8	88.8	90.3	91.7	93.2
	3	" %	89.5	91.2	92.3	93.5	94.6
4	0	Bare Pipe Loss, B.t.u.	253.5	627.9	1152.1	1901.3	3051.0
	1	Efficiency %	83.3	85.8	87.6	89.5	90.9
	2	" %	87.9	89.7	91.1	92.4	93.7
	3	" %	90.5	92.0	93.0	94.1	95.1
6	0	Bare Pipe Loss, B.t.u.	371.9	923.7	1694.9	2797.1	4488.5
	1	Efficiency %	84.2	86.5	88.3	90.1	91.4
	2	" %	89.1	90.7	91.9	93.1	94.3
	3	" %	91.5	92.9	93.8	94.8	95.6
8	0	Bare Pipe Loss, B.t.u.	485.7	1203.0	2207.3	3642.8	5845.6
	1	Efficiency %	84.8	87.0	88.7	90.4	91.7
	2	" %	89.6	91.2	92.4	93.4	94.6
	3	" %	92.1	93.4	94.2	95.1	95.9
	0	(Bare Surface) B.t.u.	215.2	533.0	978.0	1614.0	2590.0
	1	Efficiency %	84.17	86.50	88.38	90.10	91.73
	2	" %	91.32	92.61	93.61	94.55	95.44
	3	" %	94.02	94.90	95.59	96.23	96.85

JOHNS-MANVILLE STEAM TRAPS

Type A (Cast Iron)

The simplicity of the Johns-Manville Steam Trap practically eliminates all possibility of its getting out of order. It has and requires no adjustments, and consists of only three parts—the body, discharge bushing and rolling ball, the latter being the only part that moves.



Cast Iron Models

Trap No.	Pipe Size Inches	Capacity Pounds of Water per Hour	Dimensions in Inches (See Diagram) A	B	C	D	E	Weight Lbs.
2-A	¾	700	7⅝	6	2⅞	3¼	6¾	14¼
3-A	1	1000	8⅛	7⅛	3½	4½	8	23
4-A	1¼	1700	10⅞	8¾	4⅛	5½	10¼	47
5-A	1½	3500	12⅛	11¼	5⅝	7½	12½	85
6-A	2	6000	14½	13	6⅝	8⅛	14¼	126

JUNIOR MODEL (Bronze)

For steam pressures to 50 lbs. ½ in. outlet and inlet pipe connections. Bushings for pressures from 1 to 10 lbs. and 10 to 50 lbs.

Trap	Pipe Size, Inches	Pressure Range Pounds		Capacity, Pounds of water per Hour
Junior	½	1–10	10–50	250

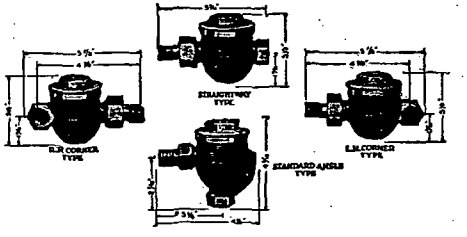
4¼ inches long by 3⅝ inches high; weight, 2 pounds, 6 ozs.

RADIATOR TRAPS (Bronze and Nickel Finishes)

For steam pressures to 10 lbs.—on open (atmospheric) or vacuum return line heating systems. For use on cast iron heating radiators only.

WEIGHTS

Style	Pipe Connection ½"	¾"
Standard	2 lb., 5 oz.	2 lb., 7 oz.
Straight-way	2 lb., 3 oz.	2 lb., 6 oz.
Corner	2 lb., 4 oz.	



JOHNS-MANVILLE UNDERGROUND SYSTEM OF INSULATION

A specially salt glazed and highly vitrified tile conduit is used as a waterproof envelope to protect the insulation—Johns-Manville Asbesto-Sponge Conduit Filling, is packed around the piping to be insulated and completely fills the conduit.

The cast iron roll frame used is installed in a mortar or concrete bed and is set at the proper elevation from an overhead batter-board line. This method prevents uneven alignment of the pipes by irregularity in the manufacture of the conduit, etc.

The insulation used to surround the pipe is made of asbestos fibre and material of a sponge-like nature, which when properly mixed with the asbestos, forms the most efficient and durable insulation for underground work.

The underdrain laid with open joints carries away the water that rapidly filters away from the system through the broken stone or gravel in which the lower half of the system and the underdrain itself is laid.

Shutters for sealing the ends of the system, manhole and anchor pits are incidental but necessary, and are placed according to conditions and requirements as recommended by our engineers.

Chamberlin Metal Weather Strip Company

Incorporated

General Offices: Detroit, Mich.

FACTORIES

Detroit, Mich. **Peru, Illinois**

DISTRICT BRANCHES

ATLANTA	CINCINNATI	KANSAS CITY	PHILADELPHIA
BALTIMORE	CLEVELAND	LOS ANGELES	PITTSBURGH
BOSTON	DENVER	MINNEAPOLIS	ST. LOUIS
BUFFALO	DETROIT	NEW YORK	WASHINGTON, D. C.
CHICAGO			WILKES BARRE

60 Sub-branches throughout the United States

Comfort with fuel economy is the aim of the engineer designing a heating and ventilating plant for any type of building and it is, therefore, essential that he have complete information on weather strips when determining heat losses from a structure.

Recent tests made by the *American Society of Heating and Ventilating Engineers* in cooperation with the *American Institute of Architects* at the experiment station of the *U. S. Bureau of Mines*, Pittsburgh, are of interest to the engineer, architect, contractor and their clients and the results are cited to aid the engineer in judging the value of weather strips.

The rib type of weather strip is used in 90 per cent of the installations made and it is universally agreed that the tongue and groove principle is correct from a practical standpoint. The weather strip becomes a part of the frame and engages in a groove in the sash insuring positive contact at all times and one that does not become disengaged after a few years use.

The width of the groove is the determining factor in the efficiency of the weather strip. In the official report covering the test made on this type of weather stripping is a paragraph which reads:

"The Rib Type strip has one metal member fastened on the frame which fits into a groove ploughed in the sash by the carpenter applying the strip. The width of this groove in comparison with the width of the metal member may be the determining factor in the leakage through a window to which this type of strip is applied. In this instance, the rib was 1/8 in. wide and the groove 1/32 in. wider. DeVolson Wood (*A. S. M. E. Transactions*, Volume No. 10) gives the lateral expansion of white pine as 2.6 per cent from dryness to saturation. With the groove 5/32 in. wide a variation of 0.004 in. in width is given from one extreme to the other. Though most sashes at the present time are made of some less expensive wood, such as Cypress or Spruce, it is probable that the expansion of either would not be much greater than white pine. **Therefore, the clearance allowed here would be ample in any case.**"

The width of the groove in comparison with the metal member is the determining factor, otherwise the groove might just as well be 1/4 inch wider. A testing apparatus built to duplicate the conditions of the test at Pittsburgh and which checked the tests made at Pittsburgh proves this conclusively.

If the lateral expansion of white pine in a groove 5/32 inch wide is but 0.004 inch in width from a thoroughly dry condition to a thoroughly wet condition, then a clearance of 1/32 inch (0.0313) is allowing nearly **eight times as much as is necessary** to take care of the expansion of the wood.

In regular installation it isn't practical to allow only 0.004 inch and the standard grooving plane for the Chamberlin Rib Type allows a clearance of 0.012 inch, this being three times the expansion of the wood and sufficient under all circumstances. **But—in the test on the Rib Type at Pittsburgh, the groove clearance was nearly three times as much as ordinary practice.**

Inasmuch as the Chamberlin Rib Type has been installed successfully for a period of thirty-three years, and the experience of these thirty-three years tells us that a clearance of 0.012 inch is ample for ordinary conditions, it is fair to assume that that clearance should be allowed.

A comparison of the figures of the following table shows very clearly the different

results obtained when the groove for the Rib Type strip is made in accordance with the standard that has been in vogue for thirty-three years.

The conclusions obtained at the Pittsburgh and other tests necessarily do not take into consideration the time element. It was not possible in a laboratory test of this kind to determine what the result would be after a period of years.

That this time element is a big factor is recognized from the Official Report which reads:

"The most important factor in the problem of infiltration has been the subject of much discussion and is not yet definitely determined. This factor is the clearance of the average window after it has been in service a sufficient length of time to have reached its final condition in regard to shrinkage which is a question for architects and heating engineers to decide. A simple solution to the problem can be obtained by actually measuring and then averaging the clearances of a sufficient number of windows in buildings which are at least five years old."

Standard Chamberlin Installations have been in use for thirty-three years, and it is possible to include in tests the time element.

Engineers have been employed to make tests on these standard installations which have been in use over a long period of years, and some of the results are given in the following tables. Tests were made by putting a collecting chamber on the inside of the window opening taking an anemometer reading of the leakage over a period of thirty minutes. The wind velocities were obtained from the U. S. Weather Bureau, and the resultant leakage compared with the leakages found on non-weather stripped windows at the Pittsburgh test.

Of course, during the thirty-three years that Standard Chamberlin Installations have been made there have been changes and improvements in the strip and the method of installation, and for this reason tests are shown on installations that have been in use from 2 to 33 years to make sure that an average could be obtained that would cover not only the original installations but likewise all of the improvements that have been added.

We submit that as a proof of efficiency, it is much more important for the Architect, Engineer, Contractor and Consumer to know what the result of a weather strip installation will be thirty or more years after the application has been made than the result obtained immediately after installation. Certainly an installation that will remain effective over this long period of years is a much more efficient installation than one which cannot hold out excepting for a comparatively few years.

CHAMBERLIN INSTALLATION POLICIES

For a period of 14 years, that is, from 1893 to 1907, Chamberlin distribution and installation functioned under the licensee or dealer system. The company, therefore, had no decisive administrative influence on the sales or installation methods of these agents.

In 1907, however, the Chamberlin Company made a radical change and for the past 18 years Chamberlin has been sold by company branches and installed by company mechanics.

Thirty-three years have proven the principle of Chamberlin Weather Strip design and the practicability of the theory that the installation is equally as important as the design.

The founders of the Chamberlin Metal Weather Strip Company considered most important the ideal of rendering not only the best of service but indefinite satisfaction in the case of every installation. The same practical ideal dominates the policies of the Company today.

Chamberlin is not merely a manufacturing organization. It is more than that. The problems of manufacture are well solved, the method well-perfected. Selling is a logical function based on accepted business principles, but weather strip installation, its life-long guarantee, that is the crowning effort to accomplish and to maintain a complete and resultful transaction, the details of which are not submitted to the care of any third parties. There are two parties to a Chamberlin installation contract, the customer and subsequent owners of any building, and Chamberlin who is manufacturer, salesman, installer and servicer.

AIR LEAKAGE THROUGH A 32" x 32" x 32" x 1⅛" WINDOW WITH AND WITHOUT WEATHER STRIPPING

Wind Velocity Miles per Hour	Leakage Through Window Not Weather Stripped	Leakage Through Window with Interlocking Type Weather Strip				Leakage Through Window with Rib Type Weather Strip. Groove Clearance 1/32 Inch. Weather Strip Not Packed				Per Cent of Air Kept Out—Interlocking Type				Per Cent of Air Kept Out—Rib Type. Groove Clearance 1/32 Inch. Weather Strip Not Packed				Leakage and Per Cent of Air Kept Out. Standard Chamberlin groove clearance 0.12 inch—all cracks	
		1/16" Crack	1/8" Crack	3/16" Crack	1/4" Crack	1/16" Crack	1/8" Crack	3/16" Crack	1/4" Crack	1/16" Crack	1/8" Crack	3/16" Crack	1/4" Crack	1/16" Crack	1/8" Crack	3/16" Crack	1/4" Crack	Leakage	Per Cent Air Kept Out
14.38	45	7	8.5	9	10	9	11	15	18	84.44	81.11	80.00	77.77	80.00	75.55	66.67	60.00	5.5	87.78
20.35	65	12	14	15	15.5	15	17.5	24	27.5	81.54	78.46	77.77	76.15	77.77	73.08	63.08	57.69	9.5	85.46
24.90	78	16	18	19.5	20.5	20	22.5	30	36	79.48	76.92	75.00	73.72	75.77	71.15	61.54	53.85	12.4	84.16
28.77	90	20	22	24	25	25	27.5	36	42	77.78	75.55	73.33	72.22	72.22	68.44	60.00	53.33	14.8	83.61
32.17	100	23	25	27.5	29	29	32	41	48	77.00	75.00	72.50	71.00	71.00	68.00	59.00	52.00	17.3	82.70
35.24	109	26	29	31.5	32.5	32.5	36	45	54	76.15	73.39	71.10	70.18	70.18	66.97	58.71	50.46	19.6	82.02
38.07	117	29	32	35	37	35	40	49	59	75.41	72.65	70.09	68.38	70.09	65.81	58.12	49.55	21.9	81.28
40.69	124	31.5	35	37.5	40	38	43	52.5	64	74.60	71.79	69.76	67.74	69.35	65.32	57.66	48.39	23.7	80.93
43.17	131	34	38	40.5	44	42	47	56	69	74.31	71.21	69.32	66.67	68.18	64.40	57.57	47.73	25.9	80.28
45.50	138	36	41	43	47	44	50	59	73	73.91	70.29	68.84	65.93	68.12	63.77	57.24	47.10	27.8	80.00

All leakages on above chart in cubic feet per minute.

The cracks mentioned in this table are in all cases the measurement of the opening between the edge of the sash and the stile. ¼ inch crack means the sash has ¼ inch opening on both sides, top and bottom and across the meeting rail. The importance of proper installation cannot be shown to better advantage than by comparing the results obtained as the cracks were increased (before weather stripping).

Neither the interlocking nor the rib strips were packed in the first test (the interlocking could not be packed). Packing, a regular part of Chamberlin standard installation, gives uniform results, regardless of the crack before installation.

Shrinkage after installation would affect the results in the table equally for all conditions, except that in the case of Chamberlin, service is always available.

In the above tests the sash clearance was 1/16 inch. In tests with greater clearances proportionate results would be obtained.

The results obtained on the standard Chamberlin installation were verified November 9, 1924, by Smith, Hinchman & Grylls of Detroit.

Since the above tests have been compiled and verified (November 9, 1924) an improved strip with the additional feature of a shoulder corrugation has been tested in a manner similar to tests made of standard Chamberlin equipment. This new Chamberlin strip tests an average of 3 per cent greater in efficiency.

Wind Velocity, Miles per Hour	14.38	20.35	24.80	28.77	32.17	35.24	38.07	40.69	43.17	45.50
Standard Chamberlin—Smith, Hinchman & Grylls Test	87.78	85.46	84.16	83.61	82.70	82.02	81.28	80.93	80.28	80.00
New Strip with Shoulder Corrugation	90.00	87.39	86.41	85.89	85.40	84.86	84.23	83.43	83.13	82.83

Chamberlin Metal Weather Strips have passed the test of time and can point to a record of 33 years service which indicates their efficiency in the service which is so important to the engineer, architect, contractor and his client.

CHAMBERLIN TESTS OF TIME

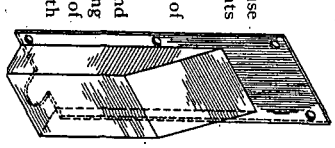
Name of Building	Location and Date of Chamberlin Installation		Date of Test	Size of Window (Lin. Ft. of Crack)	Wind Velocity, M.P.H. U.S. Weather Bureau	Leakage Without W.S. Based on *A.S.H. & V.E.* Test	Leakage on Date of Test Including Frame and Pulley Leak	Percentage of Possible Leakage Kept Out
E. A. De Wolfe Res.	St. Louis,	1893	3/ 7/25	18. 80	25	78. 88	.53	99. 3
Equity Bldg.	Detroit,	1894	12/17/24	23. 85	24	95. 04	5. 05	93. 70
Majestic Bldg.	Detroit,	1896	12/11/24	34. 00	8	46. 25	1. 79	95. 91
Majestic Bldg.	Detroit,	1896	12/12/24	34. 00	12	68. 38	4. 22	93. 86
Union Trust Co. Bldg.	Cincinnati,	1901	3/20/25	26. 00	15	72. 30	7. 00	90. 32
Adolphus Busch Res.	St. Louis,	1903	3/ 7/25	18. 25	21	66. 79	2. 51	96. 20
Horace Mann School	New York,	1903	4/11/25	20. 67	7. 5	28. 23	1. 87	93. 38
City Hall	Detroit,	1904	12/ 3/24	30. 67	9	44. 36	7. 31	83. 52
Michael Reese Hosp.	Chicago.	1906	2/15/25	32. 00	12	66. 10	10. 65	83. 90
Congress Hotel	Chicago.	1906	2/11/25	25. 33	15	63. 70	4. 00	93. 70
Detroit Club	Detroit,	1906	12/ 2/24	26. 50	8	35. 28	4. 19	88. 41
Fleming Bldg.	Des Moines,	1906	2/17/25	25. 33	6	23. 30	2. 50	89. 30
D'Youville College	Buffalo,	1907	4/ 3/25	27. 00	18	83. 15	4. 98	94. 00
Owen Bldg.	Detroit,	1907	12/ 6/24	28. 00	18	87. 00	4. 42	94. 92
Ford Bldg.	Detroit,	1908	11/27/24	26. 50	12	53. 30	5. 01	90. 60
Boston College	Newton, Mass.	1910	4/10/25	20. 67	12. 5	47. 60	3. 34	92. 40
Campau Bldg.	Detroit,	1910	12/ 3/24	28. 50	10	47. 23	5. 00	89. 44
Hosp. Rockefeller Inst.	New York.	1910	4/ 9/25	19. 50	14	46. 29	3. 66	92. 10
Cleveland Ath. Club	Cleveland	1911	4/ 2/25	31. 50	20	109. 70	6. 50	94. 16
Copley Plaza Hotel	Boston,	1912	4/10/25	20. 33	12	44. 40	1. 18	97. 34
Hubbell Bldg.	Des Moines,	1912	2/16/25	26. 00	7. 5	29. 25	4. 26	85. 00
Pharmacy Bldg.	U. of Minn.,	1912	2/23/25	25. 33	8	38. 10	3. 00	92. 13
Dime Sav. Bk. Bldg.	Detroit.	1913	11/28/24	26. 50	22	90. 15	9. 93	87. 60
Board of Commerce	Detroit.	1913	12/10/24	21. 00	12	42. 13	1. 98	95. 28
Krege Bldg.	Detroit.	1914	12/ 9/24	27. 85	28	132. 76	17. 53	86. 80
Krege Bldg.	Detroit.	1914	12/ 9/24	27. 85	24	112. 15	15. 47	86. 21
David Whitney Bldg.	Detroit.	1915	12/13/24	28. 50	19	92. 65	5. 90	94. 60
Det. Athletic Club	Detroit.	1915	12/13/24	20. 67	14. 5	49. 82	3. 76	89. 26
Peter Smith Bldg.	Detroit.	1916	12/ 1/24	19. 85		55. 17	5. 96	92. 23
Fort Shelby Hotel	Detroit.	1916	12/26/24	23. 75		50. 75	3. 96	86. 28
Field Museum	Chicago.	1919	3/29/25	24. 70	16. 5	66. 70	5. 66	91. 48
Planters Bldg.	St. Louis.	1919	3/ 2/25	26. 70		82. 75	6. 41	92. 80
Park Ave. Bldg.	Detroit.	1922	12/10/24	26. 85	21	98. 46	3. 21	96. 60
Int'l. Shoe Co. Bldg.	St. Louis.	1923	3/ 6/25	29. 00	15	74. 26	2. 55	96. 60

CHAMBERLIN SERVICE
ALSO ELIMINATES ELSEWHERE LEAKAGES

In-leakage of air between the sash and frame is prevented by the use of **Chamberlin Metal Weather Strips.** Chamberlin Calking prevents in-leakage through cracks in and around window and door frames.

A still further source of in-leakage are the pulley holes. A new service of Chamberlin is available to prevent pulley hole leakage.

When called upon to solve the problem of heating the architect and engineer should not fail to consider this complete service in conditioning windows and doors—Chamberlin weather strips, calking, calking of frames, pulley guards and also the glazing of sash in conjunction with the weather stripping and calking of old buildings.



NEW DETAIL BOOK AVAILABLE

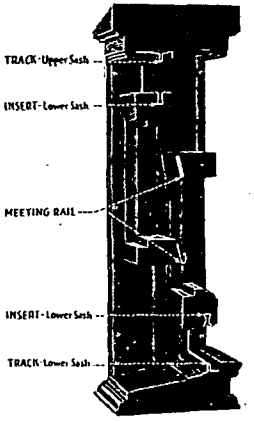
A complete book of full size details with specifications of every application of Chamberlin equipment is available on request. Adaptable to A. I. A. filing system. Pronounced superior to any other catalogue of its kind.

The Higgin Manufacturing Co.

NEWPORT, KY.

Manufacturers of Metal Weather Stripping for Windows and Doors

Representatives in Principal Cities

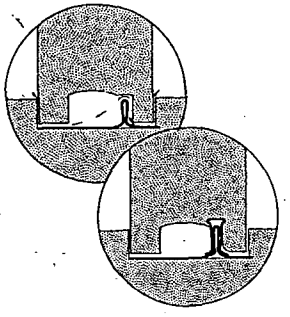


The Higgin All-Metal Weather Strip Equipment effectually reduces to a minimum infiltration losses around windows and doors.

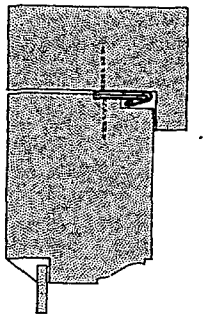
Double Hung Windows: The Higgin Two-Member Track and Insert Equipment for double hung windows consists of a rib track, zinc or copper, fitted to the window frame. The rib or raised portion is ⅜ in. high and extends into a groove cut into the edge of sash.

The Insert, usually made of bronze, very thin gage is of spring temper and is fitted and concealed into the groove in the edge of sash. It is so formed that the spring sides or flanges contact with the tongue or rib of the track. These two contacting metals seal the aperture around the edge of the sash. The insert resting on the slightly raised portion at base of rib on track insures easy sliding.

Sash Shrinkage: Air leakage can occur in around the tongue of a track strip working loosely in a groove in wood sash. The efficiency of the Higgin Two-member Track and Insert is not affected by shrinkage of the sash. If sash should draw away from frame, the Insert will snugly contact with the rib at any point of its projection. Air leakage through the pulley holes, is prevented by the Insert, dividing as it does into a separate chamber the cut out space for sash cord.



Installation: *Lower Sash*—The rib track extends to top edge of meeting rail projecting slightly into the parting strip and also lapping under inside stop. *Upper Sash*—The rib track extends about one

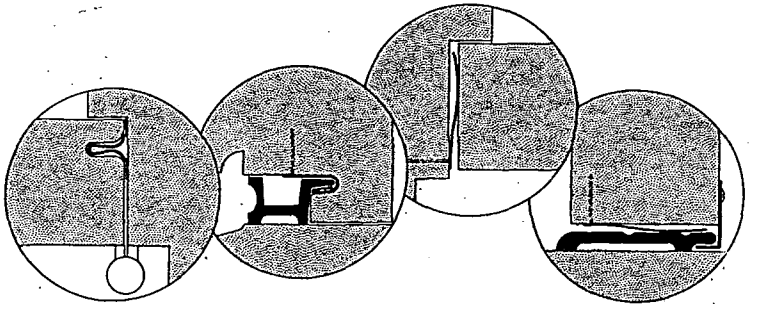


inch below meeting rail, projecting slightly into the outside stop bead. Slot is cut into track to clear pulleys. *Head and Sill*—Track extends full width of opening. Insert concealed in sash groove, at sides, bottom and head, full length. The meeting rail is equipped with a flat zinc or copper strip attached to top rail of lower sash which interlocks with a hook strip attached to the bottom rail of the upper sash.

Casement Windows: The top and lock sides are equipped with a flat zinc or copper strip attached to sash which interlocks with a hook strip of same metal, secured into the rabbet. The hinged side, a rib track is applied, the raised tongue extending into a groove in the sash. The bottom of out-opening sash are usually equipped the same as for top and lock sides. In-opening sash are equipped with an interlocking trough of either brass or zinc. This equipment has proven very efficient in stopping air and water leakage.

Doors: In the rabbet at sides and head are attached a compression spring bronze strip which contacts with door as it closes. For the bottom an extruded brass threshold with an interlocking brass hook and spring bronze contact strip makes a thoroughly air and water-tight equipment and provides a handsome and permanent threshold.

Catalogue upon request. We will contract to install Higgin All-Metal Weatherstrips in new or old buildings. Estimates gladly furnished.



Manufacturers of Higgin All-Metal Weather Strips and Higgin All-Metal Screens

Monarch Metal Products Company

5010 Penrose Street
St. Louis, Mo.

WEATHERSTRIP EFFICIENCY

Weatherstrips can only reduce the leakage through cracks between sash and frame of window. The elsewhere leakage and the leakage of air between the frame and the wall in which the frame is set, cannot be decreased by the application of weatherstrips.

The frame leakage can be stopped only by caulking and the elsewhere leakage by stopping or closing up the pulley holes.

To compare the actual or net leakage through the weatherstrips tested, refer to Table 14, Page 22 in this issue of the GUIDE, which gives the leakage through the window cracks plus the elsewhere leakage; and deduct from the values given under "Average Results" and "Best Results," the values for "Elsewhere Leakage" given in the following table.

The difference between these two values will give the net leakage through weatherstrips and will plainly show the superiority of the ***Monarch*** interlocking, tubular, self-adjusting, metal to metal strip over the other strips tested.

NET LEAKAGE THROUGH WINDOW CRACKS.
All Leakage Values in Cu. Ft. per Hour per Foot of Crack.

WIND VELOCITY IN MILES PER HOUR	ELSEWHERE LEAKAGE	BEST RESULTS	AVERAGE RESULTS.	CALCULATED WORST RESULTS.
5	2.29	0.98	1.46	1.94
7.5	5.9	1.3	2.62	3.94
10	9.15	3.95	5.55	7.16
15	17.0	8.6	11.6	14.6
20	24.9	13.7	18.7	23.7
30	44.5	21.0	30.0	39.0
40	65.5	32.7	44.5	56.3
50	85.0	49.0	61.0	73.0

* Elsewhere Leakage Computed from Test Data Published in Table 2 Page 11 of 1924-25 A.S.H. and V.E. Guide and in A.S.H. and V.E. Journal of Jan. 1924.

Engineers should use average values cautiously as it will be found extremely difficult to build pressures up in rooms, where there are fireplaces or large cracks around inside doors, under normal conditions.

Closing the pulley holes is not desirable as it is difficult to replace sash cords and frequently interferes with the satisfactory operation of the sash.

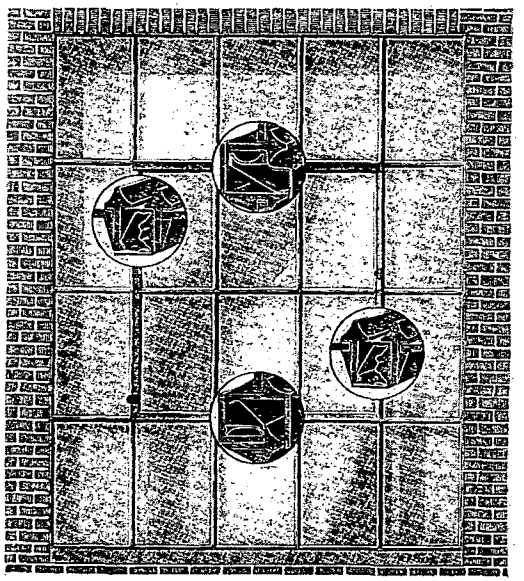
SIDE PIVOTED STEEL FACTORY WINDOWS

The leakage through a six-light ventilator 3 lights wide, 2 lights high of 14 x 20 in. glass, at a 15-mile per hour wind velocity, is 4443 cu. ft. of air per hour without weatherstrips.

When ***Monarch*** Metal Weatherstrip is applied the leakage through the same ventilator is only 826 cu. ft. of air per hour at the same wind velocity.

In brief, the amount of radiation required for heating inleaking air is reduced 81.5 per cent.

The cut below shows a typical installation of Monarch No. 300 weatherstrip.



Write for booklet describing tests and application of weatherstrip to Side Pivoted Steel Factory Sash, or for any of the following literature:

Home Comfort (An illustrated booklet for home owners)
Comparative Analysis of Air Leakage Through Wood and Steel Windows
Leakage Through Side Pivoted Steel Factory Windows
Engineers Data Book
Architects Manual
Fallacy of the Air Change

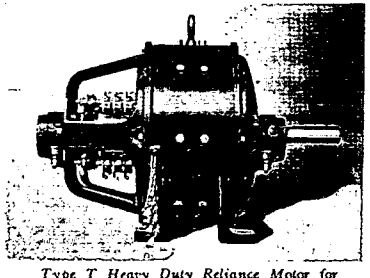
Reliance Electric & Engineering Co.

Ivanhoe Road :-: CLEVELAND, O.

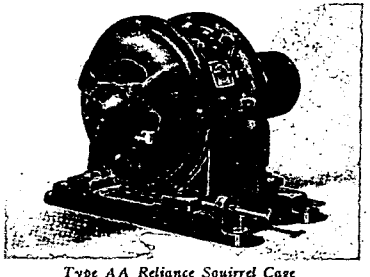
BRANCHES—BOSTON, NEW YORK, PHILADELPHIA, PITTSBURGH, CINCINNATI, DETROIT, CHICAGO, BIRMINGHAM, ALA.

Sales to building industry in New York City are handled by Building Equipment and Machinery Co., 39 Cortland Street.

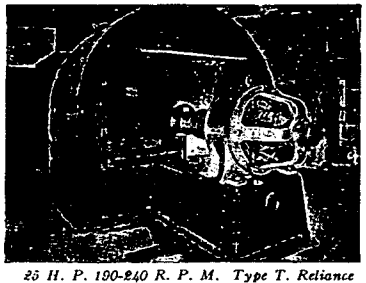
ELECTRIC MOTORS, Direct and Alternating Current



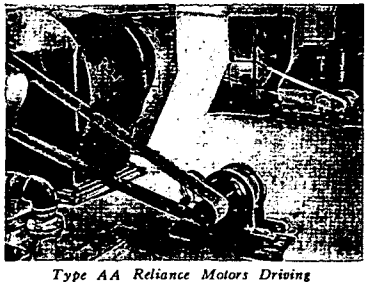
Type T Heavy Duty Reliance Motor for Direct Current



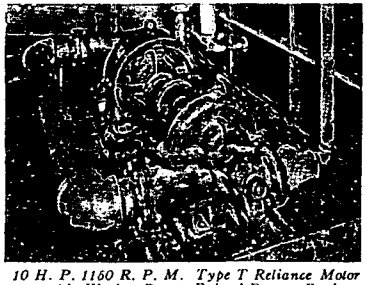
Type AA Reliance Squirrel Cage Induction Motor



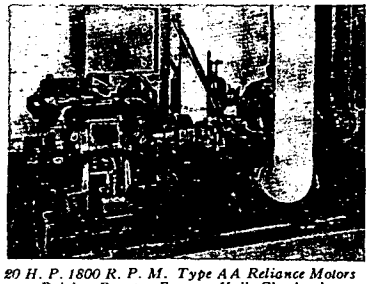
25 H. P. 190-240 R. P. M. Type T. Reliance Motor Driving Ventilating Fan in Cleveland Auditorium



Type AA Reliance Motors Driving Ventilating Fans



10 H. P. 1160 R. P. M. Type T Reliance Motor on Air Washer Pump, Federal Reserve Bank, Cleveland; 34 Reliance Motors are used in this Building



20 H. P. 1800 R. P. M. Type AA Reliance Motors Driving Pumps, Fenway Hall, Cleveland

Complete data on all types of Reliance Motors will be given gladly. Write to our nearest branch.

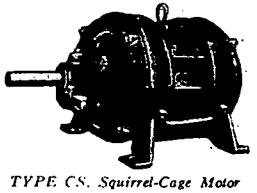
The Westinghouse Electric & Manufacturing Company

EAST PITTSBURGH, PA.

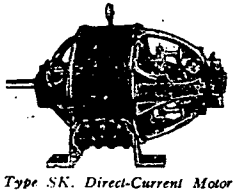
WESTINGHOUSE SALES OFFICES

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Charlotte, N. C.
Chattanooga, Tenn.
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Cleveland, O.
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Jacksonville, Fla.
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Little Rock, Ark.
Louisville, Ky.
Los Angeles, Cal.
Madison, Wis.
Memphis, Tenn.
Miami, Fla.
Middlesboro, Ky.
Milwaukee, Wis.
Minneapolis, Minn.
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Omaha, Neb.
Peoria, Ill.
Philadelphia, Pa.
Padenix, Ariz.
Pine Bluff, Ark.
Pittsburgh, Pa.
Portland, Me.
Portland, Ore.
Poughkeepsie, N. Y.
Providence, R. I.
Raleigh, N. C.
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Salt Lake City, Utah
San Antonio, Tex.
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Seattle, Wash.
Shreveport, La.
South Bend, Ind.
Spokane, Wash.
Springfield, Ill.
Springfield, Mass.
Syracuse, N. Y.
Tacoma, Wash.
Tampa, Fla.
Terre Haute, Ind.
Toledo, O.
Tulsa, Okla.
Utica, N. Y.
Washington, D. C.
Watertown, N. Y.
Wilkesbarre, Pa.
Worcester, Mass.
Youngstown, O.
Hawaiian Electric Co., Ltd., Honolulu, T. H. —Agent
Hunt-Mirk V. Company, Marine Representatives, San Francisco, Cal.

MOTORS AND CONTROL FOR HEATING, VENTILATING AND AIR CONDITIONING SYSTEMS



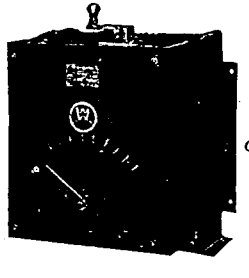
TYPE CS. Squirrel-Cage Motor



Type SK. Direct-Current Motor

Motors—Westinghouse motors and control can be supplied for practically all demands within the heating and ventilating engineer's field of activity. Noiseless operation, close speed regulation, and dependability in service are their recognized characteristics.

Motor Control—Westinghouse Electric manufactures manual and automatic starters and speed regulators to control motors in all applications. By specifying Westinghouse starters and regulators to operate Westinghouse motors, the responsibility for the successful operation of the installation is placed upon one manufacturer.



Class 7201B Regulator

Class 10700 Auto Starter



Buffalo Steam Pump Co.

Buffalo, N. Y.

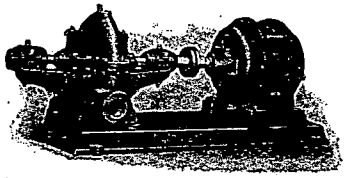
BRANCH OFFICES

New York, N. Y., 39-41 Cortland St.
Philadelphia, Pa., 1301 Land Title Bldg.
Boston, Mass., 177 State St.
Cleveland, O. 368 Rockefeller Bldg.
Pittsburgh, Pa., 917 Union Trust Bldg.
Detroit, Mich., Coon-DeVisser Co.
Chicago, Ill., 562 W. Washington Blvd.
Washington, D. C., Washington Loan & Trust Bldg.
Atlanta, Ga., Candler Bldg.
Indianapolis, Ind., 1016 Fletcher Trust Bldg.
St. Louis, Mo., 515 Chemical Bldg.
Cincinnati, O. 607 Mercantile Library Bldg.
Minneapolis, Minn., 120 South Ninth Bldg.
Los Angeles, Calif., 636 H. W. Hellman Bldg.
Charlotte, N. C., J. W. Fraser & Co.
New Orleans, La., Woodward Wight & Co.
San Francisco, Calif., 216 Pine St.
Seattle, Wash., 905 Olympic Way

Canadian Blower and Forge Co., Kitchener, Ont.

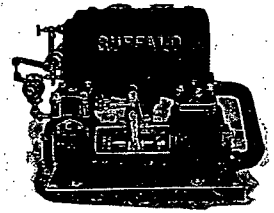
Products

Centrifugal Pumps For All Purposes—Single and Double Suction, Single and Multistage, Horizontal and Vertical. Steam Pumps—Duplex and Simplex, Inside Packed and Outside Packed. Vacuum Pumps and Condensers.



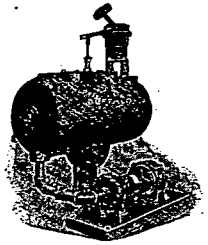
Class S Double Suction Centrifugal Pump

Horizontally divided casing. Extensively used with air washers, and for circulating systems and booster service.



Duplex Steam Pump and Receiver

Entirely automatic. Can be furnished for high or low boiler pressure.



Centrifugal Condensation Return Pump and Receiver

Also built vertical with receiver pit. Especially adapted for low pressure boilers. Automatic in operation.



Automatic Sump Pump

Self contained. Ball bearing thrust with automatic oil lubrication.

Complete Catalogs Will Be Furnished Upon Request

Chicago Pump Company

Office and Works

2303 Wolfram Street - - CHICAGO, ILL.

Representatives in Principal Cities

Quality Centrifugal Pumps
Condensation - Vacuum - Sump - Sewage
House - Circulating - Fire

Return Line Vacuum Pumps

Where condensation, return line, boiler-feed or other pumps are required for the mechanical system of a building, the **Chicago** line has a unit for the service required.

Return line vacuum pump and receiver with separate motors and individual automatic control of air and water pumps for maintaining the vacuum on the return line of a heating system or returning condensation directly to the boilers are furnished for high and low pressure work and range in capacity from 1,000 to 65,000 sq. ft. direct radiation.

Capacities, Horsepower and Floor Space

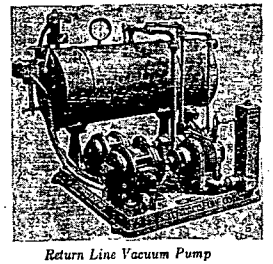
Unit No:	Sq. Ft. Radiation	Horsepower Motor	Approximate Floor Space Required Inches
V. 1	8,000	1	55x32
V. 2	16,000	1½	60x34
V. 3	26,000	2	62x35
V. 4	40,000	3	65x37
V. 5	65,000	5	68x40

Horizontal and Vertical Condensation Pumps

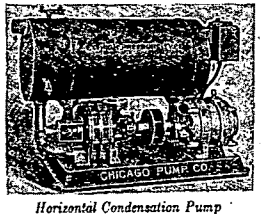
Condensation pumps and receivers are made in both horizontal and vertical styles. They are simple in construction, quiet in operation and are self-contained units, vertical pumps being specially designed for service where return line comes below floor.

Horizontal Condensation Pump
Capacities, Horsepower and Floor Space

Unit No.	Maximum Sq. Ft. Direct Radiation	Horsepower Motor	Approximate Floor Space Required Inches	Highest Water Level in Receiver from Floor Line Inches
H. 650	3,000	¼	43x28	26
H. 651	6,000	½	43x30	26
H. 652	10,000	½	55x30	30
H. 653	15,000	¾	57x32	30
H. 654	20,000	¾	59x32	30
H. 655	25,000	1	59x32	35
H. 656	35,000	1	61x34	39
H. 657	50,000	1½	65x36	41



Return Line Vacuum Pump



Horizontal Condensation Pump

VERTICAL CONDENSATION PUMP AND RECEIVER AT 1720 R. P. M.

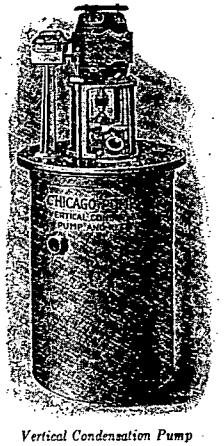
Table of Capacities and Horsepower

Unit includes Pump, Motor, Complete Automatic Control and Steel Receiver made of ⅜ in. Armco Rust-resisting Iron.

Unit No.	Maximum Sq. Ft. Direct Radiation	Lbs. Press. Pump will Disch. Against	Horsepower Motor Furnished	Size of Discharge, Inches	Size of Inlet, In.	Capacity Pump in Gals. per Min.	Gals. per Min. Radiation will Condense	Dia. Receiver, In.; also Floor Space	Type and Frame Number of Pump Furnished	Approx. Ship. Wt. with 3 ft. deep rec.
1650	3,000	10	½	1½	3	5	1½	24	C-L1	610
1651	"	17	¾	"	"	"	"	"	C-LL1	625
1652	"	22	1	"	"	"	"	"	"	660
1653	"	26	1½	"	"	"	"	"	"	700
1654	6,000	10	½	1½	3	10	3	24	C-L1	610
1655	"	17	¾	"	"	"	"	"	C-LL1	625
1656	"	22	1	"	"	"	"	"	"	660
1657	"	26	1½	"	"	"	"	"	"	700
1658	10,000	10	½	1½	3	15	5	24	C-L1	610
1659	"	17	¾	"	"	"	"	"	C-LL1	625
1660	"	22	1	"	"	"	"	"	"	660
1661	"	26	1½	"	"	"	"	"	"	700
1662	15,000	14	¾	1½	3	21	7½	24	C-LL1	625
1663	"	18	1	"	"	"	"	"	"	660
1664	"	26	1½	"	"	"	"	"	"	700
1665	25,000	12	¾	2	3	35	12½	30	C-LL1	750
1666	"	16	1	"	"	"	"	"	"	770
1667	"	25	1½	"	"	"	"	"	"	790
1668	40,000	10	¾	2	3	55	20	30	C-LL1	750
1669	"	14	1	"	"	"	"	"	"	770
1670	"	21	1½	"	"	"	"	"	"	790
1671	"	23	2	"	"	"	"	"	"	800

ENGINEERING SERVICE

The cooperation and advice of skilled engineers will be gladly given to Engineers, Architects, and Contractors in the solution of their pump problems. Complete data are available in bulletins on all types of pumps.



Vertical Condensation Pump

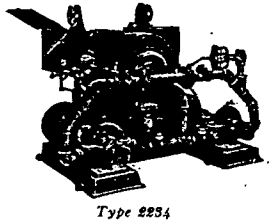
Economy Pumping Machinery Co.

98-124 N. Curtis St., CHICAGO — **Works, JOLIET, ILL.**

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Economy Centrifugal Return Line Vacuum Pump and Boiler Feeder



Type ΣΣ54

Economy vacuum pumps remove air and condensation from the heating system automatically discharging the water to boiler. Their flexibility imposes no limitations on capacity or pressure. Reasonable delivery is made on pumps designed to discharge against 100 lb. boiler pressure. Units rated over 5000 sq. ft. capacity have bronze fitted horizontal split case, double suction pumps with perfectly balanced rotors. All standard units are supplied with bronze suction strainer scale pocket and automatic control all firmly mounted on cast iron base. Wiring is in conduit to conform with Underwriter's rules. Each pump tested and ready for operation when delivered.

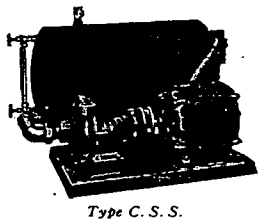
Economy Centrifugal Vacuum Pump

Unit No.	Capacity in Sq. Ft. Direct C. I. Radiation	Motor Horse Power	Cubic Feet Air per Min.	Size Discharge to Boiler	Size Return Inlet	Shipping Weight
CV-1	2,500	¾	1¾	¾"	1½	650
CV-2	5,000	1	4	1"	2	750
CV-3	8,000	1½	6	1	2½	900
CV-4	16,000	2	10	1¼	3	1,025
CV-5	20,000	3	15	1¼	3	1,150
CV-6	27,500	5	19	1½	3½	1,300
CV-7	40,000	5	24	1½	4	1,550
CV-8	65,000	7½	40	2	5	1,800
CV-9	100,000	10	60	2½	6	3,100
CV-10	150,000	15	90	2½	6	.....

Duplex units consisting of single tank, two pumps, motors and control apparatus will approximate 75 per cent addition to the weights above listed.

Economy Pumps and Receivers

Made in variety of forms to meet every requirement.

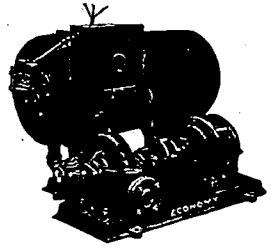


Type C. S. S.

C. S. S. type pumps and receivers are made for standard low boiler pressure work up to 25 lbs. The pump is bronze fitted single side suction type with oil-less sleeve bearing at pump and ring oiling bearing. Also has ball thrust bearing and flexible coupling. Crank action, float mechanism operated by copper float insures positive operation for enclosed switch. Mounted on heavy cast iron base the units are fully assembled, ready for operation. We have a proper size pump for every job. Cracked boiler sections eliminated when Economy Pumps are used. Receivers and pump capacities proportioned to prevent excessive low water conditions of boiler.

No. of Unit	Capacity in Sq. Ft. Direct C. I. Radiation	Discharge Pressure, Lbs. per Sq. In.	Motor H. P.	Pump Capacity G. P. M.	Receiver Capacity Gallons	Gals. Condensate per Min. at 0.25 Lbs.—Sq. Ft. Hr.
6	2,000	10	¼	7½	13	1
6½	3,500	10	¼	12	16	1¼
7	5,000	10	½	15	20	2½
7A	5,000	15	¾	15	20	2½
7B	5,000	20	1	15	20	2½
7½A	7,500	10	½	20	26	3¼
7½	7,500	15	¾	20	26	3¼
7½B	7,500	20	1	20	26	3¼
8A	10,000	10	½	25	33	5
8	10,000	15	1	25	33	5
8B	10,000	25	1½	25	33	5
8½A	15,000	10	¾	37	41	7½
8½	15,000	15	1	37	41	7½
8½B	15,000	25	2	37	41	7½
9A	25,000	10	1	60	49	12½
9	25,000	15	2	60	49	12½
9B	25,000	25	3	60	49	12½
9½A	35,000	10	1½	80	70	17½
9½	35,000	15	2	80	70	17½
9½B	35,000	25	3	80	70	17½
10	50,000	15	2	110	82	25
10A	50,000	25	5	110	82	25
10B	50,000	35	5	110	82	25

Economy Pumps and Receivers C. S. M. Type

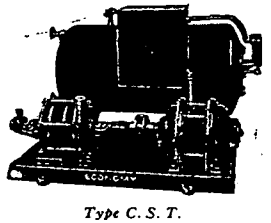


Type C. S. M.

The demand for an unusually high-grade pump and receiver has caused us to make available a complete line of sizes from 5,000 to 50,000 sq. ft. capacity, inclusive. These units include horizontal split double suction bronze fitted pumps with double ring oiling bearings; a heavy receiver, our special float mechanism, switch and a self-starter for the motor. These units are designed to discharge against boiler pressures up to 55 lbs. They are made both single and duplex pump units.

Economy S. S. T. Type

Made in both single and duplex form.



Type C. S. T.

These units are the same as C. S. M. except the pumps are multi-stage vertical split bronze fitted, double outboard ring oil bearings made in sufficient number of stages to discharge against boiler pressures from 25 to 150 lbs.

Economy Underground Pump and Receiver C. U.

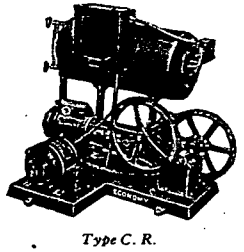


Type C. U.

Intended for work where radiation is placed on the floor with returns underground. They consist of a special pump and float switch mechanism which prevents binding and sticking of float rods. Made in sizes of 2,000 to 50,000 sq. ft. radiation capacity for either 10 or 20 lbs. boiler pressure. Receiver is cast iron, stuffing box around pump shaft, thrust carried on ball bearing in cage above stuffing box. The lower bearing is of oil-less sleeve type.

Economy Reciprocating Pump C. R. Type

Pump and receiver for work up to 125 lbs. boiler pressure.



Type C. R.
Pump and Receiver

These units are frequently used in old remodelled jobs, comprising several types of heating systems. They will handle the condensate from all and sometimes are used to establish a vacuum in parts of the apparatus. This feature is not automatic or capable of close adjustment. Silent chain drive is used. Pump is fully bronze fitted and made for capacities ranging from 1,250 to 25,000 sq. ft. radiation.

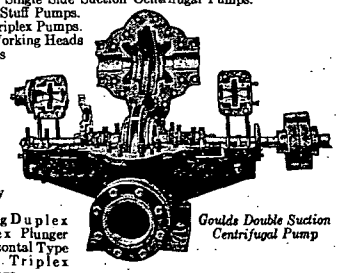
The Goulds Manufacturing Company

PUMP MAKERS SINCE 1848

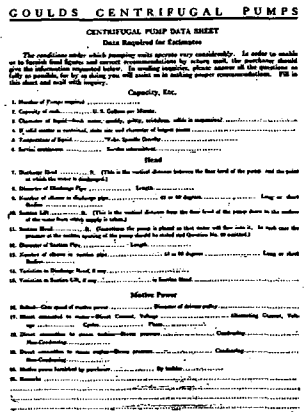
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GOULDS PUMPS have been made for every service for more than three-quarters of a century and have an established reputation for reliable service, economy in operation, and conservative rating. Bulletins on power pumps give complete specifications of the standard types as follows:

No. 100. Double-Acting, Single Cylinder Piston Pumps.
No. 101. Single-Acting Triplex Plunger Pumps, Outside-Guided Type.
No. 103. Single-Acting Triplex Plunger Pumps, Large Capacity and High Pressure Types.
No. 104. Double-Acting Triplex Piston Pumps, Vertical Type.
No. 105. Single Stage, Single Side Suction Centrifugal Pumps.
No. 106. Vacuum and Stuff Pumps.
No. 107. Deep Well Triplex Pumps.
No. 108. Deep Well Working Heads and Cylinders
No. 110. Single Stage, Double Suction Centrifugal Pumps.
No. 111. Centrifugal Sump Pumps
No. 112. Handy Data on Power Pumping.
No. 113. Power Rotary Pumps.
No. 115. Double-Acting Duplex and Triplex Plunger Pumps, Horizontal Type
No. 116. Single-Acting Triplex Pressure Pumps.
No. 118. Centrifugal Fire Pumps.
No. 119. Single Stage, Single Suction Centrifugal Pumps, Enclosed Impeller Type.
No. 120. Multi-Stage Centrifugal Pumps for General Service.
No. 122. Centrifugal Pump Data.
No. 124. Installation—Operation—Inspection, Goulds Centrifugal Pumps.
No. 125. Single Stage, Double Suction Centrifugal Pumps.



Goulds Double Suction Centrifugal Pump


GOULDS CENTRIFUGAL PUMPS

CENTRIFUGAL PUMP DATA SHEET
Data Required for Estimates

Pump Data

Several units of interest to heating engineers and architects are shown here accompanied by data on capacity, speed, efficiency which will assist them in choosing the right Goulds pump for the service desired.

GOULDS DOUBLE SUCTION CENTRIFUGAL PUMPS are the result of over 12 years of research and progressive development and are of exceptionally high efficiences.

CASING.—Close grained iron, divided horizontally, the two castings bolted together. The lower half of the bearing housings are cast integral with the lower half of casing. Casing is provided with air cocks, and with openings for priming and draining.
IMPELLER: Cast iron, accurately machined and balanced.
BEARINGS: Ring oiling type with split cast iron shells lined with babbit, supported in horizontally divided housings, securely locked against rotation or lateral motion. Shells are removable without disturbing rotating element.
THRUST BEARINGS: All pumps are provided with a self-aligning double-acting ball thrust bearing, running in an oil bath, which takes care of any unbalanced thrust due to uneven wear of sealing surfaces.
SHAFT: Special alloy steel, heat treated, accurately machined to gauge.
STUFFING BOX: Of extra long design with brass water seal ring and water seal piping.
GLANDS: The glands are split horizontally, permitting the gland to be removed and affording maximum space for repacking. They are adjusted by swing bolts.
CASING WEARING RINGS: Casing is equipped with bronze wearing rings, which can be renewed as required, thus keeping the clearances to a minimum.
IMPELLER WEARING RINGS: Wearing rings on bronze impellers can be furnished as an extra.

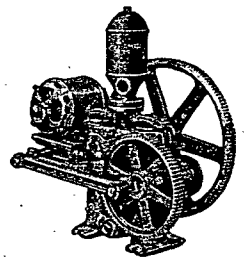
Table of Capacities for Goulds Centrifugal Pumps

Figure No.	Pump No.	Pipe Sizes: Discharge In.	Pipe Sizes: Suction In.	Approx. Capacity Gals. per Min.: Minimum	Approx. Capacity Gals. per Min.: Maximum	Standard Pulleys: Diameter In.	Standard Pulleys: Face In.	†Approx Domestic Shipping Weight Lb.
3065	5	5	6	400	800	8	8	1020
	6	6	8	600	1300	10	10	1325
	8	8	10	1000	2700	12	12	2100
3075	5	5	6	400	900	8	8	1275
	6	6	8	600	1500	10	10	1605
	8	8	10	1100	2900	12	12	2525
3085	3	3	4	150	350	6	6	950
	4	4	5	250	750	10	10	1270
	5	5	6	400	1000	10	10	1520
	6	6	8	800	1700	12	12	2400
	8	8	10	1300	3000	12	15	3425
3095	2	2	3	50	250	6	6	1020
	3	3	4	200	450	8	8	1120
	4	4	5	400	800	10	10	1585

†Weight includes either bedplate and coupling for direct connected drive or bedplate, pulley, pulley shaft, coupling and two pedestal bearings for belt drive.

FLEXIBLE COUPLING: A flexible coupling of the pin-and-buffer type is provided to connect the pump to prime mover or belt pulley shaft.
BED PLATE: Pump and prime mover are mounted on a rugged cast iron bedplate of neat design, with a drip canal around the four sides.

Goulds "Pyramid" Double-Acting Piston Pump (Fig. 1678) is especially adapted for handling Condensation of Steam Heating Systems and for General Water Supply, Mine Service and Hot Water Pumping. Built in a single iron casting embodying the base, cylinder, bearings and one cylinder head, with the cylinder fitted with a renewable cast bronze lining and the piston fibrous packed, this pump is of strong and rigid construction.



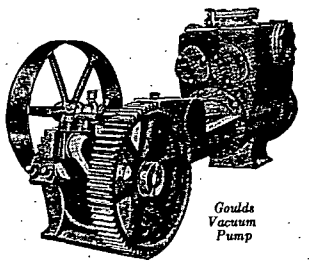
Goulds Pyramid Piston Pump

Dimensions, Speeds, Displacements, Goulds "Pyramid" Pump Ratings Based on Pumping Cold Water.

Pistons: Diam.	Pistons: Stroke	Displ. per Rev. of Crank Shaft, Gal.	Usual Speed and Displacement per Min.: Rev.	Usual Speed and Displacement per Min.: Gal.	Horse Power at Catalog Rating	Horse Power for Vacuum Service	†No. Sq. Ft. Heating Radiation	Size Pipe: Suction In.	Size Pipe: Discharge In.	Geared	Pulleys Tight and Loose In.	Weight Lb.
2¼	4	.130	39	5	.50	.50	700	1¼	1¼	5 to 1	8x2½	170
2¾	5	.245	41	10	1.00	.50	1450	1½	1½	5 to 1	15x2½	295
3¼	5	.465	39	18	1.50	1.00	2600	2	2	5 to 1	15x3	340
4¼	5	.741	38	28	3.00	1.00	4000	2½	2½	5 to 1	16x4	525
5¼	6	1.316	38	50	5.00	1.50	7000	3	3	5 to 1	20x4	680

†Figures based on the condensation of one-third of a pound of steam per square foot of radiating surface per hour, which is a good average condition.

Goulds Double-Acting Piston Vacuum Pump (Fig. 1049) has a displacement of 10,200 gal. to 81,000 gal. per hr. The waterways are so constructed that the valves at both ends of the cylinder are always submerged. The frame is of cast iron in one piece bolted to the cylinder, supporting the bearings and crosshead guides. These pumps are designed for Suction Box on Paper Machines, Vacuum Pans, Surface Condensers, and Vacuum System of Steam Heating.



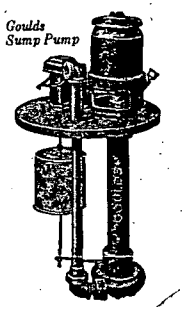
Goulds Vacuum Pump

Goulds Vacuum Pump—Dimensions and Displacements

Gallons Displacement per Min.	Pistons: Diam. In.	Pistons: Stroke In.	Displacement 1 Rev. of Crank Shaft	Vacuum Steam Heating Systems: H. P. Required	Vacuum Steam Heating Systems: *Sq. Ft. of Radiation	R. P. M.	Sizes of Pipes: Suction In.	Sizes of Pipes: Discharge In.	Geared	Single Pulley In.
170	8	10	4.28 gal.	3	24500	40	5	5	4 to 1	30x4
265	10	10	6.73 "	5	38000	40	5	5	4 to 1	30x5
385	12	10	9.72 "	5	55000	40	5	5	4 to 1	30x5
525	14	10	13.22 "	7½	75500	40	6	6	4 to 1	30x5
700	14	14	18.51 "	10	100000	38	6	6	4 to 1	36x6
1000	16	16	27.62 "	10	144000	37	8	8	4 to 1	36x6
1350	18	18	39.31 "	15	194500	35	10	10	4 to 1	42x8

*Figures based on the condensation of one-third of a pound of steam per square foot of radiating surface per hour, which is a good average condition.

The Goulds Sump Pump (Fig. 3029) is a standardized outfit built in one size. Ratings for this size are given below. When the sump is full the float rises and actuates the switch which in turn starts the motor. When sump is drained, the float falls and the motor is stopped. Electric current is used only when pump is running and the pump is always submerged ready to start work instantly.



Goulds Sump Pump

Ratings—Fig. 3029 Sump Pump

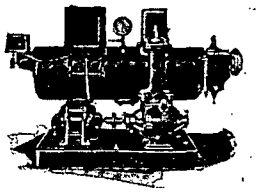
	with ¼ H.P.—1725 R.P.M. Motor						with ¼ H.P.—1450 R.P.M. Motor				
Gals. per Min..	10	15	20	25	30	35	12	15	20	25	30
Head in Ft.....	24	22	20	18	16	13	15	14	13	11	8

The Nash Engineering Company

South Norwalk, Conn., U. S. A.

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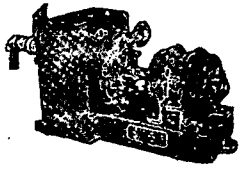
Motor-Driven Return Line Vacuum Pump

Jennings Hytor Vacuum Pump for Return Line Heating Systems

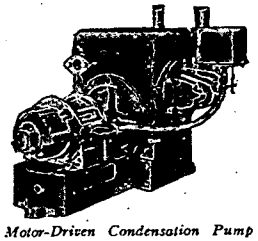
This pump removes air and water from the heating system, discharges the air to the atmosphere without back pressure, and automatically returns the water under pressure to the boiler or hot-well. Air and water are handled independently, resulting in a 50% saving in horsepower required for pump operation. Occupies one-third the space of other apparatus of equivalent capacity.

Interior parts bronze. Moving parts revolve without metal-to-metal contact and are supported on radial ball bearings mounted outside casing.

Furnished direct connected to standard electric motors, for belt drive, or for steam turbine drive.



Motor-Driven Return Line Vacuum Pump, Size M



Motor-Driven Condensation Pump

Jennings Hytor Condensation Pump and Receiver, Unit Type

No piping between the pump and receiving tank is necessary. The only connections are main return, water discharge, and air vent. Companion flanges are furnished.

The pump has an integral cast bronze impeller mounted on motor shaft supported by large motor bearings.

Literature, Recommendations and Proposals on Request

Bulletin 37—Return Line Vacuum Heating Pump.
Bulletin 25—Return Line Vacuum Heating Pump Size M.
Bulletin 18—Return Line Vacuum Heating Pump, Turbine Driven.
Bulletin 29—Condensation Pump.
Bulletin 17—Air-Line Vacuum Heating Pump.
Bulletin 10—Air and Gas Compressors.
Bulletin 11—Air and Gas Vacuum Pumps.

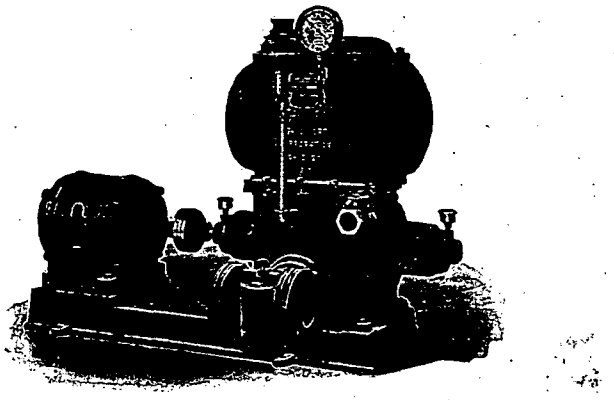
STANDARD SIZES AND CAPACITIES, JENNINGS HYTOR VACUUM PUMPS

Size	Square Feet direct equivalent radiation surface	Air Capacity cubic feet per min.	Water Capacity gals. per min. 10 lbs. pres. 180 F.	Actual Horse Power	R. P. M.	Horse Power of Motor
M	5,000	3	8	.6	1700	¾
A	8,000	5	11	.9	1800	1
B	16,000	11	22	1.4	1800	1½
C	26,000	15	35	2.0	1800	2
D	40,000	19	60	2.8	1200	3
E	65,000	34	90	3.9	1200	5
F	100,000	60	140	7.	1200	7½
G	150,000	80	200	9.8	900	10
H	300,000	150	400	19.	720	20

Skidmore Corporation

General Offices and Factory

1535 Dayton Street :-: :-: **CHICAGO, U. S. A.**



The New Type "B"

SKIDMORE HYDRO TURBINE VACUUM AND BOILER FEED PUMP

Where a self-contained unit reliable and quiet in operation is desired the Skidmore will be found.

Positive removal of air and water from the heating system and the return of water to the boiler.

A unit of pleasing design of large capacity and maintained efficiency, occupying less than half the floor space of pumps for similar service, self-contained, all on one base with return connections close to floor with strainer arranged so that connections can be made to one or both sides as desired. Furnished with direct connected motors for 10 and 20 lb. pressure, or up to 60 lb. if desired. For continuous service or with automatic vacuum control or automatic float control or both.

A strictly high grade product, bronze rotors and bronze fitted throughout, shaft carried on oversize ball bearings, no close clearances or rubbing parts.

CAPACITIES FOR 10-in. Vacuum—10 and 20 lb. Pressure

Size of Pump	Capacity Sq. Ft. of Radiation	Gal. of Water per min.	Motor H. P. 10 lb.	Motor H. P. 20 lb.	Size of Companion Flanges for Returns	Size of Discharge to Boiler	Approx. Floor Space	Shipping Weight lb.
0	5,000	8	¾	1	1½"	1"	18"x34"	500
1	8,000	11	1	1½	2"	1¼"	18"x46"	600
2	16,000	22	1½	2	2"	1¼"	18"x48"	700
3	26,000	35	2	3	2½"	1¼"	18"x48"	775
4	40,000	60	3	5	2½"	1½"	18"x52"	800
5	60,000	90	5	7½	3"	2"	20"x54"	1200
6	100,000	150	10	15	4"	2½"	20"x60"	1400

R. P. M. 1800 for all sizes.
Above weights are for continuous service, add 100 lb. for automatic control.

PUMP DIVISION
(See also Vapor-Vacuum Division

The Trane Company

La Crosse, Wis.

BRANCH OFFICES

New York, Chicago, Boston, Philadelphia, Buffalo, Cleveland, Detroit, Seattle, Los Angeles, Albany, Minneapolis, Salt Lake City, Ft. Wayne, Portland, Oregon, Greensboro, N. C., Zanesville, Ohio, Atlanta, Ga.; ENGLAND: 22-23 Clerkenwell Close, London, E. C. 1. CANADA: The Trane Co.; 23 River St., Toronto; Thomas Robertson & Co., 134 Craig St., West, Montreal: F. S. Murdock, 310 Breadalbane, Winnipeg. JAPAN: The Uchida Trading Co., Ltd., Tokio—Osaka—Kobe. CHINA: C. J. Doughty & Co., 7 Jinkee Road, Shanghai.

The Trane Systems of Vapor and Vacuum Heating, Patented Heating Specialties Trane Automatic Electric Pumps, For All Purposes

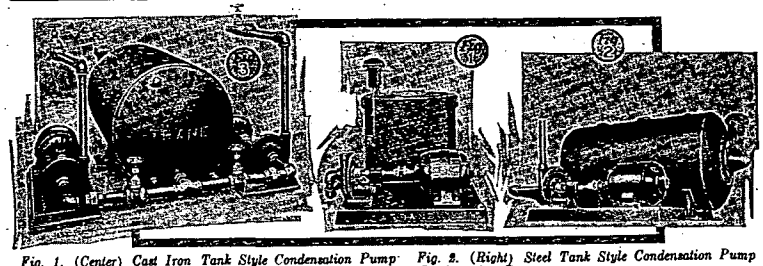


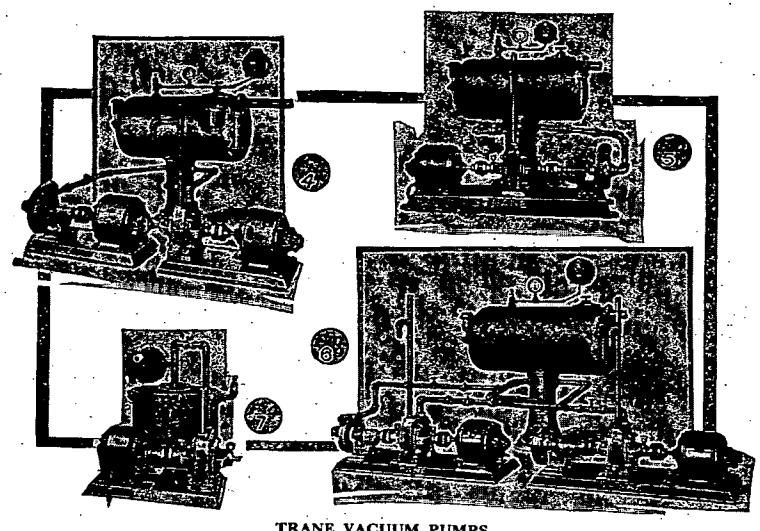
Fig. 1. (Center) Cast Iron Tank Style Condensation Pump Fig. 2. (Right) Steel Tank Style Condensation Pump Fig. 3. (Left) Duplex Type Condensation Pump

CONDENSATION PUMPS, SINGLE AND DUPLEX, SIZES, STYLES, AND CAPACITIES

For specifications and other information on these units turn to pages 432 and 433 following

Pump No.	Radiation in Sq. Ft.	Minimum Gallons per Minute	Maximum Pressure at Pump	Motor H. P.	Suggested Size of Piping Inches	Shipping Weight Lb. Condensation Pump Complete	Shipping Weight Lb. Duplex Pump Complete
410	4,000	6-8	10	½	1	325	475
415	4,000	6-8	15	½	1	325	475
420	4,000	6-8	20	½	1	325	475
430	4,000	6-8	30	½	1	325	475
440	4,000	6-8	40	½	1	325	475
450	4,000	6-8	50	¾	1	350	525
460	4,000	6-8	60	¾	1	350	525
610	6,000	9-12	10	¼	1¼	450	600
615	6,000	9-12	15	¾	1¼	450	600
620	6,000	9-12	20	¾	1¼	450	600
630	6,000	9-12	30	¾	1¼	500	700
640	6,000	9-12	40	¾	1¼	500	700
650	6,000	9-12	50	1	1¼	500	700
660	6,000	9-12	60	1	1¼	500	700
810	8,000	12-16	10	½	1¼	500	700
815	8,000	12-16	15	¾	1¼	500	700
820	8,000	12-16	20	1	1¼	525	750
830	8,000	12-16	30	1½	1¼	550	800
840	8,000	12-16	40	1½	1¼	550	800
850	8,000	12-16	50	1½	1¼	550	800
860	8,000	12-16	60	1½	1¼	550	800
1010	10,000	15-20	10	½	1½	525	750
1015	10,000	15-20	15	¾	1½	525	750
1020	10,000	15-20	20	1	1½	525	750
1030	10,000	15-20	30	1½	1½	550	800
1040	10,000	15-20	40	1½	1½	550	800
1050	10,000	15-20	50	2	1½	650	925
1060	10,000	15-20	60	2	1½	650	925
1510	15,000	25-30	10	¾	2	525	750
1515	15,000	25-30	15	1	2	525	750
1520	15,000	25-30	20	1½	2	525	750
1530	15,000	25-30	30	1½	2	550	800
1540	15,000	25-30	40	2	2	575	850
1550	15,000	25-30	50	3	2	700	1000
1560	15,000	25-30	60	3	2	700	1000
2010	20,000	30-40	10	¾	2	525	750
2015	20,000	30-40	15	1	2	575	850
2020	20,000	30-40	20	2	2	600	875
2030	20,000	30-40	30	3	2	600	900
2040	20,000	30-40	40	3	2	650	950
2050	20,000	30-40	50	5	2	675	1000
2060	20,000	30-40	60	5	2	675	1000
10010	100,000	150-200	10	3	4	725	1050
10015	100,000	150-200	15	5	4	750	1075
10020	100,000	150-200	20	5	4	750	1075
10030	100,000	150-200	30	7½	4	775	1125
10040	100,000	150-200	40	10	4	950	1500
10050	100,000	150-200	50	15	4	950	1500
10060	100,000	150-200	60	15	4	950	1500

Write for regular Trane literature giving listings on all Trane pumps between 2060 and 10,010. Lack of space does not permit placing a complete list here.



TRANE VACUUM PUMPS

Fig. 4. Two-Motor Return Line Style. Fig. 5. Single Unit Return Line. Fig. 6. Duplex Return Line. Fig. 7. Air Line

For Specifications, etc., see page 432 following

Capacity in Sq. Ft.	Capacity in G. P. M.	Pressure at Pump	Two-Motor Return Line Special: Motor H. P. Air	Two-Motor Return Line Special: Motor H. P. Water	Two-Motor Return Line Special: Shipping Weight	Two-Motor Return Line Special: Shipping Weights Special Duplex	Standard Return Line Pumps: Motor H. P.	Standard Return Line Pumps: Shipping Weight	Standard Return Line Pumps: Shipping Weights Standard Duplex
6000	9	10	½	¾	650	1000	¾	550	875
6000	9	15	½	¾	650	1000	1	575	900
8000	12	10	½	¾	700	1200	1	695	1025
8000	12	15	½	1	725	1250	1½	725	1050
12000	18	10	¾	¾	775	1350	1	675	1050
12000	18	15	¾	1	800	1400	1½	725	1075
18000	27	10	¾	1	825	1450	1½	725	1075
18000	27	15	¾	2	850	1500	2	750	1125
25000	38	10	1	1½	875	1550			
25000	38	15	1	2	900	1600			
30000	45	10	1	1½	900	1600	2	775	1325
30000	45	15	1	2	925	1650	3	800	1375
40000	60	10	1½	2	1150	2000	3	950	1625
40000	60	15	1½	3	1250	2100	5	1050	1725
65000	100	10	2	3	1350	2300	5	1150	1900
65000	100	15	2	5	1450	2400	7½	1400	2150
100000	150	10	3	5	1650	2800	7½	1450	2500
100000	150	15	3	7½	1700	2900	10	1550	2600

TRANE AIR LINE VACUUM PUMPS

Pump No.	Capacity	H. P.	Shipping Wt.
8A	8000	½	375
16A	16000	¾	425
30A	30000	1	450
40A	40000	1½	500
65A	65000	2	550
100A	100000	3	625

NOTE—Motors of 1½ h. p. and larger on a. c. include magnetic type of starter having thermal relays and give protection against phase failure. Under voltage release is also provided with automatic control.

Water Pump Capacities Based on Water at 180 deg. fahr.

See General Information on pages 428-433, following

BOOSTER AND CIRCULATING PUMPS

—see next page for specifications, etc.—

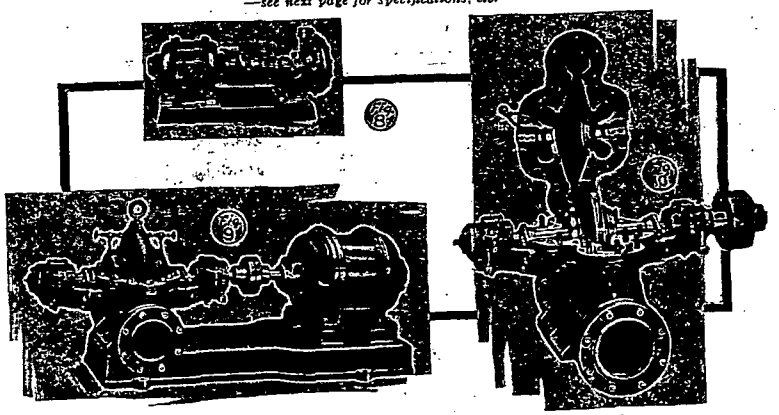


Fig. 8. Trane Vertical Split Shell Pump, Capacities available up to 1500 G. P. M.
Fig. 9. Trane Horizontal Split Shell Pump, Capacities available between 100 and 5000 G. P. M.
Fig. 10. Interior of Trane Horizontal Split Shell Pump.

PERFORMANCE TABLE OF TRANE VERTICAL SPLIT SHELL (Fig. 8) CIRCULATING AND BOOSTER PUMPS
All speeds 1725 except those marked in note. To convert feet head into pounds pressure divide by 2.3.

G.P.M.	Feet Head	10	20	30	40	50	60	80	100	125	150	175	200	225
5	Pump No....	C1	C1	C1	C2	C2	C6	C6	C6	C6	C6	C6		
	H. P.....	¼	¼	¼	½	¾	1	1	1½	1½	1½	1½		
10	Pump No....	C1	C1	C1	C2	C3	C3	C6	C6	C6	C6	C6		
	H. P.....	¼	¼	½	¾	¾	1	1	1½	1½	1½	1½		
20	Pump No....	C1	C2	C2	C3	C3	C3	C7	C7	C7	C8	C8		
	H. P.....	¼	½	½	¾	1	1½	1½	2	2	3	3		
30	Pump No....	C2	C2	C3	C3	C3	C4	C7	C7	C8	C8	C8	C8	C8
	H. P.....	½	½	¾	1	1½	2	2	2	3	3	5	5	5
50	Pump No....	C2	C3	C3	C3	C3	C5	C5	C9	C10	C11	C11	C12	C12
	H. P.....	¾	1	1½	1½	2	3	5	5	5	7½	7½	10	10
75	Pump No....	C3	C3	C3	C3	C4	C5	C5	C12	C12	C12	C12		
	H. P.....	1½	1½	1½	2	3	5	5	7½	7½	7½	10		
100	Pump No....	C15	C3	C14	C14	C5	C5	C5	C15	C15	C15			
	H. P.....	2	2	3	5	5	5	7½	10	10	15			
125	Pump No....	C15	C15	C14	C14	C5	C14	C15	C15	C16	C16			
	H. P.....	2	2	3	5	5	5	7½	10	15	15			
150	Pump No....	C15	C15	C14	C14	C14	C14	C15	C15	C16				
	H. P.....	3	3	5	5	7½	7½	7½	10	15				
200	Pump No....	C15	C15	C15	C15	C15	C15	C15	C15	C16				
	H. P.....	5	5	5	5	7½	7½	10	15	20				

NOTE—Pumps marked C11, C12 and C15 are to run at 1200 r. p. m. to give the above performance. Pumps for brine service will in most cases take the next larger commercial size of motor than the one given here due to higher specific gravity of the brine.

RECEIVING TANKS, SIZES, STYLES AND CAPACITIES

Condensation Pumps

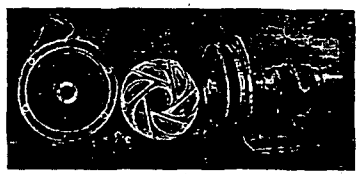
400 Series, Case Iron Tank, capacity 5 to 6 gal. 600 to 1,000 Series, inclusive, 20 x 30 steel receiving tank, capacity 22 gal. 1,500 to 4,000 Series, inclusive, 20 x 40 steel receiving tank, capacity 30 gal. 6,500 to 10,000 Series, inclusive, 20 x 72 steel receiving tank, capacity 52 gal.

Return Line Vacuum Pumps

(Standard and Two-Motor styles; single and duplex) Pumps having capacities up to and including 8,000 sq. ft. equipped with cast iron tank, 14 x 26, capacity 13 gal. Pumps having capacities 12,000 to 18,000 sq. ft., inclusive, cast iron tank 16 x 30, capacity 21 gal. Pumps having capacities 25,000 to 40,000 sq. ft., inclusive, cast iron tank, 16 x 40, capacity 28 gal. Pumps having capacities 65,000 to 100,000 sq. ft., inclusive, steel tank, 20 x 72, capacity 52 gal.

SMALL CENTRIFUGALS

Used on Condensation, Circulating, Booster, and Vacuum Pumps



Parts of Standard Trane Single Stage Centrifugal Pump. This construction used only in the smaller sizes

Specifications given here are for small Trane centrifugals only. Write for special specification on larger pumps used for booster and circulating service.

Pump—Trane single stage low pressure pumps are of the centrifugal type with vertical split casing and vertical split impeller, arranged so pump may be easily taken apart for inspection.

Volute—(Casings) Close grained cast iron, carefully machined. Made of special materials where liquids other than water are to be handled.

Bearings—Ball bearings, ring, waste packed, and chain oiling types, depending on size and style of pump. They are entirely removed from all contact with liquid being pumped. Turbo-Glyco Babbitt bearings, enclosed in bronze shell. Thrust taken care of by Ball Thrust Bearings.

Impellers—Brass, enclosed type; especially designed for the particular service to be rendered. Exactly balanced. Vane plate and impeller plate made separately; easy to clean where dirty or gritty liquids are handled.

Shafts—Steel. No deflection.

Packing Glands—Brass. Metallic braided packing used always.

Couplings—Pin and endless belt type, liberally oversized.

Base—Cast iron, heavily ribbed. An absolutely rigid foundation.

Motors—Wagner, Westinghouse or G. E., depending on service to be rendered.

Trane Centrifugal Pumps are used on all Trane condensation units up to 20 lb. pressure, on all circulating units to 75 ft. head, and on booster and return line vacuum units.

The Trane Company specializes in pumping equipment required in the mechanical equipment of buildings. A complete line of pumps of the classes mentioned above, suitable for any conditions that may ordinarily be encountered, is carried.

Guarantee—Every Trane Pump is guaranteed to deliver its rated capacity against the head or pressure for which it is sold. In addition it is guaranteed against all mechanical defects for a period of one year.

AIR UNITS

Used on Trane Vacuum Pumps, Air Line, and Return Line



Parts of Standard Trane Air Unit

A glance at the above engraving shows gearless, valveless simplicity. Non-reciprocating.

The discharge plates and block-off ring are made of toughest bronze.

The impeller is bronze too, perfectly aligned and hydraulically balanced. It revolves on Ball Thrust Bearings.

Impeller is held out of metallic contact with other parts of the pump by a combination of radial and thrust ball bearings.

And the result is a quiet pump; an efficient pump; and an everlasting pump.

Straight Line Action

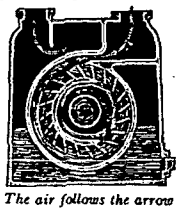
Air enters top of each bucket and leaves through the bottom once only per revolution.

Greater efficiency.
Greater separation of air inlet and outlet.
No priming or recirculation.
No close clearances, anywhere.
High speed efficiency.

One Moving Part

A perfectly aligned and hydraulically balanced impeller that revolves on ball thrust bearings.

A quiet pump.
Nothing to leak or wear.
Less motor load.
No permanent water supply needed.
One air inlet and one air outlet.
No leaky stuffing boxes.



The air follows the arrow

WORTHINGTON PUMP AND MACHINERY CORPORATION

115 BROADWAY, NEW YORK CITY

BRANCH OFFICES

Atlanta	Trust Company of Georgia Bldg.	Kansas City	Scarritt Bldg.
Birmingham	American Trust and Savings Bank Bldg.	Los Angeles	2424-2426 Enterprise Street
Boston	Boston Safe Deposit and Trust Bldg.	New Orleans	533 Baronne Street
Buffalo	Iroquois Bldg.	Philadelphia	North American Bldg.
Chicago	Old Colony Bldg.	Pittsburgh	407 Oliver Bldg.
Cincinnati	First National Bank Bldg.	St. Louis	Laclede Gas Bldg.
Cleveland	Rockefeller Bldg.	St. Paul	Commerce Bldg.
Dallas	Magnolia Bldg.	Salt Lake City	Walker Bank Bldg.
Denver	435 Seventeenth Street	San Francisco	Sharon Bldg.
Detroit	Majestic Bldg.	Seattle	Maynard Bldg.
El Paso	Mills Bldg.	Tulsa	424 North Boulder Street
Houston	Southern Pacific Bldg.	Washington, D. C.	Homer Bldg.

Steam Pumps—Centrifugal Pumps—Power Pumps—Deep-well Pumps—Water Meters—Compressors—Feed-water Heaters—Automatic Feed Pumps and Receivers—Steam Heating Vacuum Pumps

WORTHINGTON

Manufacturing all types of pumps and air compressors used in the building trade, Worthington engineers hold no brief for any particular kind. Let them assist you in specifying the correct machinery for the purpose. The Worthington Line includes:

Steam Pumps

Simplex and duplex types; simple, compound and triple expansion; condensing and non-condensing; in all sizes and designs to meet every service requirement.

Centrifugal Pumps

Open or closed impeller, volute and multi-stage pumps, in all sizes and capacities for all heads.

Power Pumps

Single-cylinder, duplex and triplex; horizontal or vertical; single-acting or double-acting.

Deep-well Pumps

Single-plunger, two-plunger and three-plunger reciprocating types and "Axiflo" and "Coniflo" centrifugal types.

Water Meters

Hot-water boiler-feed; cold-water meters of the disc, turbine and compound types, with a range of capacities from the smallest flow to the largest service; also oil meters.

Compressors

Air and ammonia; single-stage or two-stage, vertical and horizontal; belt driven, direct-connected motor or uniflow steam drive.

Feed-water Heaters

Open type, vertical and horizontal. Serves as feed-water heater, purifier, condensation receiver and feed-water softener all in one.

Automatic Feed Pumps and Receivers

For returning condensate from heating coils.

Steam Heating Vacuum Pumps

Both steam and power driven.

Yeomans Brothers Company

(ESTABLISHED IN 1898)

1433 Dayton Street - CHICAGO, ILL.

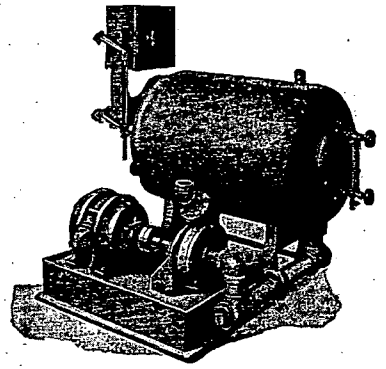
Manufacturers of a Complete Line of Pumps

PRODUCTS

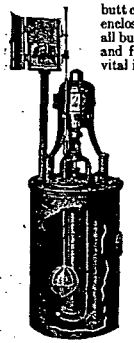
Shone Pneumatic Sewage Ejectors
Yeomans Centrifugal Sewage Ejectors
Sewage Pumping Plants for municipalities
Bilge or Sump Pumps, Electric or Steam Driven, Single or Duplex
Emergency Flood Pumps
Condensation Return Pumps
Centrifugal Pumps for all purposes

Yeomans automatic electric Condensation Return Pumps are designed for returning condensate from gravity heating systems to boilers where the return lines are too low to drain by gravity. They are built in horizontal type, suitable for return lines above basement floor level, and vertical type for return lines close to or below floor level.

The *type HCC horizontal pump includes* a heavy cast iron receiver mounted on same cast iron base with pump and motor and equipped with carbon butt contact enclosed automatic float switch, enclosed knife switch and protective device, all built to meet the most exacting demands and for service where dependability is of vital importance.



HCC Condensation Pump and Cast Iron Receiver



Type V

The type HCS horizontal machine, though compact, durable and economical in operation, is of lighter construction, being equipped with steel receiver, light type enclosed float switch and without knife switch.

The type V vertical unit is similar in construction to the Yeomans Electric Bilge Pump, being equipped with cast iron receiver or basin, cast iron cover, vertical direct connected motor and enclosed automatic control.

Special pumps for larger capacities and higher pressures can be furnished on order.

STANDARD SIZES—TYPE HCC

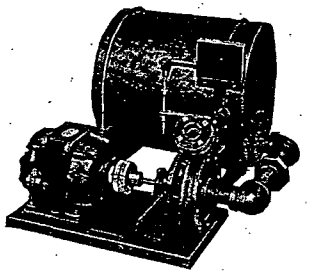
Pump No.	Max. Sq. Ft. Direct Radiation	Gals. per Min.	Size of Receiver	H. P. of Motor		Approximate Shipping Weight
				10 lbs.	20 lbs.	
1	1,000	5	20x30	½	1	1,000
2	3,000	10	20x30	½	1	1,100
3	6,000	15	20x30	¾	1½	1,200
4	10,000	20	20x40	¾	1½	1,400
5	15,000	30	20x40	1	2	1,500
6	30,000	60	20x40	2	3	1,600

STANDARD SIZES—TYPE V

Pump No.	Max. Sq. Ft. Direct Radiation	Gals. per Min.	Size of Receiver	H. P. of Motor		Approximate Shipping Weight
				10 lbs.	20 lbs.	
1	1,000	5	24x48	½	1	1,500
2	3,000	10	24x48	½	1	1,550
3	6,000	15	24x48	¾	1½	1,600
4	10,000	20	24x48	¾	1½	1,650
5	15,000	30	24x48	1	2	1,750
6	30,000	60	24x48	2	3	1,850

Standard Sizes—Type H. C. S.

Pump No.	Sq. Ft. Direct Radiation	Size of Receiver	H. P. Motor	
			10 lbs.	20 lbs.
2	1000/3000	18"x20"	½	¾
3	4000/6000	18"x20"	½	¾
4	7000/10000	18"x24"	½	1
5	11000/15000	18"x24"	½	1
6	16000/30000	18"x24"	¾	1½
7	31000/45000	18"x30"	1	1½
8	46000/60000	18"x30"	1½	2



Type H. C. S.

YOUNG PUMP COMPANY

230 East Ohio Street
CHICAGO

Factory
MICHIGAN CITY, IND.

YOUNG CENTRIFUGAL VACUUM AND BOILER FEED PUMP

A reliable Vacuum System Pump for handling both gases and liquids efficiently

Patented December 10, 1918

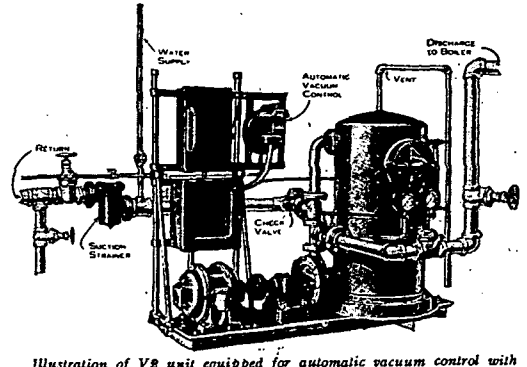


Illustration of V8 unit equipped for automatic vacuum control with piping connections made and ready for operation. Piping connections shown in gray tone are to be made by contractor. Suction strainer and check valve at inlet of pump are furnished with unit, as well as companion flanges, bolts and gaskets.

In the present construction of the Young Centrifugal Vacuum and Boiler Feed Pump we offer the simplest, most fool-proof and efficient electric vaccum pump on the market. The unit is completely assembled (including electrical equipment) at the factory and tested before shipment. In operation it requires practically no attention. The Pump is guaranteed to give complete satisfaction on a properly laid out and equipped vacuum heating system. The air capacities are standardized to produce under these conditions 10 inches of vacuum with reasonably tight vacuum traps and temperature of returns not to exceed 180 deg. fahr.

TABLE OF CAPACITIES

Size	Sq. Ft. Direct Radiation	Motor H. P.	Actual H. P.	Water Capacity G. P. M.	Air Capacity Cu. Ft. per Min.
V0	5,000	¾	0.6	8	4.5
V1	8,000	1	0.8	12	6.0
V2A	16,000	1½	1.3	25	9.8
V3A	26,000	2	1.8	40	16.0
V4A	40,000	3	2.7	70	20.0
V5A	65,000	5	4.1	100	32.0

The principle of the vacuum producing element is the oldest and is most efficient in practice—that of the ejector. Whenever the pump is in operation, water is supplied under pressure to the ejector nozzle, which causes the ejector to pull a strong suction on the return line of the heating system.

The Heating and Ventilating Magazine

NEW YORK
1123 Broadway

CHICAGO
105 So. Dearborn St.

A Monthly Journal of Engineering Progress

Field

Heating and Ventilation is a specialized branch of engineering. It comprises consulting engineers who design the heating, ventilating, and air conditioning systems for schools, hospitals, hotels, office buildings, department stores, apartment houses, institutions and industrial plants. They specify or buy the apparatus and material and supervise the installation—*the most direct sales contact for manufacturers of such apparatus and material.*

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Heating and Ventilating Engineers.

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Calibre and buying power are outstanding characteristics of the readers of *The Heating and Ventilating Magazine.* Their services are required only where high grade material and workmanship are a larger consideration with the architect and owner than mere price.

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Rates

Single insertion.....$86.00 per page
Twelve consecutive insertions..... 75.00 per page

Over 130 manufacturers of heating and ventilating apparatus and appliances are using the advertising columns of *The Heating and Ventilating Magazine* every month in the year.

Member A. B. C.

THE DIRECT ROUTE to the Specifier and Buyer of Heating and Ventilating Equipment

Member A. B. P.

Subscription Price $2.00 per year.

BELL. BROAD 2594

Farley Sleeve & Hanger Co.

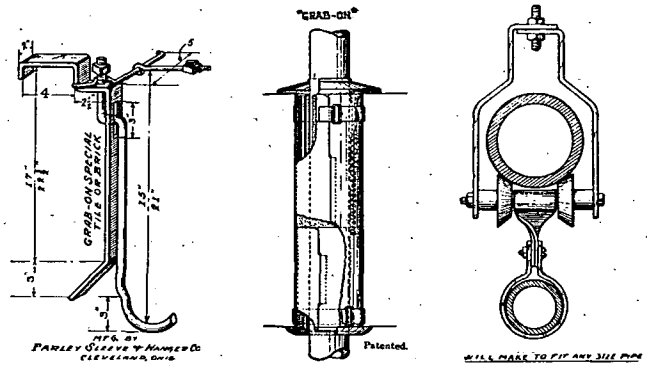
J. W. FARLEY, Manager

3748 E. 71st St., S. E. Cor. FLEET AVENUE
(NEAR BROADWAY)

Cleveland, Ohio

Manufacturers of

"Grab-On" Fire Resisting Floor and Wall Sleeves, Floor, Ceiling and Wall Plates, "Grab-On" Hangers, Hanger Bars, Inserts Adjustable Radiator Hangers and Anchors



FIRE RESISTING "GRAB-ON" SLEEVES AND HANGERS

The "Grab-on" Adjustable Fire Resisting Sleeves and Hangers are designed for and used in the largest and smallest buildings such as Federal Banks, Hospitals, Schools, Factories and Residences.

They are fire, smoke and water-proof. A special Sleeve is made exclusively for Hospital work. This type is made with or without Plates. Without Plates when covering pipes in rooms the covering can be fastened to the Sleeve to allow expansion and contraction and to hold the covering against the ceiling. This Sleeve can be opened in four parts and can be put on after the pipe is up as well as when the pipe is being erected.

All Hangers are made of Hot Rolled Steel and have 3 in. adjustment. The Hooks on the Radiator Hangers are made to fit any radiation when specified. These Hangers can be fastened to any type of wall and by making it possible to hang the radiation on the wall it is easy to clean underneath the radiators. This is particularly desirable in offices, schools and hospitals.

These Hangers are made to fasten over brick or tile which does not need shields or bolts. We also make Hangers where shields and bolts are used.

Expert workmanship and high grade materials do their part in stamping Farley specialties as quality products. Prompt attention to all inquiries and quick deliveries are included in our service to architects, engineers and contractors.

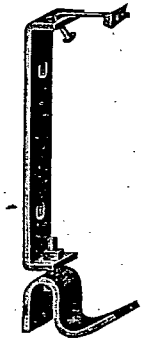
A. F. Gleockle, Jr.

415 Bay Street, ROCHESTER, N. Y.

Sales Representatives in Principal Cities

GLEOCKLE Wrought Iron Adjustable WALL and Column Radiator Brackets
(Patented March 23, 1920)

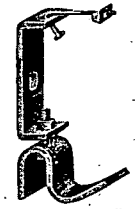
There is a Gleockle Radiator Bracket for every requirement in heating factories, office and public buildings, churches, stores and residences where radiation must be hung on walls, ceilings, etc. Every Gleockle bracket is of sturdy wrought iron—servicable and durable. Several styles, and their application are shown.



No. 1 Gleockle

Wall Radiator Bracket Supports 7′ and 9′ Vertical Wall Radiators.

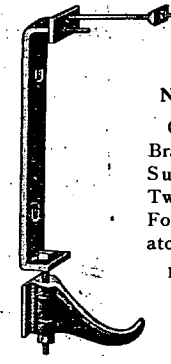
List Price, $2.50



No. 2. Gleockle

Wall Radiator Bracket supports 5′, 7′ or 9′ Horizontal or 5′ Vertical Wall Radiators.

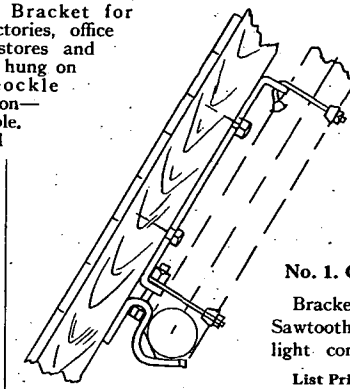
List Price, $2.50



No. 9. Gleockle

Column Radiator Bracket. Made to Support Single, Two, Three and Four Column Radiators.

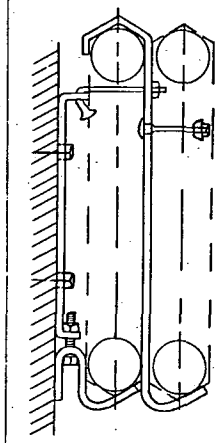
List Price, $2.50



No. 1. Gleockle

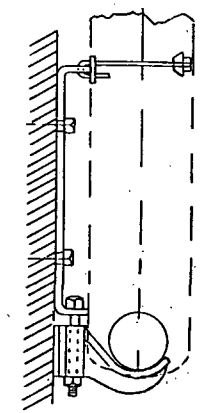
Bracket used on Sawtooth or Skylight construction.

List Price, $4.50



No. 1. Gleockle

Wall Radiator Bracket Supporting Double Row of Wall Radiation. Specify for use on 5′, 7′ or 9′; Vertical or Horizontal wall radiators.



Gleockle Brackets Support the radiators 2″ from Wall, and are adjustable, strong and flexible.

Healy-Ruff Company

St. Paul, Minn.

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CANADA

TORONTO, VANCOUVER, HALIFAX, MONTREAL, WINNIPEG, OTTAWA, CALGARY

Manufacturers of E-Z Radiator Hangers Write 781 Hampden Avenue

E-Z RADIATOR HANGERS are designed to hang all Wall and Column Radiation of any make. They have both vertical and horizontal adjustments, and are designed to anticipate the use of temperature control valves.

Only one bolt per hanger. No accurate placing of anchor bolts required. Washer at top makes hanger absolutely invisible.

Style "R", shown below, places radiator 1½ in. from wall, but is not adjustable for baseboard. Convertible, with parts No. 5 and No. 8, into Style "H", which places radiator 2½ in. from wall and provides for baseboard adjustment.

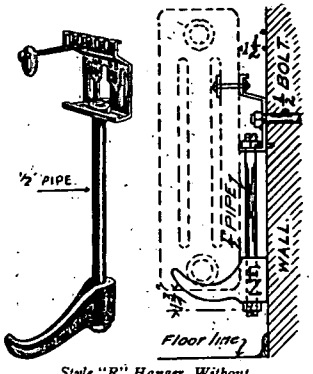
TYPICAL SPECIFICATIONS

Where Baseboards Are Used

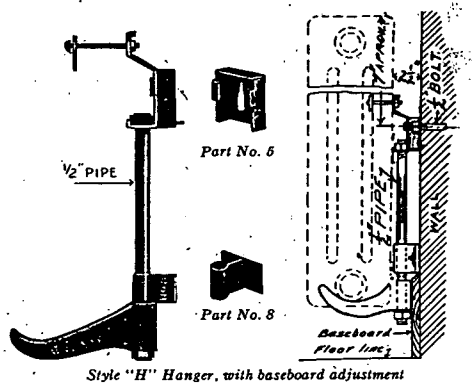
All radiation, unless otherwise noted shall be supported on wall by means of E-Z Radiator Hangers, Style "H" as manufactured by the Healy-Ruff Co., St. Paul, Minn., or equal and approved in writing by the Architect arranged to support the radiator 2½ in. from the wall and with baseboard adjustment.

Where Baseboard Adjustment is Not Desired

All radiation, unless otherwise noted, shall be supported on wall by means of E-Z Radiator Hangers, Style "R," as manufactured by the Healy-Ruff Co., St. Paul, Minn., or equal and approved in writing by the Architect, arranged to support the radiator 1½ in. from the wall.



Style "R" Hanger, Without baseboard adjustment



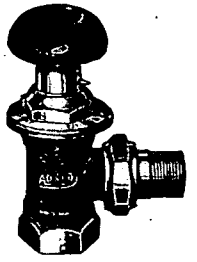
Style "H" Hanger, with baseboard adjustment

AMERICAN DISTRICT STEAM COMPANY

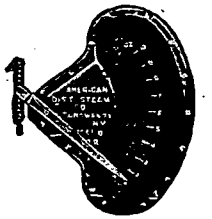
GENERAL OFFICES AND WORKS

NORTH TONAWANDA, N.Y.

OFFICES—NEW YORK, SEATTLE, CHICAGO



Adsco Packless Graduated Radiator Valve Model A-1 Hand Wheel Type

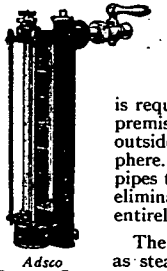


Adsco Damper Regulator, Model B

ADSCO

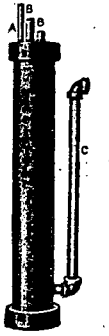
SYSTEM OF ATMOSPHERIC STEAM HEATING

The Adsco System of Atmospheric Steam Heating, a vapor heating system, is adaptable for all types of buildings, from the smallest bungalow to the largest office building. It is extremely simple in design. The only specialties used are those actually needed to gain the greatest economy in the consumption of fuel and make possible the control of temperature in every room, furthermore, reducing to a minimum the attention necessary in the operation of the heating plant. With this system it is not necessary to use air valves on the radiators.



Adsco Pressure Gage

A very low steam pressure averaging between 3 to 5 ounces at the radiator in ordinary weather conditions, is required. The steam may be supplied by a boiler on the premises or from a **District Steam Heating Plant** or other outside source. The entire system is vented to the atmosphere. Therefore when steam as vapor rises through supply pipes to the radiator, the air flows out naturally and quickly, eliminating all resistance to the flow of steam and preventing entirely any noise.



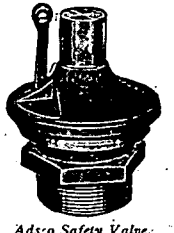
Adsco Pipe Receiver

The quick circulation of steam assures instant heat as soon as steam is available. Hot water type radiators are used.

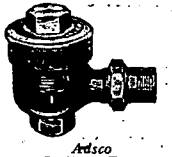
The **Adsco System** was originally designed to combine two very important features: simplicity and economical operation. To obtain the maximum in these two features, we strongly recommend our practice of figuring approximately 20 per cent more radiation than is usually specified and eliminating the necessity of radiator traps.

We realize, however, that there are many instances where radiator traps are desired. In such cases we recommend that the radiation be specified to conform to the lower standard and radiator traps be employed. These traps will in no way interfere with the positive operation of an **Adsco System.**

We maintain at our general offices a complete engineering staff, ready to cooperate in the preparation of plans for **Adsco Heating.**



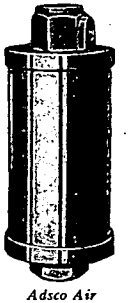
Adsco Safety Valve Model E



Adsco Radiator Trap



Adsco Return Elbows



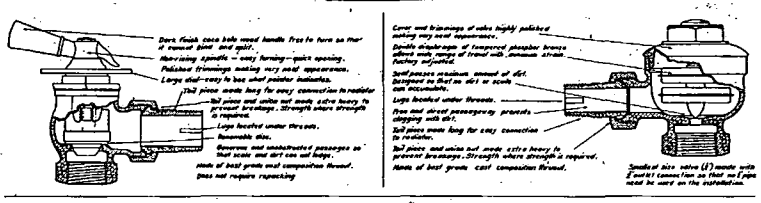
Adsco Air Eliminator

Barnes & Jones

5 Melrose Street BOSTON, MASS.

Modulating Vapor and Vacuum Heating Apparatus—Condensators, Blast Traps, Vent Traps and Modulating Hot Water Valves

BARNES & JONES VALVES



CAPACITIES

BARNES & JONES MODULATION VALVES

Size Valve	CAPACITIES Sq. feet C.I. Rad.	Sq. feet Coils
¾"	60	45
1"	100	75
1¼"	180	135
1½"	260	200

BARNES & JONES RETURN VALVES

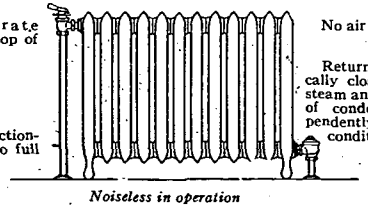
CAPACITIES Size valve	Lbs. water per hour	Sq. feet C.I. Rad.	Sq. feet coils
½"	30	125	100
¾"	80	320	240
1"	200	800	600

Radiator Equipped with Barnes & Jones System

Only one valve to operate—quick opening—placed at top of radiator.

No leaks from either valve.

Radiator may be heated fractionally from smallest amount to full hot.



No air valve required.

Return valve or trap automatically closes in the presence of steam and opens to remove water of condensation and air independently of varying pressure conditions.

Noiseless in operation

VAPOR *and* VACUUM HEATING EQUIPMENT *of* PROVEN QUALITY

THE RESULT *of* TWENTY-FIVE YEARS' EXPERIENCE

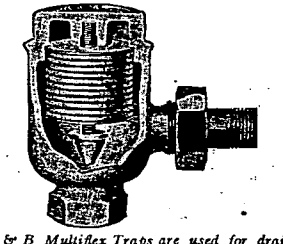
The Bishop & Babcock Mfg. Co.

The Massachusetts Blower Co.

General Offices CLEVELAND

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CINCINNATI, 1025 Central Avenue
DENVER, 1724 Lawrence Street
PITTSBURGH, 412 Third Avenue
DALLAS, 1106 Commerce Street
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ST. LOUIS, 210-212 South Broadway
ATLANTA, 60 W. Mitchell Street
CHICAGO, 112 West Austin Avenue

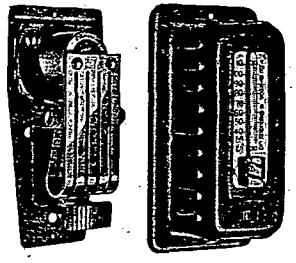
The B & B Line
The World's Most Complete Line of Heating Specialties



The B & B Multiflex Traps are used for draining Radiator Drip and Blast Coils of Air and Condensation.

SCHEDULE OF MULTIFLEX TRAPS

Size	Capacity Vapor	Capacity Vacuum	Weight
½"	200	250	2½
¾"	500	600	3
1"	1,000	1,100	3½



Positive or Graduate Type Thermostat

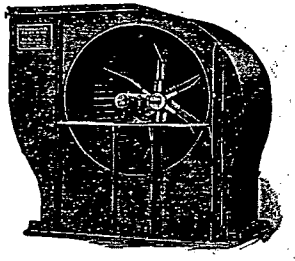
THE B & B LINE OF ALL-METAL THERMOSTATS

The B & B All-Metal Thermostat is furnished in special types for all vapor and steam heating installations where positive heat control is essential. The B & B All-Metal Thermostat, used in conjunction with the B & B Multiflex Pneumatic Valve, gives a most complete and efficient temperature control system.

The Positive Type Thermostat is of such construction that it is either fully open or tightly shut, that is, there is no intermediate position. It is used extensively on 1-pipe steam systems.

The Graduate Type Thermostat is of such construction that it throttles, that is, it will maintain a valve in an intermediate position. It is used extensively on vacuum and vapor systems.

The Compound Type Thermostat is a combination of both Positive and Graduate types. The positive feature operates radiators, while the Graduate feature is utilized to operate dampers, i. e. the ventilating in a split system or partly direct, and partly indirect system of heating.



Single Width Squirrel Cage Fan

THE B & B LINE OF MASSACHUSETTS MODIFIED SQUIRREL CAGE FANS

The Modified Squirrel Cage Fan is made single width, single inlet, when it is used as an exhauster. When used as a blower, fans ranging from size No. 1½ and up can be equipped with two inlets with housing of single width. Fans with two inlets have a different characteristic from single inlet as the tip speed will average about 5 per cent lower for a given volume and pressure.

Combustion Specialties Corporation

Manufacturers of

DRAFT COMBUSTO REGULATING SYSTEM

250 West 54th Street, New York

FOR HEATING PLANTS
Saves coal and labor, maintains even heat with less draft.

FOR POWER PLANTS
Higher evaporation per pound of coal eliminates smoke

Walter S. Timmis, past president of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS has written an extensive report on COMBUSTO Draft System from which the following paragraphs are quoted. (Complete report will gladly be forwarded on request.)

Mr. Timmis states, "To secure the most economical results in combustion for heating it is necessary to use the proper amount of air under the fuel bed for the distillation of the gases and the correct amount of air properly diffused, preferably heated and delivered over the fire bed in order to complete the combustion by burning the distilled gases—**in brief—an efficient boiler is a gas producer having means for consuming gas produced.**"

WHAT COMBUSTO IS

To quote Mr. Timmis further, "**Combusto** is a system carefully studied, tested and developed for each individually different case and provides means for supplying the necessary diffused and heated air (oxygen) over the fire to properly complete in the second stage the combustion begun in the fuel bed by distillation of gases."

UNIQUE AND FUNDAMENTAL REQUIREMENT FOUND IN COMBUSTO

"Perhaps the most important feature of **Combusto** is the resistance to the flow of air through the apparatus itself, which is made to equal the resistance of the fuel bed, thus producing a balanced condition above and below and through the fuel bed—**a fundamental requirement for correct and economical combustion which is ignored in regular furnace and boiler design.**

WHAT COMBUSTO DOES
(See illustration of COMBUSTO equipped plant below.)

"**Combusto** is of cast iron cellular structure, the air is heated on passing through this structure and is then discharged through a large number of small apertures over the fire bed. The amount of air thus admitted having been carefully computed for the required conditions, the result is practically perfect combustion, which to the user of **Combusto** results in—

Economy of fuel
Fewer firings
Complete combustion of fuel, hence—
A finer ash and reduction of clinker
Elimination of coal gases
Means for producing a steady even heat."

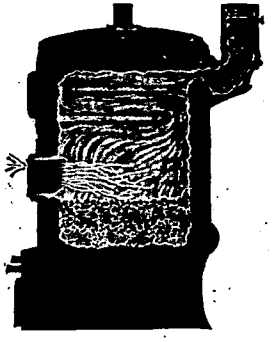


COAL WASTED (Left)

Without **Combusto**, a checked fire produces no dependable results. The gases that distill from fuel bed are a total loss. Heat can be produced only by speeding up stack draft. This is wasteful and requires frequent attention.

COAL SAVED (Right)

With **Combusto**, all gases are burned completely with Bunsen blue flame with stack draft continuously checked to minimum. Hence, amount of gas made can be regulated to amount of heat needed by simple adjustment of the ash pit damper.



SPECIFICATION: The following clause adopted since 1916 by one of the largest railways in the United States is suitable as a standard specification in connection with low pressure hot water or heating boilers or warm air plants. "Equip all boilers (warm air furnaces) with **Combusto** of size recommended by Combustion Specialties Corporation's engineers."

STYLES: **Combusto** is manufactured in 28 basic styles—each style is capable of adjustment to meet specified conditions. Suitable styles are manufactured for practically any type of heating plant and for all sizes and grades of fuel.

PRICES: Prices range from $25.00 on small house-heating plants to $200.00 on largest low pressure heating boilers. Definite estimates can at once be submitted if manufacturer's name and number of boiler is sent to us.

A FEW NOTABLE INSTALLATIONS

Daniel Guggenheim Estate
Clarence H. Mackay Estate
Otto Kahn Estate
George Eastman (Eastman Kodak Co.)
H. R. Mallinson
U. S. Department of Labor
John J. Bausch (Bausch & Lomb)
Firestone Tire & Rubber Co.
Frederick G. Erbe (Yawman & Erbe)
Childs Co., 52 installations
D. L. & W. Railroad, 40 installations
Bank of the Manhattan Co., 26 inst.

G. M. Davis Regulator Company

Manufacturers of Automatic Valve Specialties

407 MILWAUKEE AVENUE :-: CHICAGO

New York Office, 71 Fulton Street—Sales Representatives in Principal Cities

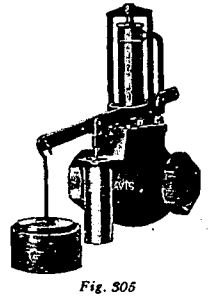


Fig. 305
Pressure Regulator—Piston Type

Fig. 305—The Davis Standard Regulator is constructed for automatic steam pressure reduction. It accomplishes its purpose in the most direct manner and with the least liability to go wrong. It has visible action—you can see it work—you can test it by hand. Good for any service pressure.

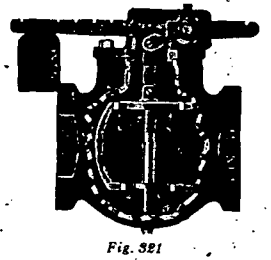


Fig. 321
Back Pressure Valve

Fig. 321—To automatically regulate the pressure of exhaust steam is the purpose of the Davis Noiseless Back Pressure Valve. The globe pattern may be used either horizontally or vertically. The piston disc is semi-balanced which results in reducing the size of the counterweight necessary to maintain a given pressure.

Fig. 311—This Regulator is for use on vapor, vacuum and low pressure heating systems. Having a diaphragm of large area and no stuffing box, it is very sensitive. Control pressure is taken from the service pipe 5 to 10 feet ahead of the valve where an accurate average pressure may be had.

Fig. 318—The Davis Float Valve will automatically maintain a constant water level in a tank or reservoir. A distinctive feature is its tight closing disc—it will not leak. Another feature is its loosely fitted piston—it will not stick. Frictionless operation insures accurate regulation.

Send for general catalog

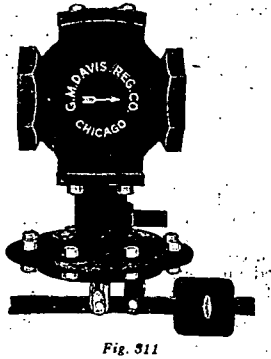


Fig. 311
Pressure Regulator—Diaphragm Type

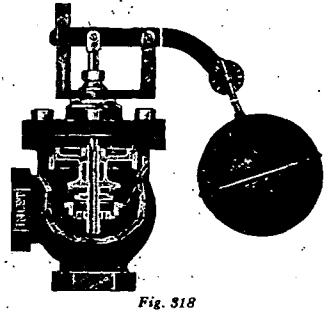


Fig. 318
Float Valve Globe or Angle

C. A. Dunham Co.

Administrative and General Offices: 230 East Ohio Street, Chicago
Factories at Marshalltown, Iowa, and Toronto, Ont., Canada

BRANCH SALES OFFICES:

Birmingham, Boston, Cheyenne, Chicago, Cincinnati, Cleveland, Dallas, Davenport, Denver, Des Moines, Detroit, El Paso, Indianapolis, Kansas City, Los Angeles, Louisville, Milwaukee, Minneapolis, New Orleans, New York, Omaha, Philadelphia, Pittsburgh, Portland (Ore.), Rochester, St. Louis, Salt Lake City, San Francisco, Seattle, Spokane, Troy, Washington.

C. A. DUNHAM CO., LTD., General Offices and Factory, Toronto, Ont.

BRANCH SALES OFFICES: Calgary, Montreal, Ottawa, Toronto, Winnipeg, Vancouver, Halifax.

FOREIGN SALES OFFICES: London, England; St. John's, Newfoundland
Distributors: Munsing & Co., Paris, France, 47 Rue Fontaine-au-roi

Manufacturers of Specialties for The Dunham Systems of Heating

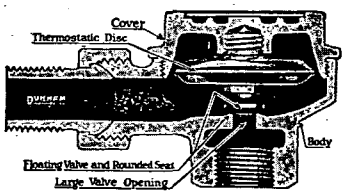
The DUNHAM HEATING SERVICE

This Service is delivered through over 60 Branch and Local Sales Offices throughout the United States and Canada. These branch and local sales offices bring Dunham Heating Service as close to your office as your telephone. Consult your telephone directory for the address of our office in your city.

Products

Specialties for use in connection with The Dunham System of Heating, known according to its several adaptable forms as The Dunham Home Heating System; The Dunham Return System and The Dunham Vacuum System—all two-pipe systems, and The Dunham Air Line System for use in connection with one-pipe steam systems.

These specialties are Radiator Traps; Float and Thermostatic Traps; Air Line Valve; Return Traps; Medium Pressure Traps; Packless Radiator Valves; Pressure Reducing Valves; Vacuum Pumps; Vacuum Pump Governors; Air Eliminators; Air Check; Oil Separators; Suction Strainers; Air Vents; Damper Control; Gauges.



Section View of No. 1 Trap

Dunham Radiator Trap

The Dunham Radiator Trap first put into service in 1903 completely revolutionized Steam Heating.

The Dunham Thermostatic Trap consists of two major parts, a body, and a cover. In the cover the operating member, the Dunham Thermostatic Disc, is securely placed. It has an exceptionally large valve opening. There are no detached loose parts in the path of flow, no sliding contacts to gum up, and no guide or pin to obstruct the valve opening or cause the valve to wear unevenly. The position and design of the valve is such that it is self-cleaning, and the closing of the trap will be tight even where the water is high in incrustants which deposit on the interior of the piping. The action of the disc is positive and the floating valve seats squarely, like a globe valve. The body is standardized, also the cover and disc, giving the further advantage of interchangeable parts.

The traps conform with the standard dimension of 3¼ in. from center of trap to end of union nipple, as adopted by The Heating and Piping Contractors' National Association for one-half in. radiator traps.

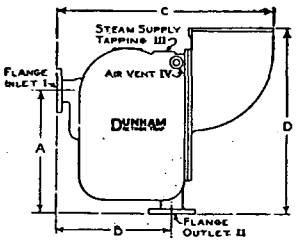
The working part of the Trap, the Thermostatic Disc, is fully exposed to the actual conditions within the radiator and it, therefore, responds instantly to any change taking place therein, preventing waste of unused steam, backing up of water and air binding.

It is made in five sizes and for varying pressures not to exceed 10 lb. gage.

These traps are used principally in steam heating work where they are attached to all forms and types of radiation, and to steam piping and risers for dripping purposes. The Nos. 1 and 2 Traps are used almost exclusively on radiators. The No. 3 Trap is used for large radiators, for medium sized pipecoils, and is particularly adaptable for dripping risers and short runs of steam piping. The Nos. 4 and 5 Traps are used where traps of large capacity are required on large pipe coils, for dripping main feed risers, and steam mains.

DUNHAM RETURN TRAP

Used to separate the air and water discharged into the dry return piping by the Radiator Traps, to release the air, and to automatically return the water to the boiler. For use on installations where the boiler steam pressure does not exceed 10 lb. gage.

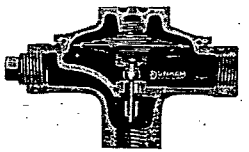


Size No.	Capacity Sq. Ft. Div. Radiation	Size of Connections, inches				Dimensions, inches				Width Over All
		I	II	III	IV	A	B	C	D	
9A	2700	1½	1½	1	½	13⅝	11¼	22⅝	20⅛	9
10	4000	2	2	1	½	14½	14½	25¼	21¼	9⅜
11	7000	2½	2½	1½	¾	16¼	15	28⅞	26¼	17½
12	12000	3	3	2	¾	16⅜	22⅜	36⅞	26¼	18¾

The above capacities are based upon a minimum distance of 6 in. between bottom of trap and water line of boiler. The capacities increase as this distance above water line increases. Further capacities upon request.

DUNHAM MEDIUM PRESSURE TRAP

This embodies the principle so successfully used in the Dunham Radiator Trap, and is just as simple and satisfactory.

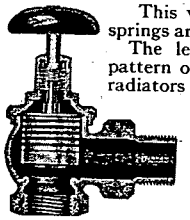


Size	Pipe Connection, In.	Capacity, Water per Hour, Lb.
No. 13	½	100
No. 14	¾	200
No. 15	1	400

Always state operating pressure when ordering.

Designed for steam pressures higher than those used in heating systems. It handles air and condensate. Adapted for process work, hospital sterilizers and distilling apparatus, steam tables and kitchen equipment where a steam pressure of from 0 to 60 lb. is used.

Dunham Packless Radiator Valve

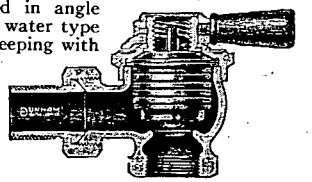


Type 140—Wheel Handle

This valve is really "packless." Neither packing of any kind nor any springs are used in its construction. It is built in two specific styles.

The lever handle valve is furnished in angle pattern only and recommended for hot water type radiators with top inlet connection in keeping with the most approved modern steam heating practice. The low bonnet is one of the attractive features of the valve.

The wheel handle valve can be used on any steam system and is furnished as follows: angle pattern, straightway pattern, right hand pattern and left hand pattern.



Type 100—Lever Handle

Only the best of materials are used. Both types are neat in appearance, and are quick opening and closing valves.

The valve is made packless by means of the bellows construction, consisting of a series of corrugated phosphor bronze diaphragms which permit the free up and down movement of the spindle and valve disc. This construction obviates the use of springs, packing or stuffing boxes of any kind and entirely prevents the leakage of steam, air or water.

Made in following sizes: Lever ½, ¾, 1, 1¼, 1½ in. Wheel ½, ¾, 1, 1¼, 1½, 2 in.

Type 100 made only in angle pattern.

Type 140 made in angle, straightway and corner patterns and can be supplied with wheel or lever handle.

The valves can be supplied with lock and shield, and special extension stems for use on radiators behind grilles, seats, etc., or on ceiling of the room.



1
Trap No. 1

No. 1. All Patterns
Tapping ½"; Capacity 100 sq. ft. Rad.

No. 2. All Patterns
Tapping ½"; Capacity 350 sq. ft. Rad.



2
Trap No. 2

No. 3. All Patterns
Tapping ¾"; Capacity 800 sq. ft. Rad.



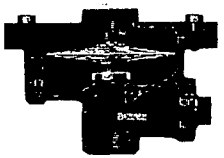
3
Trap No. 3

No. 4. Angle and Straightway
Tapping ¾"; Capacity 1500 sq. ft. Rad.



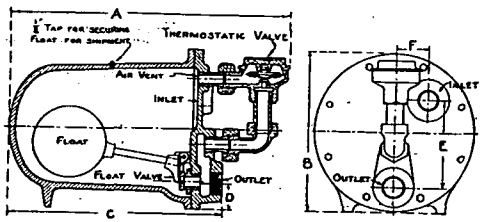
4
Trap No. 4

No. 5. Angle and Straightway
Tapping 1"; Capacity 3000 sq. ft. Rad.



5
Trap No. 5

DUNHAM FLOAT AND THERMOSTATIC TRAP

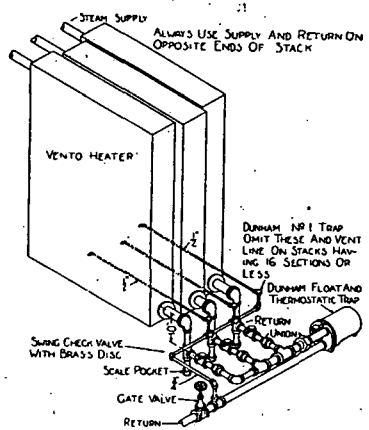


These traps handle large volumes of water and sudden calls for maximum duty. They open automatically for water and air and close for steam. They are suitable on either gravity or vacuum heating systems. The water is handled by the float operated valve which is so constructed that the opening is always sealed with water with no opportunity for steam leakage. The air is handled by the thermostatic valve. They combine the Dunham Thermostatic Principle with the float. They automatically open for air and water and close for steam. This trap adjusts itself slowly like a thermometer to the temperature conditions present and permits a continuous flow, at a rate within its capacity limits, to keep the heaters free from air and water, without waste of steam.

They may be applied to any type or make of cast iron or pipe coil blast heater. They are unsurpassed for dripping low-pressure steam mains and risers, vento heaters, unit heaters, blast coils, domestic hot water heaters, dry kilns, milk condensers, evaporators, paper machines and any industrial heater in which low-pressure steam (not exceeding 10 lbs. gauge) is used as a heating medium.

This type of trap not only drains the heater of its water of condensation but automatically releases the air, thus obtaining as nearly 100 per cent heating efficiency as may be obtainable, which results in the operation of the equipment at its maximum potential output.

In many industrial processes, it is desirable to operate on a vacuum, a condition that is fully met in this type of trap.



Typical connections using Thermostatic and Float Trap on a Vento Heater

Size	Pipe Connection. In.	Capacity. Direct Radiation. Sq. Ft.
No. 22	¾	3,000
No. 23	1	4,000
No. 16	¾	6,000
No. 17	1	7,000
No. 18	1¼	9,000
No. 19	1½	11,000
No. 20	2	16,000

Dunham Pressure Reducing Valve

Made only in standard weight for a pressure range of 125 lb. down on high side, to 10 lb. and atmosphere on low side, in straight and expanded outlet patterns.

Dunham Vacuum Pump Governor

Used on steam driven vacuum pumps to control vacuum in vacuum return lines. Made in all sizes from ½ to 2 in., inclusive.

Dunham Damper Control

The Dunham Diaphragm Damper Regulator controls the steam pressure in ounces. It operates check and draft damper with chains.

Dunham Air Eliminator

Used in connection with the Dunham Home Heating System for venting the air from the system. Two types. Capacities respectively 2000 and 6000 sq. ft. radiation.

Dunham Oil Separator

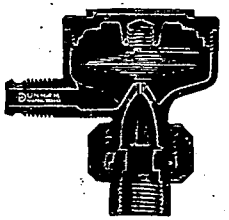
Made in all sizes from 1½ to 6 in. Flanged connections.

Dunham Strainer

Has a large brass screen basket for catching and holding the dirt; easily accessible for cleaning and at once commends itself for this purpose. Made in all sizes from ¾ to 6 in.

Dunham Air Line Valve

The principle of operation is identical, and design similar, to the Dunham Radiator Trap. Its efficiency is high, and service in connection with air line systems invaluable. Can be furnished with either ⅛ or ¼-in. radiator connection. Air piping is required in connection with its use. It must not be subjected to steam pressures exceeding 10 lb. gage.



Dunham Air Line System

This is a one-pipe steam system using a Dunham Air Line Valve on each radiator, with a system of air line piping which may discharge the air by gravity, or be attached to an air line Vacuum Pump. This system is particularly adaptable in making old one-pipe heating systems more efficient. It is easily and economically installed, and insures the quick removal of air from the radiators.

The Dunham Home Heating System

This is specially for the home or small building. It uses steam at very low pressure. Steam is admitted into the radiator by the Dunham Packless Radiator Valve, where it is retained by the Dunham Radiator Trap until it has given off its heat, when, as water, it passes through the trap together with the air, and back to the boiler through the return piping. The air is released by the Dunham Air Eliminator, and the water returns naturally to the boiler. The design is such that a partial vacuum can be obtained on receding fire, with water continuing boiling. Hot water pattern radiators with top inlet connections are required. The end of each steam main is vented through a Dunham Trap into the return piping, and is dripped through wet or dry drip pipe directly back to the boiler return header.

The Dunham Return System

This System differs from the Home Heating System in that it makes use of the Dunham Return Trap in place of the Dunham Air Eliminator, which introduces the added feature of a positive automatic return of water to the boiler when it is desired to raise the steam pressure.

The feature of a positive return under varying steam pressures makes this Dunham System particularly adaptable to apartment houses, small hotels and medium size commercial buildings, schools and churches. This System makes possible the modernizing of old one-pipe and two-pipe gravity systems, and eliminates the sputtering, leaking air valves which are such trouble makers in these old heating jobs.

The Dunham Vacuum System

Simplicity is the key note of Dunham design. There is the system of steam mains and piping to supply all radiation, and the return piping to carry away the air and water of condensation by means of a vacuum pump. Steam may be supplied direct from boiler, or through a Dunham Reducing Valve, where boiler pressure is too high for direct service. Or exhaust steam may be used, supplemented by live steam through a Reducing Valve.

Bulletins

Bulletins of standard architectural size with detailed information covering each System, and all products, including roughing-in dimensions, will be furnished on request.

The Fulton Company

Knoxville, Tennessee

NEW YORK
Hudson Terminal Bldg.
50 Church Street

PHILADELPHIA
Drexel Bldg.
4th and Chestnut Streets

SALES OFFICES:
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Book Bldg., Washington Boulevard
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CHICAGO
Wrigley Bldg.
Michigan Boulevard

BOSTON
Federal Bldg.
136 Federal Street

Patentees and manufacturers of Sylphon products. Sylphon Automatic Air and Vent Valves; Packless and Leakless Valves, Thermostats for regulating temperatures of homes by warm air furnaces, steam, vapor or hot water boilers; Temperature and Pressure Regulators, Temperature Regulating Radiator Covers; and other Heating Specialties.

Advantages

All Sylphon devices embody the seamless, one-piece bellows of drawn metal shown at right. There is not a bit of solder throughout its length—no chance for leaks or breaks. It is a feature found exclusively in Sylphon Products. Sylphon diaphragms or bellows are made in sizes ranging from 1⅛ to 12 in. O. D.

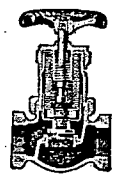


Sylphon

No. 304 Standard Pressure Packless Valve

A special alloy Sylphon bellows surrounds the stem and turning parts, forming an ever-tight barrier to leakage of steam around the stem, *no packing*, hence no need of repacking.

This valve is largely used for hazardous liquids and is approved by the Underwriters' Laboratory (No. M. H. 988.) Made in valve sizes ½ in. to 2 in. inclusive. For pressures up to 150 lbs.



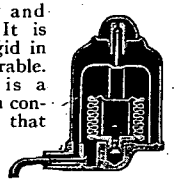
Cut Open View

SPECIFICATION—Install where shown on plans, a Sylphon Standard Pressure Packless Valve, as manufactured by The Fulton Company, Knoxville, Tenn., known as No. 304. Size (state size).

No. 536 Sylphon Radiator Air Valve

An improved radiator air valve with large thermostat and float which renders it extremely powerful and positive in action. It is pleasing in design, rigid in construction and durable.

The thermostat is a Sylphon bellows which contains a volatile liquid that expands when steam reaches it, closing the port. It will not buckle or distort, and will never lose its efficiency. Has ample movement, thus insuring tight closing of valve. Ask for Bulletin RAV-3



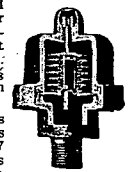
Cut Open View

SPECIFICATION—All radiators shall be equipped with No. 536 Sylphon Radiator Air Valves, as manufactured by The Fulton Company, Knoxville, Tenn., to be installed according to standard practice governing the venting of radiators.

No. 527 Quick Vent Valve

For venting mains, long runs of pipe, indirect stacks, drop risers, and all low-pressure steam jobs where a large amount of air must be expelled quickly.

Vents entire piping system and thereby heating radiators quicker under less pressure. No adjustment. Does not close against water. Venting port ⅛ in. diameter. Valve connection ⅜ in. pipe thread. Ask for Bulletin RAV-3.



Cut Open View

SPECIFICATION—The ends of long runs of pipe, risers or loops shall be vented with a No. 527 Sylphon Quick Vent Valve, as manufactured by The Fulton Company, Knoxville, Tenn.

No. 410 Sylphon Air Line Valve

An automatic, non-adjustable air line valve that will silently expel air and condensation, but close against steam. Has as its basic principle the Sylphon thermostat, which will quickly and effectively distinguish between steam and air, freely allowing the air and condensation to pass, but preventing the passage of steam. This means that every inch of radiating surface becomes 100 per cent efficient. Ask for Bulletin RAV-3.

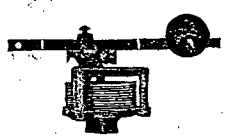


Cut Open View

SPECIFICATION—All radiators to be equipped with Sylphon Air Line Valves known as (either No. 410 or No. 410-A), as manufactured by The Fulton Company, Knoxville, Tenn.

No. 22 Steam Damper Regulator

Used to control the dampers on steam heating boilers. A simple, accurate regulator which will control the draught so as to maintain a constant steam pressure up to 5 lb. This regulator is sensitive, positive in action and will last a life time, due to the Sylphon one-piece, seamless, solderless, flexible metal bellows which it contains. Ask for Bulletin RD-3.



SPECIFICATION—The boiler shall be equipped with a No. 22 Sylphon Steam Damper Regulator, as manufactured by The Fulton Company, Knoxville, Tenn., and installed in accordance with instructions of the manufacturer.

No. 22 Junior Steam Damper Regulator

This Regulator is identical in construction with No. 22 except that it contains a smaller Sylphon bellows as its diaphragm and is therefore suitable for small steam boilers or those having light dampers which do not require much power for their operation. Will maintain a constant steam pressure up to 8 lbs. gage.

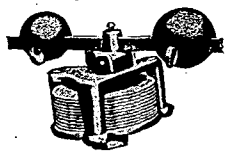


Ask for Bulletin RD-3

SPECIFICATION—The boiler shall be equipped with a No. 22 Junior Sylphon Steam Damper Regulator, as manufactured by The Fulton Company, Knoxville, Tenn., and installed in accordance with instructions of the manufacturer.

No. 924 Steam Damper Regulator

For low pressure steam boilers where extra sensitiveness and greater power are required to operate the damper. Is identical in construction with No. 22 except that it contains a larger Sylphon bellows as its diaphragm, and distance between rocker pivot and plunger pivot is greater. Will operate with pressures up to 3 lbs. gage.

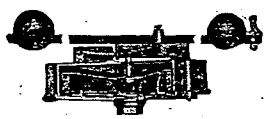


Ask for Bulletin RD-3

SPECIFICATION—Boiler shall be equipped with a No. 924 Sylphon Steam Damper Regulator as manufactured by The Fulton Company, Knoxville, Tenn., and installed in accordance with instructions of the manufacturer.

No. 925 Vapor Damper Regulator

Specially designed to control dampers on boilers used with vapor heating systems. Extremely powerful and sensitive. Has extra large flexible Sylphon bellows as diaphragm. One ounce change in vapor pressure produces a 6¼ lbs. force to open or close dampers. Operates from 2 ozs. to 1 lb. gage, perfectly smoothly and will not "flutter" under any condition.

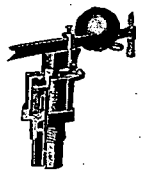


Ask for Bulletin RD-3

SPECIFICATION—The boiler shall be equipped with a No. 925 Sylphon Vapor Damper Regulator, as manufactured by The Fulton Company, Knoxville, Tenn., and installed in accordance with instructions of the manufacturer.

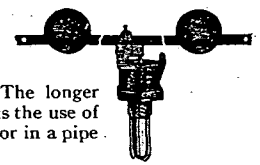
No. 45-A Hot-Water Damper Regulator

Used to control the dampers on hot water heating boilers. Simple, accurate regulators which will control the draft so as to maintain a constant temperature of the water at any point between 120 deg. and 220 deg. fahr. They prevent the temperature of the water from rising higher than necessary, insuring faucet water of even temperature every hour of the day. Installed on domestic hot-water heaters they prevent the generating of steam in the system, thus eliminating the disagreeable sputtering and blowing off when the faucet is open. Ask for Bulletin RD-3



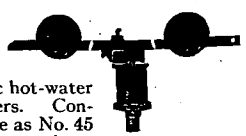
No. 45 Hot-Water Damper Regulator

Same as No. 45-A except bulb is 4 in. instead of 2 in. long and rocker does not have adjustment. The longer bulb permits the use of this regulator in a pipe fitting.



No. 46 Hot-Water Damper Regulator

This regulator with bulb 1 in. long, is designed especially for small hot-water heating boilers, or those having light dampers, also, domestic hot-water supply heaters. Construction same as No. 45 except that it contains a smaller Sylphon bellows as its diaphragm, as it requires less power to operate the light dampers of such heaters. Also suitable for laundry heaters, garbage burners, garage heaters, etc.

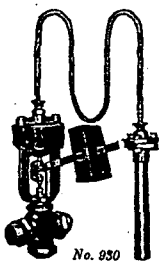


Ask for Bulletin RD-3

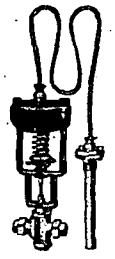
SPECIFICATION—(Boiler, heater, or tank heater) shall be equipped with a No. (45, 45-A, 45-B or 46) Sylphon Hot-Water Damper Regulator, as manufactured by The Fulton Company, Knoxville, Tenn., the regulator to have a temperature range of (specify temperature range. No. 45 and 45-A have temperature range of 120 deg. to 220 deg. fahr.; No. 45-B has temperature range of 100 deg. to 200 deg. fahr. No. 46 has temperature range of 130 deg. to 200 deg. fahr.) and to be installed in accordance with instructions furnished by the manufacturer.

No. 930 and No. 931 Temperature Regulators for Control of Liquids

Used to automatically control temperatures of liquids heated by steam, and especially for hot-water supply tanks in apartments, hotels, clubs, etc., and regularly furnished with a temperature range of 140° to 180° F. Special regulators can be furnished with adjustment for 20° above or below the operating point for temperatures not lower than 20° nor higher than 310° F.

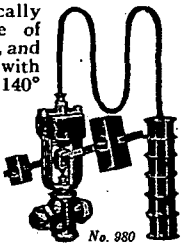

No. 930

No. 930 has lever and weight method of adjustment; No. 931 has spring type. The extreme sensitiveness, positive action and simplicity of these regulators place them in a class by themselves and make them applicable in many ways. No. 931 is made in valve sizes ½ in. to 2½ in. incl. and No. 930 in sizes ½ in. to 8 in. incl.


No. 931

No. 980 and No. 981 Temperature Regulators for Control of Air

Used to automatically control temperature of air in dry rooms, etc., and regularly furnished with temperature range of 140° to 180° F. Other ranges upon application. The thermostatic bulb, of our special "star-shaped" design, gives greatest area of exposed surface to mass of any design known. It may be placed at any point in room, and is connected with operating valve by a flexible tube of required length.


No. 980

Furnished in either lever and weight type (No. 980), or spring adjusting type (No. 981). No. 980 is made in valve sizes ½ in. to 5 in. incl. and No. 981 in sizes ½ in. to 2½ in. incl.


No. 981

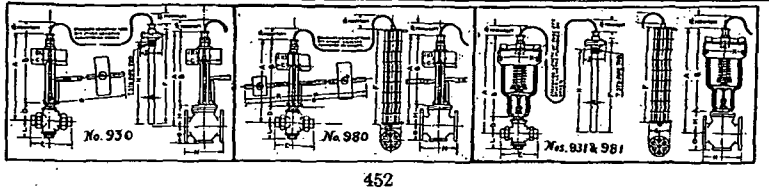
Valves—Double-seated, balanced type, bronze disc and seats. Bronze bodies fitted into bronze unions, in sizes ½ in. to 1½ in. incl. Sizes 2 in. and above have iron bodies, bodies flanged and drilled standard. Companion flanges furnished at extra cost. **Flexible metal tubing** 8 ft. long. Supplied longer on order.

Upon application a chart will be furnished showing how to determine size of regulator needed for any given condition. Ask for chart and Bulletin TR-5.

SPECIFICATION—Install where shown on plans, a Sylphon Temperature Regulator (No. 930, or No. 931 or No. 980, or No. 981) as manufactured by The Fulton Company, Knoxville, Tenn.; regulator to have a temperature range of (specify temperature range) and to be of the following size (specify size of valve), for steam pressure of — lbs.

Principal Dimensions, Prices, Etc., of No. 930, No. 931, No. 980 and No. 981 Sylphon Temperature Regulator

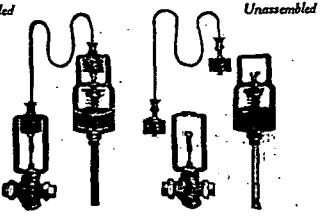
Valve Sizes, Inches	½	¾	1	1¼	1½	2	2½	3	3½	4	5	6	8
List prices 930	$60	$65	$70	$75	$80	$ 90	$ 95	$100	$110	$120	$175	$225	$275
List prices 931	$60	$65	$70	$75	$80	$ 90	$ 95						
List prices 980	$70	$75	$80	$85	$90	$100	$110	$125	$140	$150	$225	...	...
List prices 981	$70	$75	$80	$85	$90	$100	$110					...	...
Bulb thread IPS 930	1"	1"	1"	1"	1"	1¼"	1¼"	1¼"	1¼"	1¼"	1¼"	2½"	2½"
Bulb thread IPS 931	1"	1"	1"	1"	1"	1¼"	1¼"					...	...
Bulb length 930	16"	16"	16"	16"	16"	16"	16"	24"	24"	24"	24"	24"	24"
Bulb length 931 and 981	16"	16"	16"	16"	16"	16"	16"					...	...
Bulb length 980	16"	16"	16"	16"	16"	16"	16"	16"	16"	16"	16"	...	...
Lever bar length 930	24"	24"	24"	24"	24"	24"	24"	36"	36"	36"	36"	36"	36"
Lever bar length 980	41"	41"	41"	41"	41"	41"	41"	43"	43"	43"	43"	...	...
Height A+L 930	14⅞"	15¼"	16⅛"	17⅛"	17⅜"								
Height A+O 930						19⅜"	20⅜"	23½"	24⅓"	25⅓"	27⅓"	29⅓"	31¾"
Height A+L 931 and 981	18½"	18⅞"	19¼"	20¼"	20¼"								
Height A+O 931 and 981						21⅛"	22⅛"	...	...	...	...	...	...
Height A+L 980	14⅞"	15¼"	16⅛"	17⅛"	17⅜"								
Height A+O 980						19⅜"	20⅜"	23½"	24⅓"	25⅓"	27⅓"	...	...
Face to face 930	(E) 5⅛"	(E) 5⅞"	(E) 6½"	(E) 7¼"	(E) 8⅛"	(N) 7"	(N) 7¼"	(N) 8⅛"	(N) 9½"	(N) 10¼"	(N) 12¼"	(N) 14¼"	(N) 18½"
Face to face 931 and 981	(E) 5⅛"	(E) 5⅞"	(E) 6½"	(E) 7¼"	(E) 8⅛"	(N) 7"	(N) 7¼"						
Face to face 980	(E) 5⅛"	(E) 5⅞"	(E) 6½"	(E) 7¼"	(E) 8⅛"	(N) 7"	(N) 7¼"	(N) 8⅛"	(N) 9½"	(N) 10¼"	(N) 12¼"	...	...
Width incl. { Q 980	26"	26"	26"	26"	26"	26"	26"	27⅛"	27⅛"	27⅛"	27⅛"	...	...
Lever bar { R 980	14⅝"	14⅝"	14⅝"	14⅝"	14⅝"	14⅝"	14⅝"	15½"	15¼"	15¼"	15¼"	...	...



No. 932 Temperature Regulator

Detachable Tube Type: This is the latest development in self-contained regulators, and on account of its flexibility of installation is very popular with the heating trade. This regulator is composed

Assembled *Unassembled*

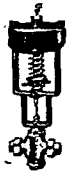


of three distinct and separable units: valve, bulb, tubing. Each unit may be separately installed, removed or replaced as the case may be. If the flexible tubing should become damaged or broken, the power transmitting unit may readily be replaced by loosening two lock nuts, and the repair part slipped into place. Movement is transmitted by liquid pressure acting between two small Sylphon bellows and is frictionless. Liquid is non-freezing.

These features are patented and possessed by no other regulator on the market. One transmission unit fits all regulators having valve sizes ½ in. to 1¼ in. inclusive; another unit for valves 1½ in. to 4 in. inclusive. Ask for Bulletin TR-5

SPECIFICATION—Install where shown on plans for control of water temperature No. 932 Sylphon Temperature Regulator as manufactured by The Fulton Company, Knoxville, Tenn.; the regulator to have a temperature range of (specify temperature range), and to be of the following size (specify the size of valve), with steam pressure of — lb.

No. 952 Sylphon Pressure Regulator



This regulator, for controlling the pressure of steam, air, and other gases, has as its operating medium a Sylphon bellows. The extreme sensitiveness of this bellows makes it possible to reduce pressure to as low as 2 lbs. It has a ball and spring adjustment such as is used in our No. 931 temperature regulator. With this regulator, it is possible to take the controlling pressure from any desired point. Made in valve sizes ½ in. to 4 in. inclusive. Ask for Bulletin TR-5

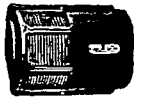
RANGE OF OPERATION

Regulator	Valve Size	Initial Pressure	Reduced Pressure
No. 952	½"–4"	50	25
No. 952-A	½"–2½"	150	25
No. 952-B	½"–2½"	150	40
No. 952-C	½"–1½"	150	100

SPECIFICATION—Install where shown on plans a Sylphon Pressure Regulator as manufactured by *The Fulton Company, Knoxville, Tenn., known* as No. 952. Size (state size) to reduce from — lb. steam (or water) pressure to — lb.

Sylphon Regitherm

The most powerful room thermostat on the market. Requires no electricity, compressed air or clockwork to operate. Responds to slight changes in temperature of air and is used to control valves, dampers and shutters. Works smoothly, never by jerks and is noiseless in operation. Requires no attention. Standard range 60 deg. to 80 deg. fahr. It is largely used in offices and industrial plant work rooms. Small and neat in appearance, being 6 in. wide by 7½ in. long. Ask for Bulletin RR-3



SPECIFICATION—Install as shown on plans for the control of room temperature Sylphon Regitherm as manufactured by The Fulton Company, *Knoxville, Tenn.; known* as No. 15, the Regitherm to have a temperature range of (specify temperature range—60 to 80 deg. fahr. is standard), and to be installed in accordance with instructions furnished by the manufacturer.

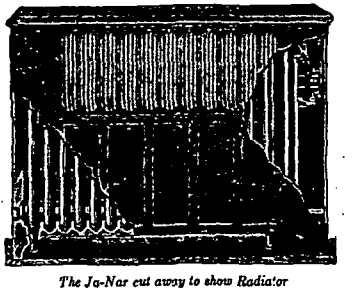
The Ja-Nar Radiator Cover

Made of fine furniture steel, lined with heat insulating material. Completely covers either high or low hot water and steam radiators. Can be installed in old homes as easily as in new. Furnished in light or dark oak, mahogany, walnut and various tinted enamels, or to match any interior wood work.

Furnished in three types: 1st, Automatic Temperature Control; 2nd, Manually Operated Temperature Control; 3rd, Uncontrolled Type.

The controlled type Ja-Nar Radiator Cover is equipped with a thermostatic device which opens or closes the shutters to regulate the heat sent out into the room. This is absolutely automatic in operation and can be set to operate at any comfortable temperature desired.

Ask for Pamphlet on the Ja-Nar



The Ja-Nar cut away to show Radiator

SPECIFICATION—Install where shown on plans, a Ja-Nar Radiator Cover as manufactured by The Fulton Company, Knoxville, Tenn. The contractor will furnish to The Fulton Company information as to size of radiator and other measurements necessary to build the Ja-Nars. (Specify finish for each room. State whether Ja-Nar Radiator Covers are to be of automatic control type, hand control type or uncontrolled type.)

"Specification Data"—Send for our "Specifications of Value" which gives complete engineering data in regard to the above products.

Hoffman Specialty Co., Inc.

Waterbury, Conn.

GENERAL SALES DEPARTMENT

25 West 45th Street :-: NEW YORK, N. Y.

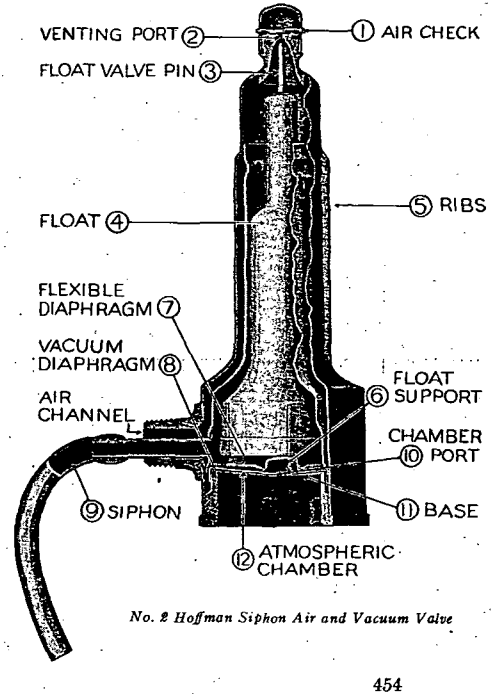
Hoffman Valves and Controlled Heat Equipment

HOFFMAN VENTING VALVES

In the Hoffman line there is a specially designed venting valve for every type of steam heating system. The basic principle used in the design of all Hoffman venting valves is that of an all-metal thermostatic member, with one or more flexible diaphragms, containing a volatile or heat sensitive fluid which causes valve action upon slight temperature changes.

Hoffman valves have a wide pressure range in which they operate with the same degree of accuracy, for the internal fluid pressure in the thermostatic member maintains a constant relationship with the external steam pressures throughout the whole range of pressure for which each valve is intended.

Hoffman valves are automatic, non-adjustable and guaranteed to properly function for a period of five years from date of installation when installed and operated under normal conditions for which designed.



No. 2 Hoffman Siphon Air and Vacuum Valve

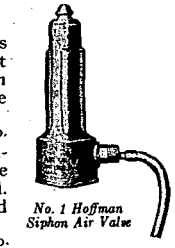
HOW THE NEW HOFFMAN No. 2 VACUUM VALVE OPERATES

NORMALLY venting port (2) through which air escapes is wide open until steam comes in contact with the float (4). Then the heat sensitive fluid in the float, the thermostatic member, is changed to gaseous state expanding the flexible diaphragm (7), raising the float and closing vent port.

If the radiator is shut off or for any reason steam contact ceases, the diaphragm contracts, and the float drops. But no air can re-enter the valve because the air check (1) makes the port a one-way street—air can go out but none can come back. So with the continuation of condensation of steam and prevention of air return, a vacuum is formed in the system. Atmospheric pressure exerted through chamber port (10) causes diaphragm (8) to lift the float (4) and keep port closed.

In other words, the air check acts as a vacuum starter, prevents return of air for a short period until the vacuum formed in the valve permits atmospheric pressure, acting through port (10) to force diaphragm (8) upward, raising the float and doubly closing the vent port.

ALL METAL—NON-ADJUSTABLE—THERMOSTATIC



No. 1 Hoffman Siphon Air Valve

The No. 1 Hoffman Siphon Air Valve is designed for systems of the one-pipe gravity type, to vent all air from radiators without loss of steam. After contact of water with the valve the siphon drains all water from the valve and venting occurs without the slightest "spit" even if the radiator is under pressure.

Radiator connection, ⅛ in. Maximum guaranteed operating pressure, 10 lb.

The No. 2 Siphon Air and Vacuum Valve is similar in construction to the No. 1, but in addition, when the radiator is once freed from air, return of air through the vent port is prevented. Through its use an ordinary one-pipe steam system may be changed into a vacuum type.

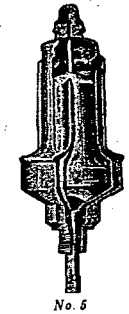
Radiator connection, ⅛ in. Maximum guaranteed operating pressure, 10 lb.

The No. 3 Hoffman Air Line Valve is specially designed for Air Line, or as they are frequently termed "Paul" Systems. It is sensitive in action and closes the instant steam fills the radiator.

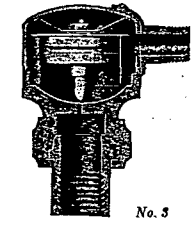
Radiator connection, ⅛ in.; Air Line connection, ¼ in. Maximum guaranteed operating pressure, 10 lb.

The No. 4 is used in venting mains, risers, vento stacks, coils, etc. All air is freely vented through a ⅛ in. vent port without steam loss, but valve does not close against water.

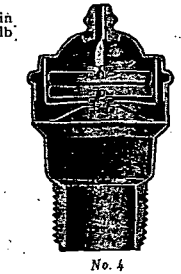
Standard connection, ¾ in., can also be supplied with ¼ in. connection. Maximum guaranteed operating pressure, 10 lb.



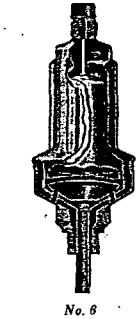
No. 5



No. 3



No. 4

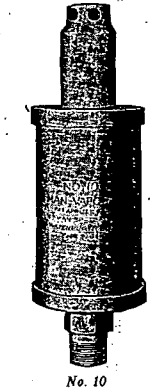


No. 6

The No. 5 is particularly adapted for use in venting: Ends of steam mains; Ends of dry return mains; Indirect radiators; Blast or "Vento" stacks; Hot-water generators; Dryers and drums, etc.

The basic principle is the same as the No. 1 Valve, having separate channels for air and water which are only found in Hoffman Valves.

Pipe connection, ⅜ in.; vent port for less than 3 lb. is ⅝ in.; for 3 lb. and over is ½ in. Unless otherwise ordered, will be shipped with ⅝ in. port. Maximum guaranteed operating pressure, 10 lb.



No. 10

The No. 6 is similar in design and application to the No. 5 with the additional feature of the Air Check or Vacuum starter above vent port and vacuum diaphragm in base.

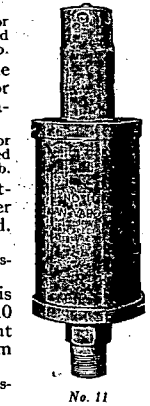
Pipe connection, ⅜ in.; vent port for less than 3 lb. is ⅝ in.; for 3 lb. and over is ½ in. Unless otherwise ordered, will be shipped with ⅝ in. port. Maximum guaranteed operating pressure, 10 lb.

The No. 10 Hoffman Vapor Valve is used for venting the return mains in vapor systems or for other conditions where a large venting capacity is required. The vent port is ¾ in. in diameter.

Pipe connection, ¾ in. Maximum guaranteed operating pressure, 15 lb.

The No. 11 Hoffman Vapor Vacuum Valve is similar in construction and application to the No. 10 valve with the addition of a vacuum check on the vent port which prevents the return of air to the system through the vent port.

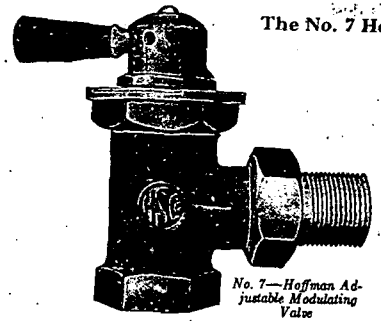
Pipe connection, ¾ in. Maximum guaranteed operating pressure, 15 lb.



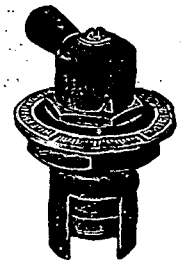
No. 11

HOFFMAN "CONTROLLED HEAT" EQUIPMENT

The No. 7 Hoffman Adjustable Modulating Valve



No. 7—Hoffman Adjustable Modulating Valve



Showing Rotary Sleeve



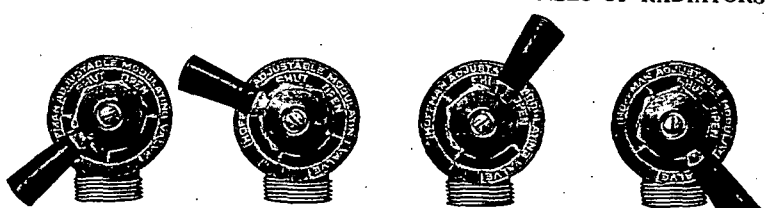
Showing Port Opening

For use in Vapor or Vapor Vacuum systems, is made in ¾ in. size only, having a range of adjustment up to 200 sq. ft. of direct cast-iron radiation.

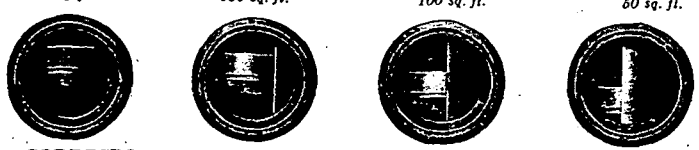
After installation, whether the system is in operation or cold, the port of each valve is adjusted for the size of the radiator to which it is attached. Adjustment is simple; loosen a locknut; turn valve handle until proper number of graduations are visible on the dial plate; *then tighten locknut.* The valve handle may then be moved to admit sufficient steam to heat a quarter, half, three-quarter, or entire radiator. The valve stem stuffing box has a frictionless metallic fibre packing that will last indefinitely and require no attention, giving at the same time, a valve action so free that the pressure of only one finger is required to open the valve.

The No. 7 valve is regularly supplied with lever handle. On special orders, it can be furnished with wood wheel, lock shield, closed top, extension stem and handle, or chain pull.

POSITIONS OF TOP DIAL PLATE FOR VARIOUS SIZES OF RADIATORS

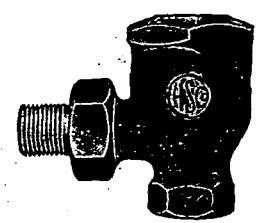


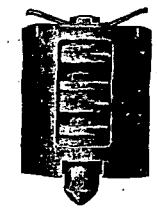
All Graduations exposed 200 sq. ft. | *15 Graduations exposed 150 sq. ft.* | *10 Graduations exposed 100 sq. ft.* | *5 Graduations exposed 50 sq. ft.*



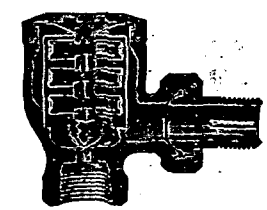
CORRESPONDING POSITIONS OF ROTARY SLEEVE SHOWING PORT AREAS FOR ABOVE GRADUATIONS

The visible adjustment enables the designing engineer and heating contractor to make a final accurate adjustment which compensates for slight irregularities in pipe sizes, failure to ream pipe, installation of extra fittings not forseen in original layout, etc. The advantages of an adjustable port in forced hot water systems to secure proper balance makes the No. 7 Valve especially adaptable for such use.





Interchangeable Thermo Member



Sectional View

The Nos. 8 and 9 Hoffman Return Line Valves

These valves are automatic, non-adjustable, thermostatic and relieve all air and condensation without the loss of steam from radiators, pipe coils, indirect radiation, steam mains and risers, steam kettles, sterilizers and other devices where it is desired to get full efficiency and economy without waste of steam.

In service, they have established a reputation for efficiency and consistency of operation with the same degree of sensitiveness under either high or low pressure.

The body of the valve is made of cast steam metal; cap and tail piece are hot brass forgings; the thermostat of a special Hoffman alloy. In continued operation the thermostats will not break, stretch or lose their tension, giving long life and perfect operation.

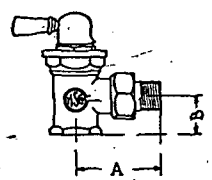
Chief Features

The valve consistently operates under a pressure range from 13 in. of vacuum to 50 lbs. steam pressure. Water at a temperature of approximately 12 deg. less than the temperature corresponding to the steam pressure causes full valve opening and free discharge of condensation.

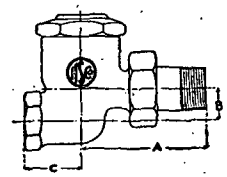
The thermostatic member is removable and may be changed from one valve to another of the same size without adjustment. This feature is appreciated by engineers who require the removal of the thermostat from the valves, until the system is thoroughly cleaned, and likewise by contractors complying with this practice.

The No. 8 Valve has ½ in. pipe connections, ¼ in. port and is furnished in Angle, Straightway, Right and Left-hand Offset Patterns. The normal capacity is 200 sq. ft. of cast iron radiation.

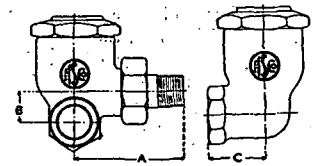
The No. 9 Valve with ¾ in. connection is made in Angle Pattern only, and is suitable for 600 sq. ft. of cast iron radiation. For pressures up to 15 lbs. valve has ⅜ in. port, for higher pressures $\frac{3}{16}$ in. port.



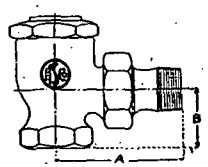
No. 7 Angle Pattern



No. 8 Straightway Pattern



No. 8 Right or Left Offset Pattern

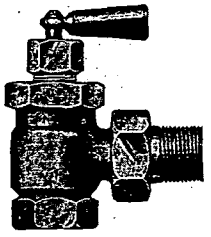


No. 8 or 9 Angle Pattern

DATA AND DIMENSIONS

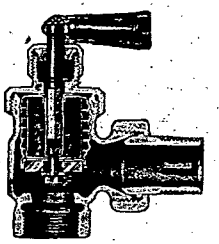
STYLE	Size Inches	Diameter Valve Port Inches	Maximum Capacity Square Feet	DIMENSIONS A	B	C
No. 7 Angle	¾	..	200	2⅛	1⅜	....
No. 17 Angle	¾	..	200	2¼	1½	....
No. 8 Angle	½	¼	200	2⅛	1⅜	....
No. 8 Straightway	½	¼	200	2⅛	1⅜	1⅜
No. 8 Offset	½	¼	200	2⅛	1⅜	1⅜
No. 18 Angle	½	¼	100	2¼	1¼	....
No. 18 Straightway	½	¼	100	2¼	1⅛	1⅜
No. 18 Offset	½	¼	100	2¼	1⅛	1⅜
No. 9 Angle	¾	⅜*	600	3⅛	1⅜	....

*No. 9 Valve furnished with ⅜ in. port for pressures above 15 lb.



The No. 17 Hoffman Radiator Valve

VALVE BODY AND TAIL PIECE—Casting of First Quality Steam Metal.
BONNET—Hot Brass Forging.
STUFFING NUT—Rod Brass.
STEM—Drawn Brass Rod.
LEVER HANDLE—Hard Black Fibre.
DISC HOLDER—Drawn Brass Shell.
DISC—Genuine Jenkins Bros.
PACKING—Special Metallic Fibre.
FINISH—Rough Body, Nickel-Plated.
Made in ¾ in. size only. Capacity 200 sq. ft. C. I. Radiation.

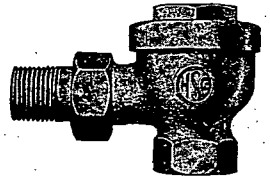


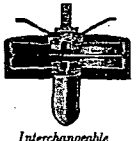
The No. 17 Hoffman Radiator Valve

No. 17 Hoffman Radiator Valve (Quick Opening Valve)

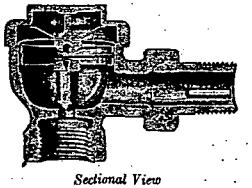
This valve is made in ¾ in. size only, suitable for radiators up to 200 sq. ft.

The valve may be turned from open to shut position or vice versa, with one turn of the lever handle. The valve action is very free, with little friction due to the novel construction of the disc holder and its extension or lead screw for raising and lowering the disc.





Interchangeable Thermo Member



Sectional View

No. 18 Hoffman Return Line Radiator Trap

The thermostat consists of one chamber made by two diaphragms separated by a space ring to which they are fastened. In the center of the bottom diaphragm, the valve pin is attached, the joint being expanded and made absolutely tight. The thermostat is held in its cage by a pin expanded and attached to the top diaphragm, this pin extending through the cage and engaging with the boss on the cap.

The thermostat contains a small quantity of thermostatic fluid, sealed under vacuum insuring extremely sensitive valve action. The fluid is such that its pressure maintains constant relationship with steam pressure and consistency of valve operation under varying pressure is thus obtained.

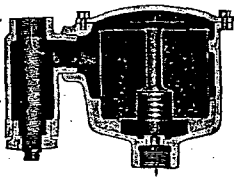
Chief Features

The valve consistently operates under a pressure range from vacuum to 15 lbs. steam pressure. Water at a temperature of approximately 12 deg. less than the temperature corresponding to the steam pressure causes full valve opening and free discharge of condensation.

These valves are absolutely non-adjustable and thermostats can be changed from one body to another.

The No. 18 Valve is made in ½ in. size only in Angle, Straightway, Right and Left-hand and Offset Patterns. Normal capacity is 100 sq. ft. of direct cast iron radiation, port diameter ¼ in. in all sizes, operating pressure from vacuum to 15 lbs.

The No. 12 Hoffman Blast Trap is especially well adapted for draining condensation from:



No. 12 Hoffman Blast Trap

Indirect Radiators	Dryers and Drums
Blast or "Vento" Stacks	Hot-Water Generators
Ends of Steam Mains and Risers	Unit Heaters, etc.

Where the operating pressure is not in excess of 30 lb. this valve will take care of large amounts of condensation.

In functioning it distinguishes between steam, heated air and water of condensation giving free discharge of air and condensation.

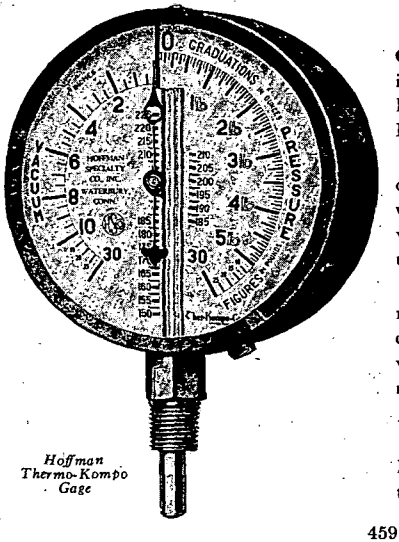
The Trap embodies the desirable feature of open bucket or float traps in that it relieves condensation immediately upon its arrival at the trap regardless of the water temperature. Coupled with the float is a thermostatic member which positively overcomes the chief difficulty with float traps by automatically relieving air as well as condensation from the system.

The normal position of the valve is open and this is held until steam reaches it when closure takes place. If small quantities of condensation flow to the trap the thermostat functions and relieves the water but if larger amounts of condensation, beyond the capacity of the thermostat reach the trap, the float lifts the thermostat from its seat and maximum capacity is obtained.

Table of Nominal Capacities No. 12 Hoffman Blast Trap

Pressure, lbs. per sq. in.	½	1	2	3	4	5
Capacity lbs. per hr.	800	1,000	1,500	1,800	2,000	2,500
Capacity in sq. ft. of radiation on the basis of ¼ lb. of condensation per hr. per sq. ft.	3,200	4,000	6,000	7,200	8,000	10,000

Maximum Operating Pressure, 30 lb. Capacities for over 5 lb. pressure, furnished on application. With Strainer; inlet connection, 1 in.; outlet 1 in. With Strainer; inlet connection, 1¼ in.; outlet, 1 in.



Hoffman Thermo-Kompo Gage

The New Hoffman Ther-Kompo Gage is used on Hoffman Controlled Heat installations or One-Pipe Gravity Steam Heating Systems, equipped with Hoffman No. 2 Vacuum Valves.

It accurately indicates the temperature of the vapor produced in the boiler, whether operating under pressure or vacuum conditions, measuring pressures up to 30 lbs. and vacuum to 30 in.

The Hoffman Ther-Kompo Gage is made in one style only—with pressed steel case, 5 in. diameter dial pressure and vacuum readings in black and temperature readings in red. Pipe connections are ½ in.

When used with the Hoffman Damper Regulator, results in marked fuel economy through more efficient firing of the boiler.

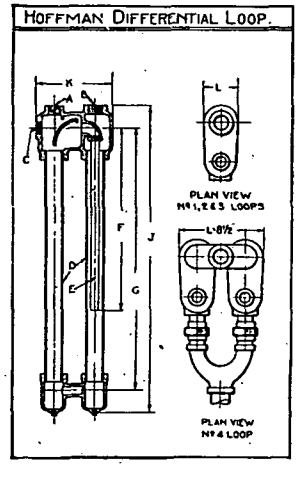


Hoffman Differential Loop

Differential Loop

The Differential Loop is the safety device for maintaining a steady water line in vapor and vapor vacuum systems. It is entirely automatic, non-adjustable and has no moving parts to stick at a critical moment.

Through its use water is permitted to rise in the return main a certain predetermined amount when the loop functions, blowing over a small quantity of steam which closes the No. 10 or 11 Valve installed on the loop for venting the system and then compresses the air which is "bottled up" in the return main and builds up a pressure which prevents further rise of water in the vertical part of the return beyond the predetermined amount. As soon as this is accomplished, and the action is almost instantaneous, the loop reseals and no more steam is blown over until the differential pressure is not maintained. It will be readily seen that, by the alternate blowing over and resealing of the loop, a constant differential pressure will be maintained between the steam main and return main and also that by the maintenance of this differential regardless of how high the boiler pressure goes circulation will take place in a radiator which is turned on with the return main vent closed through loop action.

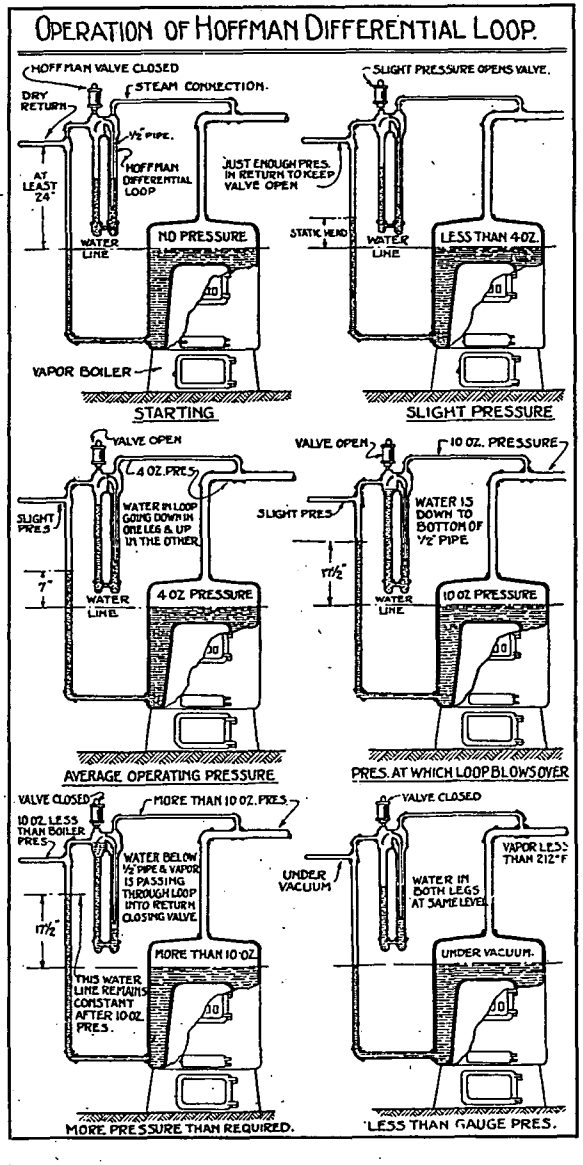


Differential Loops are made in four sizes, having a capacity up to 15,000 sq. ft. of radiation. For larger systems the No. 4 Loops can be installed in a battery or the return mains divided so as to have their load come within the capacity of standard loops.

No. 1 and No. 2 Loops should not be used where the low point in the dry return is less than 24 in. above boiler water line; with the No. 3 and No. 4 Loops this distance must be at least 30 in:

DIMENSIONS AND CAPACITIES OF LOOPS

Loop No.	A	B	C	D	E	F	G	J	K	L	Capacity Sq. Ft. Rad.
1	¾"	1¼"	1¼"	1½"	½"	18¼"	26"	30⅝"	7⅝"	3"	2000
2	¾"	1¼"	1¼"	1½"	¾"	18¼"	26"	30⅝"	7⅝"	3"	3500
3	¾"	1½"	1½"	2"	1"	25"	32"	37¼"	10"	3¼"	7500
4	¾"	2"	2"	2"	1"	25"	32"	37¼"	10"	8½"	15000





Hoffman Damper Regulator

One of the most important features of the Hoffman Damper Regulator is the accurate control that only sufficient pressure is maintained to insure circulation to all radiators.

It is extremely sensitive in its action and accomplishes control so efficiently that when inlet valves are turned on or off, the fire is accelerated or retarded to meet the change in demand for vapor. A low constant pressure is therefore maintained so that vapor enters the radiator as soon as a valve is turned on.

The compensating or balancing plate is like a pair of scales. It is practically frictionless, remarkably sensitive and operates on slight changes in pressure.

It has an additional feature for the convenience of the installing fitter, in that the fulcrum on which the lever is suspended may be turned at different angles, permitting a straight chain connection with the dampers instead of at an angle, which might cause the dampers to bind.

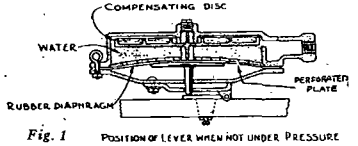


Fig. 1 POSITION OF LEVER WHEN NOT UNDER PRESSURE

Fig. 1 shows Damper Regulator under no pressure. Compensating plate is in its uppermost position, the bottom of the plate being in line with bottom of inlet. The space above diaphragm is filled with water up to the inlet. Weights on lever are to be so placed that they will hold the diaphragm against the perforated plate. Drafts are held open until the predetermined pressure is generated, when through diaphragm action which in turn is transmitted to the lever, drafts are closed.

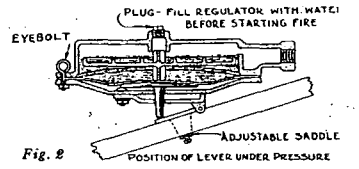
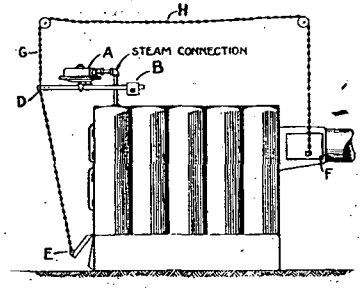


Fig. 2

Fig. 2 shows position of Damper Regulator when drafts are closed. Vapor pressure has overcome upward force exerted by the weights on lever arm and forced diaphragm downward. The water on the diaphragm lowers with it and likewise the compensating plate until top of the plate is level with the bottom of the inlet, thus preventing any addition to the water above the diaphragm. With a slight drop in vapor the weights force the diaphragm upward and drafts are opened.



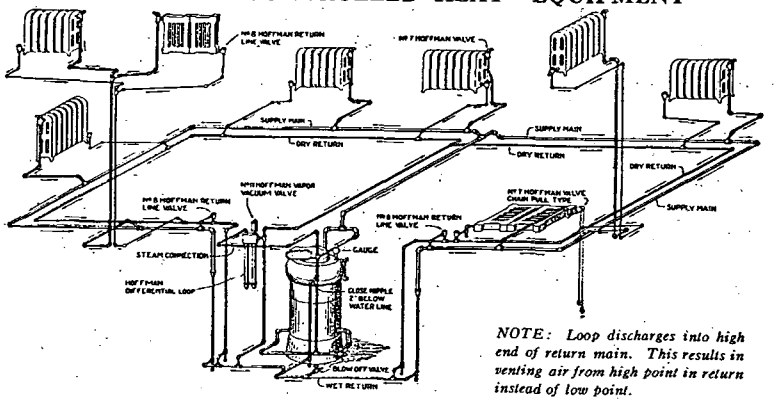
IN MAKING steam connection to boiler, locate Damper Regulator so that chain to "E" and "F" operate freely. Regulator should be set level. Remove plug on top of Regulator and fill with water.

With no pressure on boiler and weight "B" in position on lever, connect chain between "D" and "E" so that draft "E" will be open as wide as required for sufficient draft. Connect "G" over pulley to "F" leaving just enough slack to chain "G" so check draft "F" is closed.

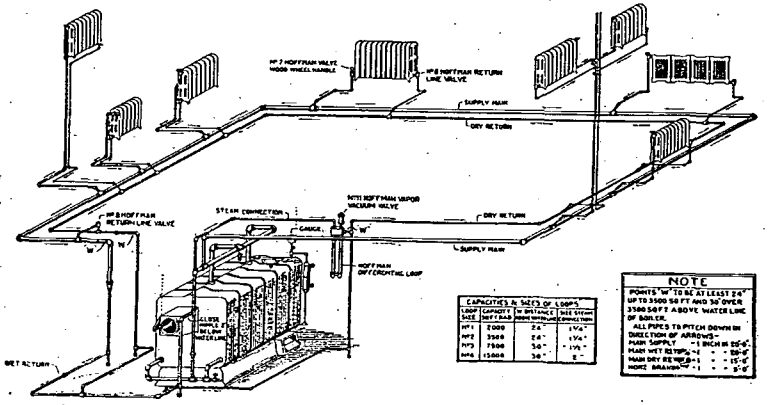
Set weight "B" so lever "D" tilts when steam is raised to pressure to be maintained. If pressure increases, draft "E" will close and check fire. If fire is clean and pressure continues to increase, lever "D" moves downward, opening check draft "F," completely checking fire. As pressure decreases, "F" will *gradually* close and if pressure falls below the desired amount "E" will open.

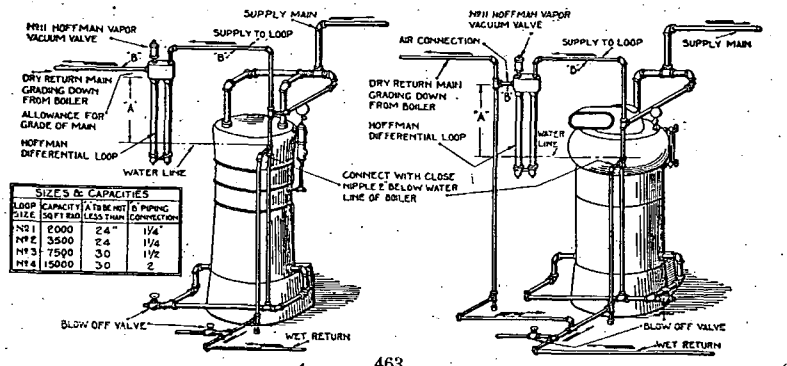
Connections should be made so that draft "E" opens slightly and check draft "F" opens wide.

TYPICAL INSTALLATIONS
HOFFMAN "CONTROLLED HEAT" EQUIPMENT



NOTE: Loop discharges into high end of return main. This results in venting air from high point in return instead of low point.





Illinois Engineering Company

General Offices and Factory: CHICAGO

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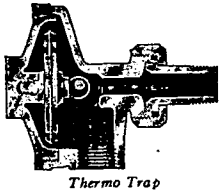
PRODUCTS—Illinois Heating Systems—Eclipse Steam Specialties

Illinois Heating Systems

Successfully installed in thousands of buildings—the result of over 25 years of special work in this line, and the ultimate in efficiency and economy.

Illinois Thermo Trap

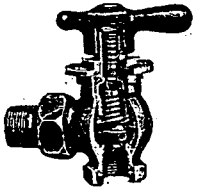
The original vertical seat trap. Dirt does not lie on seat—self cleaning, non-adjustable, positive in operation; durable, will stand 50 lb. steam pressure which shows the great strength of the diaphragm, which is the reason for the long life and durability of these Traps. Thousands in operation for over 12 years without diaphragm replacements.



Thermo Trap

Illinois Modulating Supply Valve

Quick Opening—only a half turn of handle from open to closed position. Packless, Bakelite handle, steam tight on 50 lbs. pressure. Large diameter of thread spool and machine cut threads make valve easy of operation.



Modulating Valve

The improved Bakelite handle insulates the hand from heat.

The graduated dial shows the open or closed or any position of the valve.

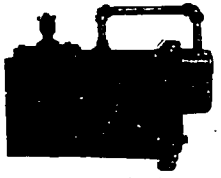
Furnished with Lock Shield and Key, or with Bakelite Wheel handle, upon order.

Illinois Vapor Systems

Illinois Vapor Systems are capable of operating automatically on any pressures possible, in a low pressure heating system—from 10 lb. to 20 in. of vacuum. Our improved equipment actually insures operation under vapor—less than atmospheric pressure—with only two or three firing periods per 24 hrs. The advantages are healthful, modulated heat, and a *fuel saving of 25-30 per cent* over other systems of heating. This result is secured by the ILLINOIS HEATER RETAINOR—Browne Patent, a device which marks an epoch in the heating art.

Illinois Heat Retainor

This improved device not only vents air from the System on ⅛ oz. pressure, but it absolutely prevents air pulling back into the System, thus allowing the System to remain under vacuum for hours at a time.



Illinois Heat Retainer

No dirt or scale can reach the valve of the Retainor, and even the air passing through same is washed, so this device will remain in operative condition over long periods.

Our Bulletin No. 21, describes the operation in detail—Copy sent upon request.

Illinois Return Trap or Alternating Receiver

This device automatically puts the water back in the boiler against any boiler pressure possible in a low pressure heating system.



Illinois Return Trap

The float trips the weights which in turn positively operate the valves. The operation is forceful and positive and this mechanism cannot be caught on dead centre by water half filling the tank. No external parts to be adjusted or tampered with. No stuffing boxes—all working parts enclosed in the tank.

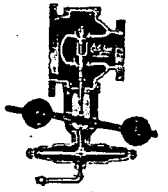
Our Sales-Engineering Organization will be glad to give detailed technical information regarding our products and to advise as to their proper installation.

ILLINOIS PRODUCTS—Eclipse Steam Specialties

Eclipse Steam Specialties

The old John Davis Co. Eclipse Steam Specialties have been on the market for over 35 years, and embody the improvements and refinements suggested by this long period of service. These Specialties are quality products, having bronze and monel metal pistons, seat rings and valve parts, the bodies are extra heavy, and every piece of apparatus is carefully steam tested—under working pressure where same is given—before shipment.

Pressure Reducing Valves, for all pressures and services.
Back Pressure, and *Atmospheric Relief Valves*.
Separators, Oil and *Steam, Cast Iron* and *Steel*.
Steam Traps, all pressures.
Non-Return or *Stop* and *Check Valves*.
Pump Governors, Balanced Valves.
Float Valves, Expansion Joints, Pipe Strainers.



Reducing Valve

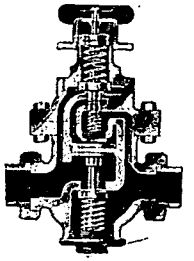
Reducing Valves. In general use on Vacuum or low pressure Heating Systems. Will reduce to 4 oz. pressure from even 150 lb. initial pressure.

The large diaphragm insures sensitive operation.

Made in both straight-way and expanded outlet bodies.

Sizes ¾ in. to 12 in.

Eclipse Master Reducing Valve

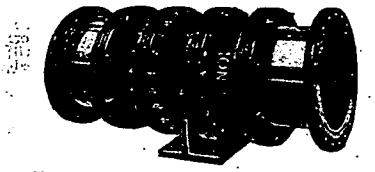


A pilot type valve will reduce from any pressure up to 250 lb. down to 10 lb. and hold reduced pressure constant at all times—even against a "dead end" pipe.

Made of Bronze with monel valves and trimmings.

Sizes ½ in. to 6 in.

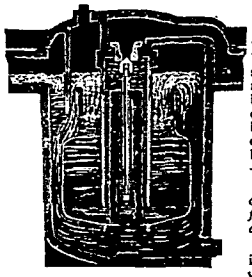
Illinois Expansion Joints - Single and Double Traverse



Heavy duty joints, the liners are cast bronze—not brass tubing. The bolts are through bolts, no stud bolts used.

Tapped for service connections in anchor section if desired.

Eclipse Steam Trap (Patent Applied for)



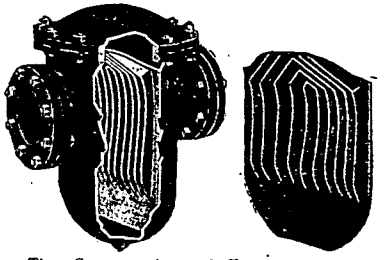
Something new in Steam trap design. The valve and stem are separate from the bucket and only operated by the bucket at its extreme top and bottom travel —*Result*—

Valve is always either full open or tight closed.

No wire drawing or cutting of valve and seat, which are of Monel metal. Steam tight and long lasting.

Bulletin No. 302 describes in detail.

Horizontal Oil Separator

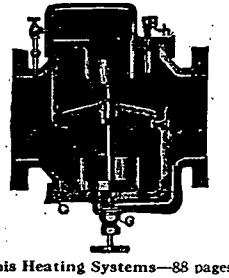


These Separators have a baffle, removable without disturbing the piping. Occasional cleaning is necessary for proper elimination of oil.

The port areas are over 3 times the diameter of the pipe area, hence these separators are effective.

Eclipse Back Pressure and Combination Relief Valves

Made in Vertical and Horizontal types, straight-way or angle pattern, for condensing and non-condensing engines.



It is noiseless and works equally well on pressure or vacuum, air cushioned by back pressure in dashpot. Constructed entirely of metal with no springs; wearing parts of special bronze.

Size 4 in. to 30 in.

Catalog and Bulletins—Illinois Heating Systems—88 pages

BULLETINS

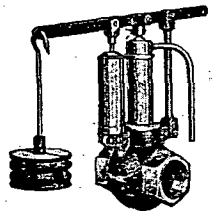
No. 12—Heating Specialties.
No. 21—Vapor System Details.
No. 102—Pressure Reducing Valves.
No. 202—Back Pressure, and Relief Valves, Exhaust Heads.
No. 302—Steam Traps.
No. 452—Non-Return Valves.
No. 502—Separators—Oil and Steam.
No. 703—Float and Balanced Valves.

Klipfel Manufacturing Co.

2641-59 West Harrison St.

Chicago, Ill.

Manufacturers of Pressure Regulating Appliances—for the Automatic Control of Steam, Air, Water or Gas



No. 1 Pressure Regulator—Piston Type

Sizes, ⅜ to 14 in., inclusive. Bronze bodies in sizes 1½ in. and under, screwed ends only. Iron bodies in sizes 2 in. and above; 2 to 6 in., inclusive, screwed or flanged ends, but screwed ends will be furnished unless otherwise specified; sizes 7 in. and above flanged ends only.

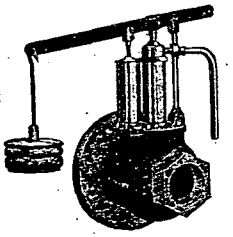
Nos. 1 AND 2 PRESSURE REGULATORS
Piston Type

Automatically reduce any initial steam, air or water pressure to any desired reduced pressure down to 2 lbs. and maintain reduced pressure constantly regardless of fluctuations in the initial pressure, or changes in the demand for steam.

When specified for control of air or water, piston is provided with special leather cup packing at no additional charge. Working parts removable while valve body remains in pipe line.

No. 2 PRESSURE REGULATORS
Piston Type—Expanded Outlet

Similar to No. 1 except have an expanded outlet, allowing use of low pressure pipe of larger size than high pressure supply pipe.

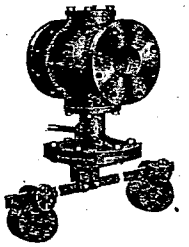


No. 2 Pressure Regulator—Piston Type—Expanded Outlet

Sizes, 1 x 2 to 12 x 24 in. inclusive. Bronze bodies in sizes 1¼ x 2½ in. and under. Iron bodies with bronze inner valves and trimmings in sizes above. Unless otherwise specified, Nos. 2 and 4 will be shipped with inlet screwed and outlet flanged in sizes 1½ x 3 to 3 x 6 in., inclusive, although they can be furnished both ends screwed or both ends flanged; sizes 4 x 8 in., and above, both ends flanged only.

Nos. 3 AND 4 PRESSURE REGULATORS
Diaphragm Type

Automatically reduce any initial steam pressure to any desired reduced pressure, either below atmosphere or up to 5 lbs. above atmosphere, and constantly maintain reduced pressure regardless of initial pressure fluctuations or changes in the demand for steam. Includes no stuffing box, thus eliminating leakage and friction on valve stem. Diaphragm of ample area insures very close regulation of reduced pressure. Inner valves and seats are bronze, bevel seated, requiring minimum diaphragm movement.



No. 3 Pressure Regulator, Diaphragm Type

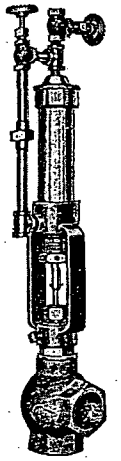
Made in same sizes and style of ends as No. 1 Pressure Regulator, Piston Type.

No. 4 PRESSURE REGULATORS
Diaphragm Type—Expanded Outlet

Similar to No. 3 except have expanded outlet, allowing use of low pressure pipe of larger size than the high pressure supply pipe. Made in same sizes and style of ends as No. 2 Regulator.

Our 96 page Catalog contains sectional illustrations and roughing-in dimensions covering our complete line.

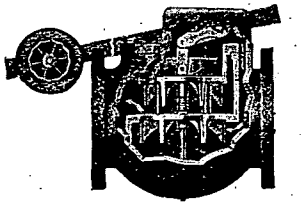
Write for your Copy—TODAY!



Improved Pump Governor

NOISELESS BACK PRESSURE VALVES—Horizontal or Vertical

Automatically and noiselessly maintain any desired back pressure, so that exhaust steam may be used for heating, drying and other purposes. For use with non-condensing engines. Because of patented construction, inner valve is effectively stabilized, and cannot pulsate in unison with stroke of engine. Can be operated either horizontal or vertical, but horizontal position is preferable.



Noiseless Back Pressure Valve

Sizes, 2 to 24 in., inclusive. All sizes made flanged ends; sizes 2 to 8 in., inclusive, also made screwed ends. Unless otherwise specified, sizes 6 in. and under will be shipped screwed ends, while sizes 8 in. and above will be shipped flanged ends.

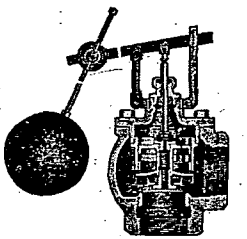
IMPROVED PUMP GOVERNORS

Automatically control any type of steam pump, and maintain discharge at a constant pressure. Simple; compact; direct acting; Monel metal stems, inner valves and seats are bronze, semi-balanced and taper seated.

Sizes, ⅜ to 12 in., inclusive. Bronze bodies in sizes 1½ in. and under, screwed ends only. Iron bodies in sizes 2 in. and above. Sizes 2 to 6 in. inclusive, made screwed or flanged ends, but screwed ends will be shipped, unless ordered flanged. Sizes 7 in. and above flanged ends only. Made globe and angle patterns in all sizes, but angle patterns will be shipped, unless ordered globe.

No. 6 BALANCED FLOAT VALVES

Automatically control the supply of hot or cold water to open tanks and maintain practically a constant water level. The inner valve consists of two perfectly balanced straight side plunger discs and consequently is unaffected by water pressure. The swivel yoke and float lever on all sizes can be turned to any desired position. A rosette at the end of lever permits ample adjustment of the seamless copper float. Inner valves and seats are bronze and are fitted for cold water working pressures up to 200 lbs., unless specified for hot water. A special right angle bent lever is furnished when valve is specified for installation in a vertical pipe line.

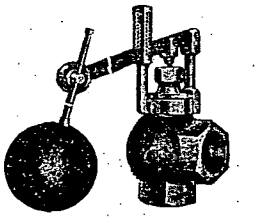


No. 7 Single Seated Float Valve

Sizes, ¾ to 8 in., inclusive. Bronze bodies in sizes 1½ in. and under, screwed ends only. Iron bodies in sizes 2 in. and above; 2 to 6 in. inclusive, screwed or flanged ends, but screwed ends will be shipped unless specified otherwise; size 8 in., flanged ends only. All sizes are made angle or globe patterns, but angle pattern will be shipped unless specified globe.

No. 7 SINGLE SEATED FLOAT VALVES

Automatically maintain a constant level of hot or cold water in open tanks. Single seated, auxiliary operated. Seat area equal to pipe size. Will not leak. Swivel guide yoke allows float to be located in any position. For working pressures up to 200 lbs.



No. 6 Balanced Float Valve

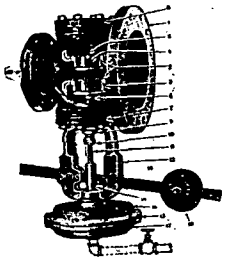
Sizes, ⅜ to 20 in., inclusive. Bronze bodies in sizes 1½ in. and under, screwed ends only. Iron bodies in sizes 2 in. and above. Sizes 2 to 6 in. inclusive, made screwed or flanged ends, but screwed ends will be shipped unless specified otherwise. Sizes 7 in. and above, made flanged ends only. All sizes 14 in. and under are made angle or globe pattern, but angle pattern will be shipped, unless ordered globe. Sizes 16 in. and above are made globe patterns only.

The McAlear Mfg. Co.

1901-1907 So. Western Avenue CHICAGO

Power and Heating Specialties for Controlling Pressures and Flow of Steam, Water, Air or Gas

PRESSURE REDUCING VALVES—used in Low Pressure, Vacuum or Vapor heating systems or any other service where close regulation and absolute control is required.

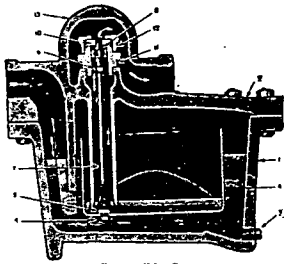


USE

Fig. 155 for initial pressures up to 150 lb. and reducing to service pressures 0-10 lb.
Fig. 185 Single Seated Valves on dead end service where reduced pressure is below 10 lb.

Fig. 245 Spring Weighted type for initial pressures up to 150 lb. and reducing to service pressures above 10 lb. Fig. 265 Single Seated Valves for dead end service such as cooking tables, kitchen utensils, laundry mangles, etc.

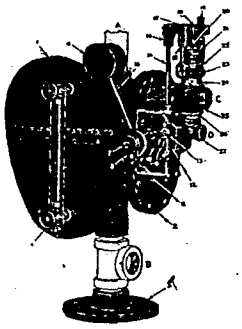
STEAM TRAPS—For draining water of condensation from any steam apparatus or steam mains.



Reversible Seat

SPECIFY

Fig. 685 for pressures up to 30 lb.
Fig. 695 for pressures up to 125 lb.
Fig. 705 for pressures above 125 lb.
Fig. 715 for special low pressures.



No. 781—Low Pressure, up to 25 lbs.

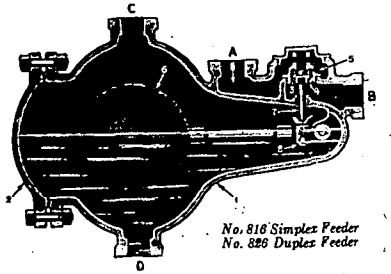
AIR ELIMINATOR AND RETURN TRAPS—Designed for automatically returning water of condensation from low pressure steam or vapor systems direct to boiler and to exhaust the air to atmosphere.

CAPACITIES

Size No.	Inlet In.	Outlet In.	Steam In.	Vent. In.	Capacity Sq. Ft.
0	1	1	1	¾	1,000
1	1¼	1¼	1	¾	2,000
2	1½	1½	1	¾	4,000
3	2	2	1	¾	6,000
4	2½	2½	1	¾	10,000
5	3	3	1¼	1	15,000
6	3	3½	1¼	1	20,000

McAlear Direct-to-Boiler Water Feeders

For maintaining constant water line in steam boilers. McAlear Automatic Water Feeders prevent boiler fractures from low water, decrease fuel consumption and reduce maintenance expense.



No. 816 Simplex Feeder
No. 826 Duplex Feeder

For oil burner installations—Feeders are equipped if desired, with LOW WATER ELECTRIC CUT-OUTS.

The McAlear line of Power, Heating, Gas and Oil Specialties include: Thermostatic Radiator Traps, Packless Radiator Valves, Air Vents, Grease Extractors, Dirt Strainers, Vacuum Pump Governors, Damper Regulators, Steam Separators, Back Pressure Valves, Water Regulating Valves, Tank Controllers, Gas Regulating Valves, Liquid Level Controllers and many other devices. General Catalogue illustrating our complete line, will be gladly furnished upon request.

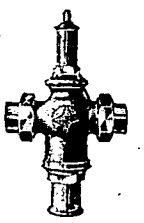
Mason Regulator Company

Boston, Mass.

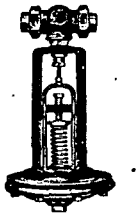
San Francisco, Calif. Montreal, Canada

Manufacturers of

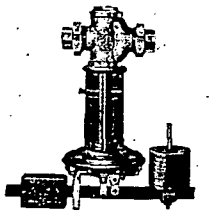
Pressure Regulators and Steam Specialites



Standard Type for General Use
Sizes ½"–8"



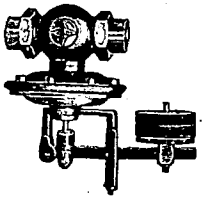
No. 220 Type
Sizes ½"–1½"



Lever Type
Sizes 8"–16"

FOR HEATING AND OTHER LOW-PRESSURE SYSTEMS

MASON Pressure Reducing Valves automatically reduce boiler pressure for Steam Heating systems, and for all situations where steam is required at a lower pressure than that of the boiler.

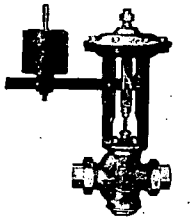


Vacuum Regulating Valve
Sizes ½"–4"

For regulating the amount of vacuum on separate branches of a main vacuum system.

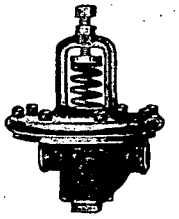
Catalog

GENERAL CATALOG GIVING FURTHER INFORMATION AND DETAILS OF THESE AND OTHER TYPES OF REGULATORS, WILL BE GLADLY SENT UPON REQUEST.



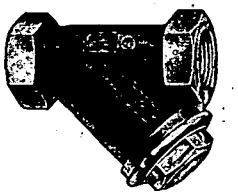
Vacuum Pump Regulators
Sizes ½"–4"

For regulating the supply of steam to the requirements of a steam driven vacuum pump and thereby automatically maintaining a uniform vacuum on the system.



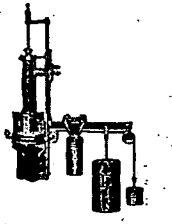
Household Water Pressure Regulator
Sizes ⅜"–1"

Designed for domestic service where the city water pressure is too great for economical house use. Eliminates noise in bathroom fixtures, leaking faucets and splashing in bowls and tubs.



Strainer
Sizes ½"–6"

MASON Strainers for water, steam or air keep piping clean and insure proper operation of regulators and valves in any system.



Damper Regulator

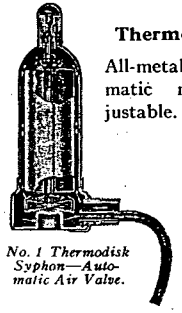
Made in various sizes for handling damper equipment on both high and low pressure boilers, operating on forced, induced, or natural draft.

Jas. P. Marsh & Company

Established 1865

114-124 S. Clinton St. - CHICAGO, ILL.

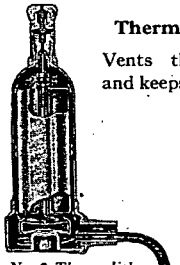
SALES AGENCIES IN MOST PRINCIPAL CITIES



Thermodisk

All-metal Automatic non-adjustable.

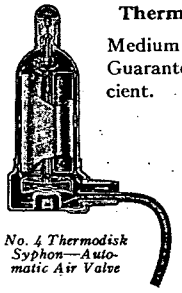
No. 1 Thermodisk Syphon—Automatic Air Valve.



Thermodisk

Vents the air and keeps it out.

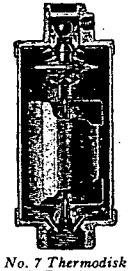
No. 2 Thermodisk Air and Vacuum Valve.



Thermodisk

Medium priced. Guaranteed efficient.

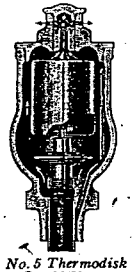
No. 4 Thermodisk Syphon—Automatic Air Valve



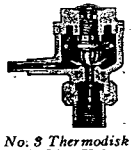
No. 7 Thermodisk Air Eliminator

Free and unlimited vent of all air, hot or cold, cannot water-log, do not spit or leak water, and close instantly for steam or vapor.

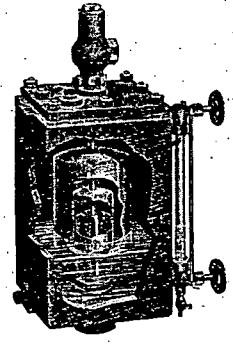
Sizes and capacities for every requirement.



No. 5 Thermodisk Rapid Vent



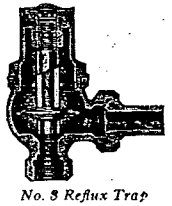
No. 3 Thermodisk Air Line Valve



Marsh Automatic Syphon Return Trap



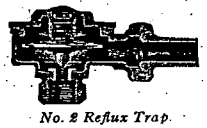
No. 1 Reflux Trap



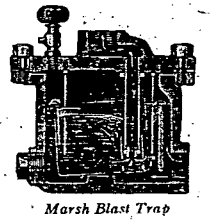
No. 3 Reflux Trap

Marsh Reflux Traps for installation on return of radiators of any two-pipe return steam heating system. Also for pipe coils in Refining, Cooking and Drying apparatus.

Marsh Blast Traps for Direct or Indirect Coils and for any location where large quantities of water are to be discharged.

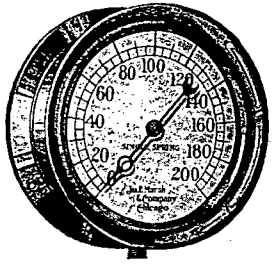


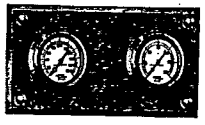
No. 2 Reflux Trap



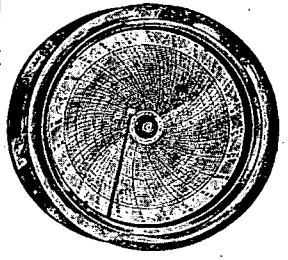
Marsh Blast Trap

Marsh Indicating Gauge





Marsh Recording Gauge

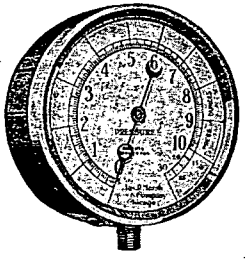


Marsh Gauges for every requirement of indicating Pressure, Vacuum, Altitude, etc.

Marsh Recording Gauges where a high grade, accurate instrument is required and where it is desired to match other instruments on Gauge Boards, etc.

We specialize in Gauge Board outfits complete with all instruments.

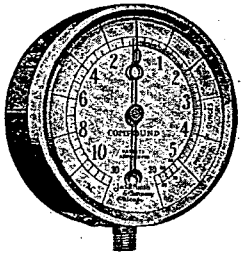
Low Pressure Ounce Gauge



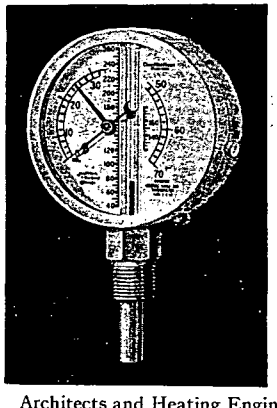
Show exact pressure in ounces and pounds.

A necessity for the intelligent, economical and proper operation of "Vapor," "Vacuum," "Semi-Vacuum," and "Atmospheric" Heating Systems and for any low pressure boiler.

Compound Ounce Gauge

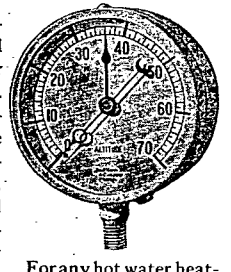


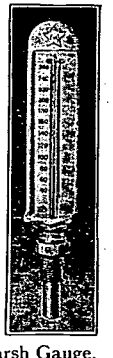
Marsh Ther-Alti-Meter



Combined Altitude Gauge and Hot Water Thermometer. The two indications, altitude and temperature, at a glance. The ideal and logical instrument to specify for any hot water heating boiler.

Marsh Hot Water Thermometer and Altitude Gauge





For any hot water heating boiler where the separate Altitude Gauge and Hot Water Thermometer are preferred.

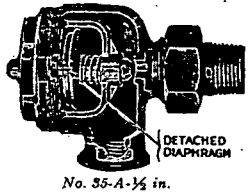
Architects and Heating Engineers will find illustrated and described a Marsh Gauge, Radiator or Steam Trap, Automatic Air Valve, Vent and Heating Specialty for each service requirement—in literature which we will be pleased to send upon request.

Monash-Younker Co., Inc.

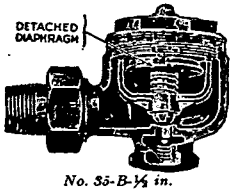
ESTABLISHED 1900

CHICAGO NEW YORK

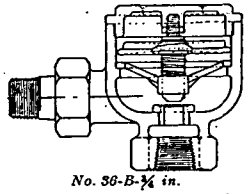
MONASH THERMOSTATIC RETURN LINE TRAPS



No. 35-A-½ in.



No. 35-B-½ in.



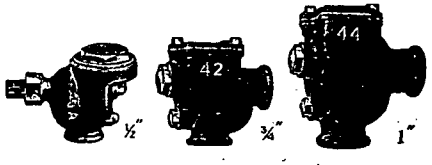
No. 36-B-¾ in.

The distinctive feature of the MONASH Thermostatic Line of Traps, is the *Diaphragm*, a separate and independent unit, so constructed and so held in place that friction and strain on the *Diaphragm* is reduced to a minimum: overcoming the hazard of fracture and rupture of the *Diaphragm*.

The No. 35-A has a vertical seat with the *Diaphragm* out of the Steam Chamber, while the No. 35-B is built with a horizontal seat and the *Diaphragm* in the Steam Chamber. These Traps are ½ in. pipe size, capacity 200 sq. ft., 65 lb. of water per hour.

MONASH No. 36-B-¾ in. Radiator Trap is built with the Diaphragm in the steam chamber, body of close-grained, gray iron, nickel plated; brass coupling, nut, nipple and cover nickel plated; capacity 500 sq. ft., 160 lb. water per hour.

Monash Thermostatic Heavy Duty or Drip Traps



MONASH thermostatic special heavy duty or drip traps are made with dirt-pocket, clean-out and by-pass. Vertical seat and diaphragm outside the steam chamber. Especially suitable for **blast coils, dry kiln coils, main drips, dryers, laundry machinery** and all points where large quantities of condensation is to be handled.

No.	40	42	44
Size.....inches	½	¾	1
Sq. Ft. of Radiation	350	1500	5000
Water per Hour.....pounds	108	475	1560
Net Weight.....pounds	3.25	5.00	7.50

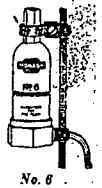
Monash Guaranteed Automatic Air Valves



No. 1

MONASH No. 1, all metal, non-adjustable automatic air valve in which the base and nipple are in one casting—no soldered or sweated joints to come apart.

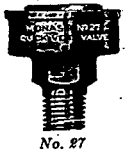
MONASH No. 6, four-way-drain, lock-shield, automatic air valve with all working parts above opening to radiator. Self-cleaning; no flooding of floors and other damage.



No. 6

Specify MONASH Valve holder with valve.

Monash Quick Venting Valves



No. 27

For mains and risers the MONASH No. 27 thermostatic quick venting valve is desirable. Has heavy brass body and cover, phosphor bronze thermostatic diaphragm.

Operates automatically at all pressures up to 10 lb.

Insures rapid steam circulation. Closes against steam, but does not close against water.

Connections are ⅜ in., 1 lb. net weight.

Monash Thermostatic Air Line Valves

for drip or air line systems; also for venting vento stacks and blast coils.

Is rapid in action and positive in results, passing all air but closing tightly against steam.

Made of brass, white plated; the No. 2 is ⅛x¼ in., the No. 3 is ¼x⅜ in. 1 lb. net weight.

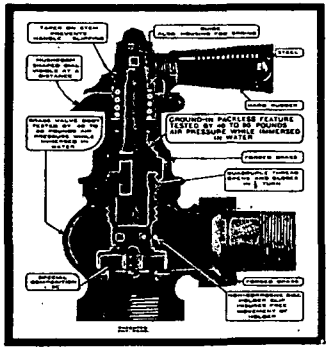


No. 2

O-E Specialty Mfg. Co.

5-7-9 Keefe Ave., MILWAUKEE, WIS.

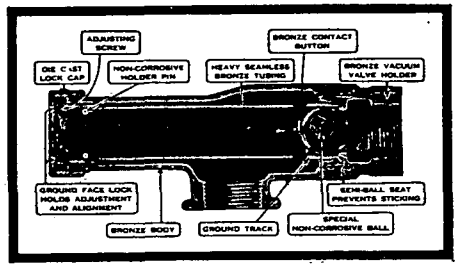
Packless Graduated Valves, Ball-Check Return Elbows, Thermo-Nickel Return Traps, Air Exhausters, Vacuum Valves, Vacuum Pressure Gages, Differential Return Traps and Balanced Swing Check Valves.



The operation of the **"O-E" Perfect Vapor Vacuum-Pressure System** is very simple: vapor generated at boiler passes up through main supply pipe and is admitted to radiator at top through the "O-E" Packless Graduated Valve. Water of condensation is returned to boiler through a ½-in. "O-E" Elbow. In passing through the Elbow the water is first trapped by means of a wall or diaphragm cast in the Elbow, *outside of the radiator*, making a water seal which holds the vapor in radiator and prevents it from short circuiting into the return main. Should the Supply Valve of radiator be closed and condensation form a vacuum any water that might be in the return pipes is prevented from returning to radiator by the "O-E" Patent Elbow, which is equipped with a small brass ball operating on a smooth guide or track, and so arranged that when a vacuum takes place in radiator ball will immediately roll against port and close it. Elbow is noiseless in operation, as water seal is below ball, which is an important feature. As soon as Supply Valve is again opened ball rolls off of seat allowing condensation and air to pass easily and freely into return main.

An air vent is tapped in the slot of the screw stop in the return elbow which not only allows air to escape freely into return system when Supply Valve is open, but also equalizes the pressure on both sides of Water Seal, thus preventing it from syphoning out, which it might otherwise do. All air and condensation pass through main return pipe in basement to a point above boiler where air is separated from water by means of "O-E" Patent *Air Exhauster* and *Vacuum Valve*.

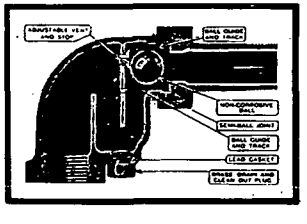
The "O-E" Improved Perfect Packless Graduated Valve is *absolutely packless* and never requires packing. It is tested by air and water test before shipment. It is quick opening, little more than one-half turn fully opens or closes it. Sand blasted and nickel plated. The handle being made of hard rubber, will not crack and is always cool and easy to operate. The graduated dial and pointer admit of partial opening so that just the amount of heat desired can be obtained. All valves are fitted with composition disc on a swivel seat without extra charge. Graduated Supply Disc will be attached when specified, at slight additional cost.



The "O-E" Improved Air Exhauster and Vacuum Valve is simple and very sensitive, operating as follows:

Being connected at a high point above where the return main enters boiler, all air in the system seeks outlet at the Air Exhauster, which is open when there is any air in the system, and as soon as all air is exhausted and heat comes in contact with the Carbon Post in Exhauster, same expands and forces the Special Bronze Ball against the seat, closing the port. When closed system will cool slightly causing a vacuum which will hold ball on seat. As soon as vacuum is lost ball will roll away from seat and permit air to escape freely and quickly. The Improved cap locks the expansion post after it is properly adjusted and also holds post in a rigid horizontal position. All Exhausters are set for ordinary use, but can be adjusted to suit any particular system to which they are attached. All Exhausters are threaded for 1-in. I. P. both inlet and outlet.

Made in one size only, 1 in. x 1 in. Capacity 2,000 sq. ft.



The "O-E" Perfect Ball-Check Water Seal Union Elbow with Adjustable Air Vent is made in two sizes, ½-in. Capacity 250 sq. ft. ¾-in. Capacity 500 sq. ft.

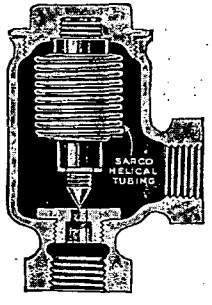
We also announce the Thermo-Nickel Return Trap, a combination thermostatic trap with a ball-check and many new features. Ask for descriptive bulletin.

Sarco Co., Inc.

233 Broadway, NEW YORK

BOSTON BUFFALO PHILADELPHIA CLEVELAND DETROIT CHICAGO

RADIATOR, BLAST AND STEAM TRAPS,
PACKLESS INLET VALVES, TEMPERATURE CONTROL AND STRAINERS



SARCO STEAM TRAP No. 9

For industrial purposes, hospitals, laundry and kitchen equipment.

Sarco Steam Trap No. 9 consists of a heavy bronze body with a powerful motor element of helical seamless bronze tubing containing an expansion fluid.

Is of the balanced pressure type, suitable for any steam pressure from 0 to 100 lbs. **without readjustment.**

Has unusually great capacity, large valve area and quick, high lift when discharging. Closes instantaneously. No live steam can escape. Cannot air bind.

Small in size and low in price.

Write for Booklet No. 261.

List Prices F. O. B. Bethlehem, Pa.		Dimensions	Capacity
½"	$ 8.50	1¾" inlet to outlet	500 lbs. of water per hour
¾"	11.50	1¾" inlet to outlet	600 lbs. of water per hour
1"	14.50	2" inlet to outlet	800 lbs. of water per hour

For Steam Pressure from 0 to 30 lbs. Type 9–1 can be used. It has the same capacities as Type 9–2 but is furnished with brass composition valve heads and seats at ½"–$7.50; ¾"–$10.50; 1"–$13.50 list.

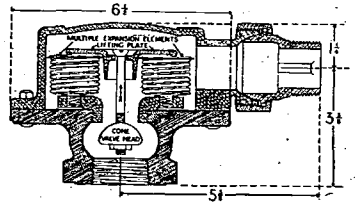
SARCO BLAST TRAP No. 9–3

This Heavy-Service or Blast Trap is for draining steam coils of hot-water tanks, vento heaters and main drip lines; also where a large capacity trap is required on low-pressure work such as for draining coils in dryers, heating coils, cooking vessels, etc.

Will handle great flows of condensation without loss of steam. Is entirely thermostatic, so removes the air as well as water.

Operates on the same principle as the Sarco Radiator Rrap.

Write for Blast Trap Booklet.



Section of 1¼" and 1½" No. 9-3

List Prices F. O. B. Bethlehem, Pa.		CAPACITY	
		Lbs. per Hour	Sq. Ft. Direct Radiation
1"	$25.00	1000	3000
1¼"	27.50	1000	3000
1½"	30.00	1500	4500
2"	35.00	2000	6000

SARCO TEMPERATURE REGULATOR

For hot-water service tanks, and cold storage plants; also for manufacturing purposes and dry room or kiln control. Write for Booklet No. 91.

SARCO SELF-CLEANING STRAINER

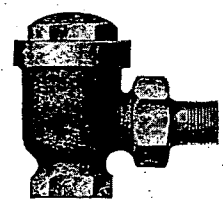
For Steam, water and oil lines. Write for Booklet No. 204

Sarco Co., Inc.

233 Broadway, NEW YORK

BOSTON BUFFALO PHILADELPHIA CLEVELAND DETROIT CHICAGO

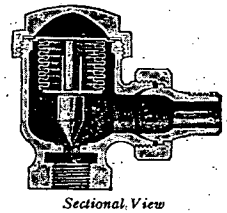
RADIATOR, BLAST AND STEAM TRAPS,
PACKLESS INLET VALVES, TEMPERATURE CONTROL AND STRAINERS



SARCO RADIATOR TRAP

For vacuum, vapor and low-pressure heating systems. The Sarco is of the thermostatic type, using Seamless Helical Bellows and a volatile liquid filling. Its positive action keeps radiators thoroughly drained, preventing water hammer and air binding.

Helical Bellows is phosphor bronze. It has a high lift, insuring free discharge, a maximum closing pressure and an unusually long life.



Sectional View

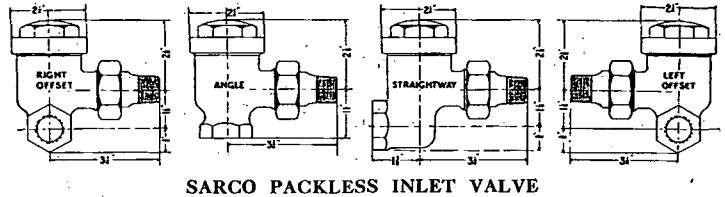
The motor element is not attached to the body and can be lifted out to wash out scale and dirt in new installations without affecting adjustment. Body is heavy brass, nickel plated.

Is factory adjusted and can be used on all pressures up to 25 lbs. without adjusting.

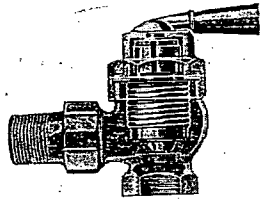
Write for Booklet No. 116.

List Prices F. O. B. Bethlehem, Pa.		Dimensions		CAPACITY—DIRECT RADIATION	
				Vapor System	Vacuum System
½"	$ 6.00	A 3¼"	B 1½"	200 Sq. Ft.	250 Sq. Ft.
¾"	8.00	A 3¼"	B 1½"	600 Sq. Ft.	800 Sq. Ft.
1"	15.00	A 3⅝"	B 2"	1500 Sq. Ft.	1800 Sq. Ft.

Angle, straightway and offset types are furnished at same prices.



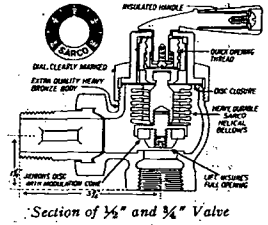
SARCO PACKLESS INLET VALVE



For use on vapor and vacuum heating systems.

This valve cannot leak as it is of the true Packless type.

By the use of the Sarco Helical Tubing it eliminates the necessity for packing of any kind.



Section of ½" and ¾" Valve

Valve opens or closes with a three-quarter turn and the pressure is always even, smooth and regular. Easy to turn. Dial is distinctly marked.

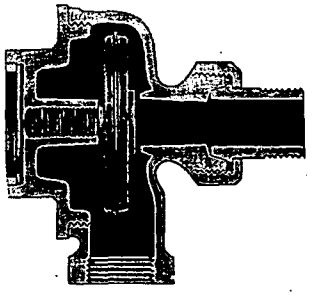
Has heavy brass, well-nickeled body. Furnished with lever or round moulded handles.

Write for Booklet No. 151.

List Prices F. O. B. Bethlehem, Pa.		Center Inlet to Outlet	CAPACITIES Feet Direct Radiation
½"	$5.50	3¼"	up to 40 sq. ft.
¾"	6.00	3¼"	41 to 75 sq. ft.
1"	7.50	3¼"	76 to 125 sq. ft.
1¼"	9.50	4"	126 to 200 sq. ft.

Sterling Engineering Company

1636-44 Holton Street MILWAUKEE, WIS.

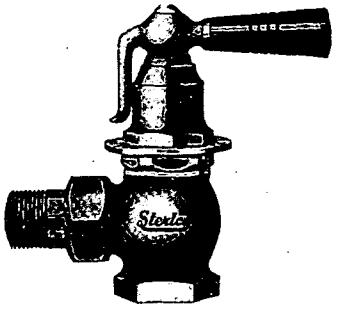


STERLCO THERMOSTATIC TRAP

The Sterlco Thermostatic Radiator Trap is designed for use on both vacuum and vapor heating systems. It is an all brass trap constructed with a vertical diaphragm with a flat seat. The expansion of the diaphragm closes the trap against the steam pressure. The vertical seat is a self-cleaning feature as dirt and scale after passing the seat drop down into the return line instead of collecting inside the trap. The diaphgram is the result of long and careful experiment. The metal is carefully tested before being used and the greatest care is exercised by skilled mechanics to insure perfection in each diaphragm. They are guaranteed to function properly for a period of at least five years.

Capacities and Sizes

No.	Size	Capacity
2	½"	Up to 200 sq. ft. rad.
3	¾"	200 to 500 sq. ft. rad.
4	1"	500 to 1000 sq. ft. rad.

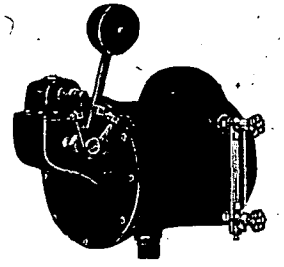


STERLCO GRADUATED PACKLESS VALVE

The Sterlco Graduated Packless Radiator Valve is of the Jenkins Disc Type. A half turn of the handle will open or close it. A graduated dial indicates the degree of opening through the valve. The valve is neat in appearance, easily dismantled as all parts are threaded and screwed together and does not require packing. These valves are furnished with either lever or wooden wheel handles or with lock and shield.

Capacities and Sizes

Size	Capacity
½"x ½"	Up to 24 ft.
¾"x ¾"	25 to 70 ft.
1" x1"	71 to 150 ft.
1¼"x1¼"	151 to 200 ft.
1½"x1½"	201 to 300 ft.

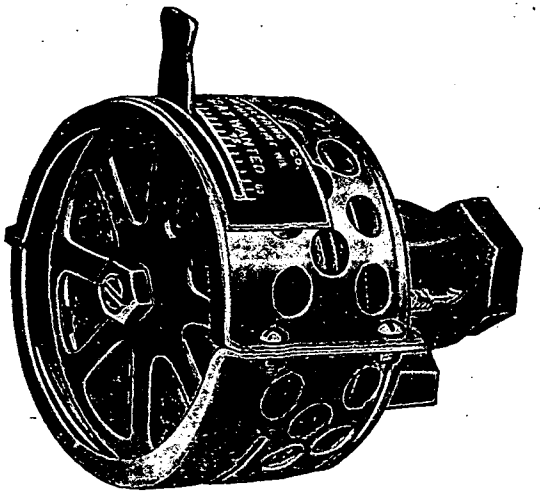


STERLCO SLIDE VALVE RETURN TRAP

The Sterlco Slide Valve Return Trap differs in principle from other return traps on the market by utilizing the sliding type of valve and besides draining return lines of heating systems and returning water to boilers, it will lift liquids to higher levels where steam or air pressure is available. It is especially adaptable where ceilings are low.

Size Return Traps	Sq. Ft. Surface	Inlet and Outlet	Steam Connection	Vent Connection	Height	Length Overall	Shipping Weight
1	2000	1½"	¾"	½"	14"	20½"	150
2	4000	2"	¾"	½"	16"	26"	190
3	6000	2"	¾"	½"	18"	32"	250

STERLCO-ROYS THERMOTROL—Type B



The Sterlco-Roys Thermotrol consists of a valve installed in the supply line to the unit of radiation which is controlled by a combination of highly sensitive diaphragms. These diaphragms are insulated from the heat of the radiator and enclosed in a housing. At the top of the control is mounted a graduated scale indicating temperatures. The regulator can be set to operate at any desired temperature marked on the scale. The supply can be connected to it at any angle and it can be connected to either the top or bottom of the radiator.

This Thermotrol will regulate room temperatures above 60 deg. Fahr. The standard control is designed for temperatures between 60 and 80 deg. but the controls can be built to regulate temperatures from 60 to 200 deg.

Capacities

¾ in. Size— 70 sq. ft.
1 in. Size—150 sq. ft.

WE MANUFACTURE THE FOLLOWING STERLCO PRODUCTS:

THERMOSTATIC TRAPS,
PACKLESS RADIATOR VALVES,
AIR LINE VALVES,
RETURN TRAPS,
AIR ELIMINATORS,
VACU FLOAT VENTS,
CONDENSATION PUMPS AND RECEIVERS,
STRAINERS,
TEMPERATURE REGULATORS.

VAPOR-VACUUM DIVISION

(See also Pump Division)

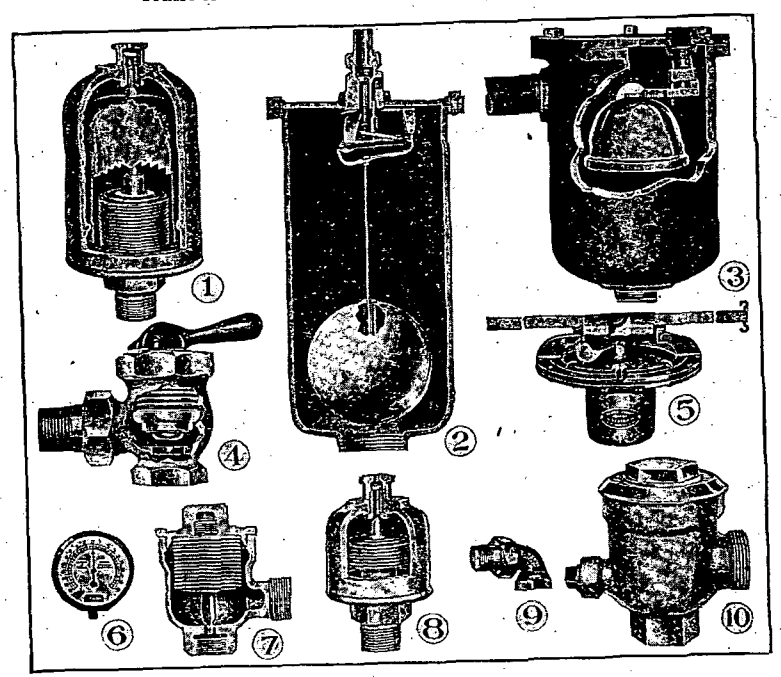
The Trane Company

La Crosse, Wis.

BRANCH OFFICES

New York, Chicago, Boston, Philadelphia, Buffalo, Cleveland, Detroit, Seattle, Los Angeles, Albany, Minneapolis, Salt Lake City, Ft. Wayne, Portland, Oregon, Greensboro, N. C., Zanesville, Ohio, Atlanta, Ga.; ENGLAND: 22-23 Clerkenwell Close, London, E. C. 1. CANADA: The Trane Co., 23 River St., Toronto; Thomas Robertson & Co., 134 Craig St., West, Montreal; F. S. Murdock, 310 Breadalbane, Winnipeg. JAPAN: The Uchida Trading Co., Ltd., Tokio—Osaka—Kobe. CHINA: C. J. Doughty & Co., 7 Jinkee Road, Shanghai.

The Trane Systems of Vapor and Vacuum Heating, Patented Heating Specialties
Trane Automatic Electric Pumps, For All Purposes



TRANE HEATING SPECIALTIES

No. 1 Trane Float Vent Valve vents air but closes tightly against steam and water. Capacity unlimited for practical purposes. Full ¼ in. venting ports. ¾ inch pipe connection only. Weight 4 lb. Contains genuine Trane bellows.

No. 2 Trane Direct Return Traps and broken boilers are never found on the same vapor heating or straight steam job. Two sizes: 2,000 and 4,000 sq. ft. Multiples used for larger requirements.

No. 3 Trane Receivers are used on Return Fitting Vapor Heating Systems to return condensation to the boiler under all operating conditions. Two sizes: 400 and 2,000 sq. ft.

No. 4 Trane Bellows Packless Valves are packless in every respect. Contain genuine Trane bellows. Brass body. Nickled, highly polished trimmings. Practically indestructible handle. Especially designed as companion product for use with Trane Bellows Traps (No. 7) in connection with Trane Vacuum Pumps. (See Trane Pumps in Pump section of this Guide). Valves furnished in ½ in., ¾ in., 1 in. and 1¼ in. sizes.

No. 5 Trane Vapor Regulators are sensitive to ounces pressure instead of pounds. Two grades, Sensitive and Extra Sensitive, known as Size 1 and Size 2.

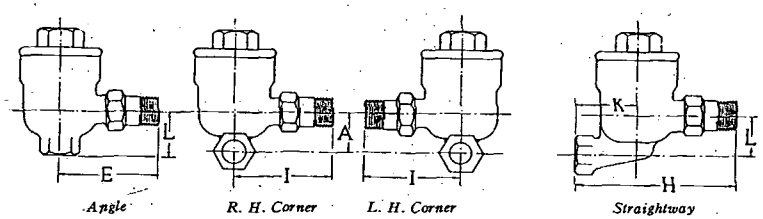
No. 6 Trane Pressure-Vacuum Gauges register to 30 lb. pressure and 18 in. vacuum. Also furnished to register to 30 in. vacuum only over entire scale. 4½-in. face. ¼-in. pipe connection.

No. 7 Trane Bellows-Type Radiator Traps have 14 corrugation bellows. These bellows are made without seams or joints of any kind. Trap bodies are made of steam brass. Sizes and styles are as listed below. Guaranteed range is from 15 in. vacuum to 25 lb. pressure without adjustment of any kind. These same traps are also available for high pressure service up to and including 125 lb.

No. 8 Trane Quick Vent Valves do the work of Float Vent Valves (see No. 1), except that they are designed to close against steam only. ¾-in. pipe connection. Contain Genuine Trane bellows.

No. 9 Trane Return Fittings are used in connection with Trane Receivers (see No. 3), on jobs that have 400 sq. ft. of radiation or less.

No. 10 Trane 1-in. Bellows Trap specified for Drip or Blast Trap service. Made with ½-in. bypass as illustrated. Capacity at 1 lb. pressure difference is 1700 sq. ft. equivalent direct radiation. At 25 pounds, 8500 sq. ft. For large capacities use Trane 1¼ in. or 1½ in. Heavy Duty Blast Traps (not illustrated).



Angle *R. H. Corner* *L. H. Corner* *Straightway*

SIZES, CAPACITIES, ETC., OF TRANE RADIATOR TRAPS

Style	Size Inches	Capacity in Sq. Ft. at Various Pressure Differences				DIMENSIONS, INCHES					
		4 oz.	8 oz.	1 lb.	2 lb.	A	E	L	H	I	K
No. B2	½	125	175	245	344	1 3/32	3¼	1 7/16	5⅛	3¼	1⅛
No. B3	¾	375	525	735	1030	1 3/32	3¼	1 7/16	5⅛	3¼	1⅛
No. B4*	1	750	1050	1700	2200	...	3 5/16	1 23/32	...	...	...

*Made in angle pattern only. **Write for information on Trane 1¼" large capacity traps.**
Sizes conform to recommendations of Heating and Piping Contractors' National Association.

Stickle Steam Specialties Co.

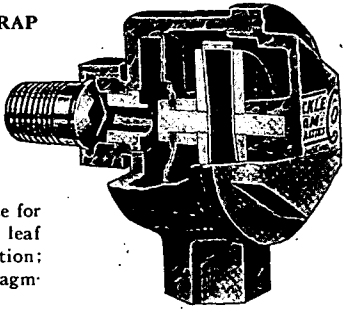
Main Office and Works, INDIANAPOLIS, IND.

NEW YORK OFFICE
48 E. 41st St.

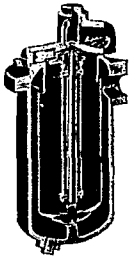
BOSTON OFFICE
52 Sudbury St.

Manufacturer of the STICKLE Open Coil Feed Water Heaters and Purifiers, STICKLE Steam Traps high and low pressure and vacuum, Pressure Regulators, Damper Controls, Back Pressure Valves, Standard Balance Valves, Vacuum Heating Specialties, Blast Coil Heaters, Heating and Ventilating equipment, Triplex Oil and Steam Separators.

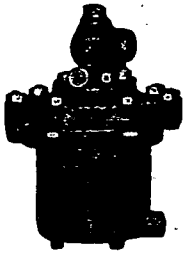
STICKLE THERMOSTATIC RADIATOR TRAP



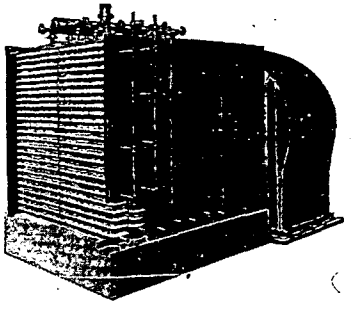
The special feature of the STICKLE Thermostatic Radiator Trap is the diaphragm; with box shape inverted heads, side walls reinforced with seamless drawn brass tubing, a solid disc protecting each head and so constructed that the diaphragm cannot get out of place. The diaphragm is so reinforced that there is no possible chance for it to become distorted or ruptured. The flat leaf bronze spring makes a positive opening action; supplementing the spring action of the diaphragm.



STICKLE THERMIC VACUUM TRAPS



Designed for draining steam headers and risers on low pressure heating systems. A Thermostatic trap will close on hot water and for this reason they will not drain a steam header. This trap is mechanically operated with positive air release. No matter what the temperature of the water this trap will handle it. This is the ideal trap for Blast Coil Service, made in sizes up to 2 inch. Send for the descriptive matter.



THE STICKLE VAPOR VACUUM BLAST COIL

Primarily designed to operate with condensation discharged from the dryers on a Paper Machine. It has proven a great success to furnish heated air to ventilate the machine room. It is the most efficient Blast Coil Heater made for low pressure steam. Being a continuous coil construction it is absolutely guaranteed to maintain a positive steam circulation at all times; cannot air bind.

ESTABLISHED 1888

WARREN WEBSTER & COMPANY

Pioneers of the Vacuum System of Steam Heating

Camden, N. J. — 50 Branch Offices

MANUFACTURERS OF SPECIALTIES FOR WEBSTER SYSTEMS OF STEAM HEATING—OVER 34,000 INSTALLATIONS

Webster Products

WEBSTER VACUUM AND MODULATION SYSTEMS OF STEAM HEATING.

WEBSTER SYSTEM APPARATUS: Including Sylphon Traps; Diaphragm (No. 7) Traps; Modulation Supply Valves; Sylphon Quick-opening Packless Valves; Dirt Strainers; Heavy-duty Traps; Double Service Valves; Water Accumulators; Expansion Joints; Lift Fittings; Suction Strainers; Vacuum Governors; Hy-Lo Traps and Controllers; Damper Regulators; Vent Traps and Vent Valves; Boiler Return Traps; Air Separating Tank, Feed-Water Heaters, Webster-Lea Heater-Meters, Steam and Oil Separators.

Webster Service

Is an integral part of every Webster System delivered through 50 branch offices. Webster Service places the accurate, comprehensive information resulting from the extensive experience of this organization at the disposal of industrial executives and engineers, architects and heating contractors.

"*Steam Heating*" is a manual of practical data prepared by the Webster organization. It has been adopted as text in several universities. Extremely useful to those having *steam heating design problems.* It is cloth bound, has 368 pages, 8x10½ in., 162 tables of useful data and 493 typical layouts and illustrations. Consulting engineers are invited to request a copy on their letterheads.

Service Details—Are provided showing accepted standard practice to be followed in installing Webster System apparatus and in making connections. Over 160 separate service details are available in loose-leaf form. These are supplied, as needed, to users of Webster System.

The use of Webster Service Details saves a substantial amount of the designer's time in laying out a system and helps to assure correct installation of each system.

Catalogue Bulletins—Describe Webster apparatus from the standpoint of the engineer, providing complete tables, drawings and other technical data. Issued in loose-leaf catalogue size for convenient reference.

Webster Vacuum Systems

Operate on exhaust or live steam at very low pressure. Used with direct radiation or in combination with blast coils or unit heaters. Particularly suited for large buildings or where process steam is used.

Operation—A partial vacuum is created and maintained by a steam or power driven vacuum pump. Steam is admitted to radiators or other heating units through Webster Sylphon Quick-opening Packless Valves, or Webster Modulation Valves. Condensation and air are discharged from each heating unit through Webster Return Traps, which *close to prevent the passage of steam, thus preventing waste.*

Water of condensation and air are removed from the system through the return piping by the vacuum pump. The air is discharged to the atmosphere, the water is returned to the boiler, by means suited to particular conditions.

Webster Type "R" Modulation System

A low pressure steam heating system suitable for all types of buildings having little or no demand for process steam and a basement or other means for placing low pressure boiler *below* the lowest radiator. For installations from 500 to 32,000 sq. ft. of equivalent direct cast iron radiation. Can be operated safely and satisfactorily by unskilled labor.

Operation—Initial steam pressure is closely controlled by an extremely sensitive Webster Damper Regulator. Steam is admitted to radiators through Webster Modulation Valves which permit close regulation of room temperature through an effective throttling control. Condensation and air are discharged from radiators by Webster Return Traps, which prevent discharge of steam, thus avoiding waste. Condensation and air are carried to a Webster Vent Trap, which automatically vents air from the system through a vent valve, permitting operation under partial vacuum for long periods.

Return of water to boiler is assured by the Webster Boiler Return Trap. A typical Webster Type "R" Modulation System installation is shown in Fig. 1.

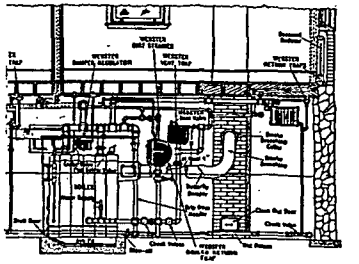


Fig. 1

Webster Modulation Supply Valves

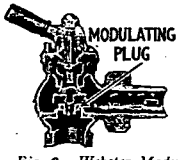


Fig. 2. Webster Modulation Supply Valve

Provide by means of the tapered modulating plug, accurate heat control of each radiator. Particularly well-suited for residence heating systems, as it permits heating any desired portion of radiator. Sizes, ½ to 1¼ in. Ask for Bulletin 705-3.

Webster Sylphon Traps

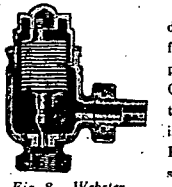


Fig. 3. Webster Sylphon Trap

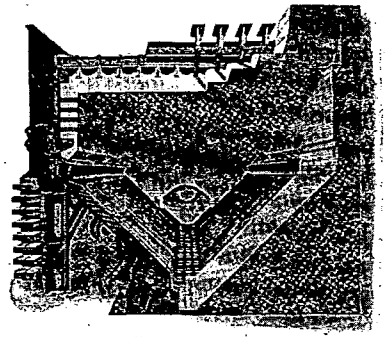
Effectively discharge all condenstaion and entrained air from radiators or coils without permitting passage of steam. Operation is by means of a sensitive volatile liquid contained in a rugged Sylphon bellows. Factory adjusted, and made in sizes from ½ to 1¼ in.

Ask for Bulletin 701.

Detroit Stoker Company

Underfeed Forced Draft and Overfeed Natural Draft Stokers

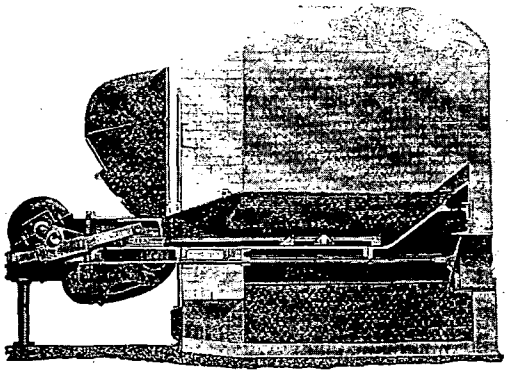
369 General Motors Bldg. Detroit, Michigan



"V" Type—Rear View

Detroit "V" Type Natural Draft Stokers for boilers from 50 up to 600 H. P. Successfully burns all grades of bituminous coal, wet tan bark, wood refuse, etc. Widely used in heating, hundreds being installed in schools, public and office buildings, large apartments, hotels, etc.; insuring complete combustion and eliminating smoke. Either sprung arch or flat suspended arch may be used. Detrick Flat Suspended Arches as sold by **Detroit Stoker Company** provide greater furnace volume.

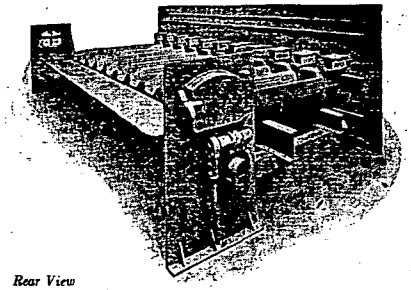
First cost of installation of **Detroit "V" Type Stokers** is very low because no forced draft equipment is needed and no basement required for ash removal. Requires little power for operation. Can be used with low pressure boilers. Fires can be banked over night and keep sufficient heat on heating system over Sundays. Substantially built to withstand hard usage. Maintenance cost low. Ask for Bulletin 369.



Single Retort Longitudinal View

Detroit Single Retort Forced Draft Underfeed Stokers "Cut the Cost of Producing Steam." Designed to serve boilers up to 250 or 300 H. P. Many installed burning Illinois, Indiana and all Eastern coals successfully. Widely used in all sections where bituminous coal is burned.

Outstanding features are: mechanically driven, adjustable rams, positive control of the movement of the fuel; no moving parts in the fire; low maintenance cost; side dumps for cleaning fires; refuse quenched in ash pits and removed through ash doors; installation cost unusually low; operates on low pressure if desired. Ask for Bulletin 269.



Rear View Detroit Multiple Retort Stoker

Detroit Multiple Retort Underfeed Stokers are built in large sizes for heavy duty work and under boilers ranging from 300 H. P. and up to the very largest units. Widely used in high schools, offices and other large buildings with heavy heating load.

The outstanding feature of the Detroit Multiple Retort Stoker is the level fuel bed in conjunction with a variable control of the fuel movement by means of a separate and independent adjustment to each retort; no avalanching of the fuel to the dumps, and bridgewall clinker formation is eliminated.

Burns Illinois, Indiana, and all eastern Bituminous Coals with high efficiency. Ask for Bulletin 169.

Riley Stoker Corporation

"RILEY" *Underfeed Stokers* **"JONES"** *Underfeed Stokers* **"HARRINGTON"** *Traveling Grate Stokers*

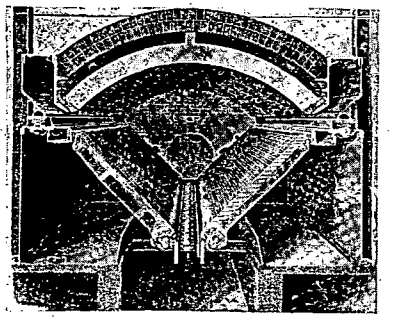
"MURPHY" *Automatic Furnaces* *Pulverized Coal Installations*

9 Neponset Street, WORCESTER, MASS., U. S. A.

BOSTON NEW YORK PHILADELPHIA PITTSBURGH BUFFALO CLEVELAND DETROIT
CINCINNATI CHICAGO ST PAUL KANSAS CITY DENVER CHARLOTTE DALLAS

Riley Engineering and Supply Co., Ltd., Toronto

As makers of Riley and Jones Underfeed Stokers, Harrington Traveling Grate Stokers and Murphy Automatic Furnaces, we are able to offer a type suitable for all kinds and sizes of boilers from 50 H. P. up, burning all grades of coal. Each of these stokers is fully described and illustrated in a separate catalog which we will gladly send on request.



Murphy Automatic Furnace

MURPHY AUTOMATIC FURNACE

The Murphy Automatic Furnace is of the overfeed, natural draft type and is particularly adapted for use in office buildings, hotels and schools. It saves 15 to 25 per cent over hand-fired methods, it saves labor, it is smokeless in operation, it does not emit gases to circulate up through the building. All ash and refuse are removed automatically. This means a clean fire and high efficiency at all times. The Murphy Furnace does away with the necessity of opening furnace doors and thereby eliminates the admission of cold air. The coal supply for the furnace is under absolute control and automatic regulation. It is a natural draft furnace and requires no fan or blower equipment.

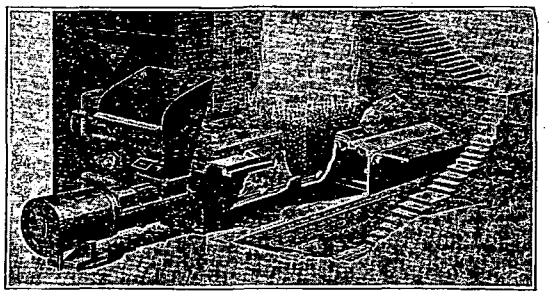
Installations

A few representative installations using our stoker equipment in office buildings, hotels and schools:

Hamm Building, St. Paul, Minn.
Cleveland Public Library, Cleveland, Ohio.
State Office Bldg., Lansing, Mich.
76 Schools, Detroit.
33 Schools, Cleveland.
11 Schools, Buffalo.
Book-Cadillac Hotel, Detroit.
Hotel Syracuse, Syracuse, N. Y.
New Willard Hotel, Washington, D. C.
Wade Park Manor, Cleveland, Ohio.
Business Men's Club, Cincinnati, Ohio.
Highland Hospital, Rochester, N. Y.

JONES "SIDE DUMP" STOKER

The Jones Side Dump Stoker is of the forced draft, underfeed type and is very widely used for both heating and power loads in all types of buildings thruout the country. It is of the side cleaning type, ashes being dropped into a shallow ashpit, permitting easy removal. Only slight excavation is required for the two shallow ashpits, therefore the installation cost is low. This stoker gives high efficiency and responds very quickly to load demands. Has a fuel burning capacity of 1200 to 1800 lbs. of coal per hour. This stoker is made in steam driven type and also mechanically driven type.



Jones "Side Dump" Stoker

Johnson Service Company

Milwaukee, Wis.

BRANCHES

ALBANY, N. Y., 4 Ramsey Place
ATLANTA, GA., 206 Bona Allen Building
BOSTON, MASS., 31 Waltham Street
BUFFALO, N. Y., 503 Franklin Street
DALLAS, TEXAS, 333 Fidelity Union Bldg.
CHICAGO, ILL., 1355 W. Washington Blvd.
CINCINNATI, OHIO, 1113 Race Street
CLEVELAND, OHIO, 2028 East 22nd Street
DENVER, COLO., 1230 California Street
DES MOINES, IOWA, 441 Ins. Exchg. Bldg.
DETROIT, MICH., 427 Brainard Street
INDIANAPOLIS, IND., 312 E. Ohio Street
KANSAS CITY, MO., 411 East Tenth Street
MILWAUKEE, WIS., 149 Michigan Street
LOS ANGELES, CAL., 607 Van Nuys Bldg.
MINNEAPOLIS, MINN., 922 Second Ave., South
NEW YORK, N. Y., 118 East Twenty-eight Street
PHILADELPHIA, PA., 258 S. Van Pelt Street
PITTSBURGH, PA., 10 E. North Diamond St., N. S.
PORTLAND, ORE., 404 Failing Building
SALT LAKE CITY, UTAH, 610 McIntyre Bldg.
SAN FRANCISCO, CAL., 417 Rialto Building
SEATTLE, WASH., 452 Colman Building
ST. LOUIS, MO., 14 North Twelfth Street
GREENSBORO, N. C., Daily News Building, P. O. Box No. 617

CANADIAN REPRESENTATIVE

Johnson Temperature Regulating Company of Canada, Limited

OFFICES

CALGARY, ALTA., 605 Second Street, West
VANCOUVER, B. C., 550-6th Avenue, West
TORONTO, ONT., 147 Church Street
WINNIPEG, MAN., 259 Stanley Street

Products and Services

ENGINEERS and CONTRACTORS for the CONTROL of TEMPERATURE or HUMIDITY for any purpose and over every range used in manufacturing purposes or buildings, furnishing and installing:

Temperature Controlling Apparatus for any and all kinds of heating and ventilating systems.

Temperature Controlling Apparatus for any industrial process requiring the medium of heat.

Control of Humidity in industrial processes requiring artificial humidity.

Temperature Control of hot water tanks and all liquids.

Control of Temperatures of refrigerating and cold storage plants.

Thermostat Control of electric motors on automatic refrigerating machines.

Manufacturers of THERMOSTATS and Other APPARATUS for the CONTROL of TEMPERATURES and HUMIDITY, including:

Pneumatic Room and Insertion Thermostats and Humidostats.

Electric Room and Insertion Thermostats and Humidostats.

"Sylphon" Metal Diaphragm Valves.

High Grade Dampers of all Shapes and sizes.

Low Pressure, Limited Capacity, Electric Air Compressors.

Low Pressure, Limited Capacity, Hydraulic Air Compressors.

Air and Water Reducing Valves.

Pneumatic Switches or Push Buttons.

Specific Applications of Temperature Control

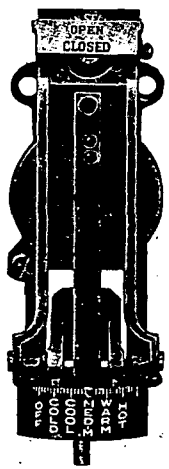
Bake ovens for enamels, japans, etc.
Core drying ovens.
Drying room for paint, varnish, patent leather, etc.
Storage room for tobacco, rubber or similar goods.
Cold storage rooms, fur vaults, etc.
Canning machinery, cookers, exhausters, processors.
Corn and oats drying apparatus.
Fruit drying apparatus.

Johnson All-Metal Thermostats

Every Johnson Thermostat is ALL-METAL throughout, having no soft or hard rubber parts to deteriorate and become inoperative. Every thermostat exquisitly made and thoroughly tested for accuracy, efficiency and durability.

Johnson Positive Thermostat

Has a snap action for closing and opening valves quickly, positively and fully, thereby assuring their durable and satisfactory operation. Has an indicator showing at a glance whether the heat is "ON" or "OFF." Has a convenient means for shutting off the heat when desired.



Model Positive Metal Diaphragm Thermostat

Johnson Intermediate Thermostat

Has all-metal movement, giving true graduated motion to mixing dampers for "Blast Heating Systems" and, where desirable, can be used to operate steam valves on a "Vacuum Heating System."

Johnson Compound Thermostat

The Johnson All-Metal Compound Thermostat combines the feature of both the Positive and Intermediate and is applicable for control of valves or dampers where certain units are to be operated positively and others intermediately at an interval of a few degrees in temperature.

Johnson Dual or Two-Temperature Thermostat

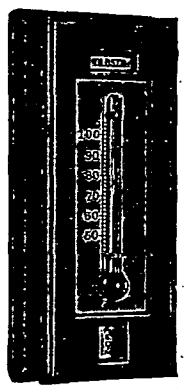
The Dual, or two-temperature Thermostat provides for a daytime temperature (usually 70°) and a night-time temperature (35° to 50°), as desired, for all or some of the rooms in a building, simply by the manipulation of a single push button by the engineer or other person in authority. It is a factor for the greatest economy in school buildings, a number of rooms of which are occupied at night as well as day, and for any buildings in which some of the rooms are occupied only at certain times, such as churches, auditoriums, masonic temples and lodges.

Thermostat Covers

The covers which conceal the thermostat proper are small, inconspicuous and very neat in design and workmanship.

There are two distinct styles: one called the **R** type and one called the **P** type.

The **R** type is a die-casting, very beautifully designed and used generally in residences and other handsomely decorated buildings.



Model R. I. Cover
4¾"x2"x1⅛" deep

The **P** type is a pressed metal cover, very finely finished but not as orna-

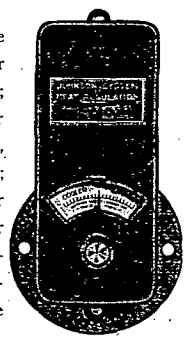
mental and artistic as the R cover, and used more generally in schools, office buildings, hospitals and places where simple and neat design is desired rather than artistic and ornamental.

Johnson Pneumatic Insertion Thermostat

Designed to control temperatures within closed air chambers or ducts. The body of thermostat is a dust-proof case containing the two working parts and extending outside the chamber.

This thermostat is made either positive or graduated acting.

Applications



Pneumatic Insertion Thermostat

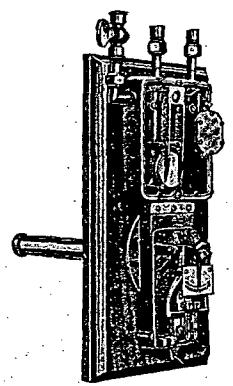
Adaptable for use in bake ovens for enamels, japans, etc.; drying rooms for paints, varnishes, patent leather, etc.; storage rooms for tobacco, rubber or similar goods; sterilizers or pasteurizers; cold storage rooms, fur vaults, etc.; refrigerator machine control; humidity control for air washers; flue gas temperature control; hot blast heating plants; combination tempered ventilation and hot blast systems; greenhouses, turkish bath rooms, etc.; tempered ventilation for buildings.

Johnson Calibrated Thermostat

This is an especially high grade insertion thermostat for use where it is desired to change frequently the adjustment to operate at different temperatures. It is operated by compressed air at 15 lb. per sq. in., and used to control temperatures of liquids and air by automatically opening and closing a diaphragm valve or damper. Graduations made to meet requirements, limited to a total range of 60 deg.

Multiple Insertion Thermostat

Similar to the insertion duct thermostat, excepting that one multiple thermostat takes the place of a number of separate duct thermostats set for different temperatures. The 4-point multiple thermostat shown will operate four separate diaphragm valves at as many different temperatures. It has become very popular with heating engineers for the control of heating and tempering coils where it is desired to have these coils turn on at different temperatures. It is made to work with *positive action when controlling valves*; with graduated action when controlling dampers; or with both positive and graduated action when controlling valves and dampers.



Multiple Insertion Thermostat

Tank Thermostat

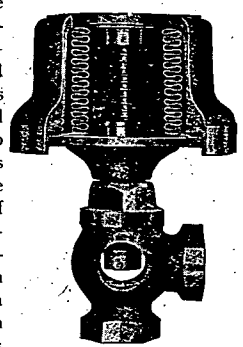
Designed for insertion through 1-in. tapped hole in tank and controlling, in the case of hot water tanks, a diaphragm valve on the supply pipe to the steam coils in the tank. It can be used to control the temperature of any liquid, either hot or cold. It is especially adaptable for controlling the temperature of water in hot water heating plants by its control of the boiler draft doors.

Humidostats and Humidifiers

The humidostat automatically controls the supply of moisture delivered to the air by a humidifier and maintains a constant percentage of relative humidity. It operates a diaphragm valve on the steam coils in the pan humidifier. The pan is provided with float box to maintain constant water level and is located in the ventilating air duct leading throughout the building. Steam jet and water spray types of humidifiers are also furnished.

"Sylphon" Metal Diaphragm Valves

This valve having an indestructible 1-piece metal diaphragm, is permanent and requires no repairs. Its value for the control of steam is obvious and particularly so in connection with steam coils, radiators in wall boxes where excessive heat would destroy rubber diaphragms.



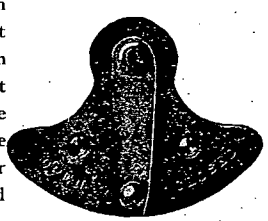
"Sylphon" Metal Diaphragm Valve

Humidity Control

The supplying of moisture to the heated air in buildings and the automatic control of the percentage of moisture in this air are recognized by authorities to be as important as maintaining proper temperatures.

Pneumatic Switch Control

Remote valve and damper control plays, by means of our pneumatic switches, a very important part in the economical operation of the modern heating plant especially in schools. It saves the janitor's time for other duties, and makes it possible to accomplish results in the operation of the heating plant which can not be obtained in any other way. It makes it easy to operate the fresh air, return air and vent dampers, with the corresponding assurance that these dampers will be economically operated as intended by the heating engineer.



Pneumatic Switch

The following types of pneumatic switches for different purposes and different conditions are made:

Lever Handle Switch,

Push Button Switch,

Indicating Switch, to open and close dampers partially as desired.

Electro Pneumatic Switch, to open and close dampers automatically—with the starting and stopping of fan motors.

How to Specify

Furnish and install a complete system of automatic temperature regulation and humidity control, furnishing all necessary thermostats, valves, dampers, humidifiers, special devices, air compressors, piping and fittings, and labor of installing system, except setting valves and dampers in position—all in accordance with the following schedule and detailed specification:

SCHEDULE—State the rooms to be controlled and number of thermostats in each; the manner in which the tempered air, if there is any, is to be controlled; the manner in which the drafts of the boiler are to be controlled; and specify the manner of the control of any fresh air, vent or return air dampers, stating the location and number of switches.

THERMOSTATS—Where the greatest economy of fuel and the most flexible handling of the heating system is desired specify the Johnson Dual or Two-Temperature thermostat and that it shall operate at all times at one set pressure not less than 15 lbs. per square inch. If dual thermostats are not desired specify Johnson Metal Diaphragm Model Thermostat, size, 4½ x 2 x 1 in.; and state whether it is to have residence or school cover, indicating device, positive shut-off, and whether it is to be positive or intermediate motion. Specify the number and kind of inserted thermostats.

VALVES—Specify Johnson Metal Diaphragm Valve having the "Sylphon" Metal Bellows for its diaphragm. State whether valves are to be plain or nickel-plated with or without unions; add: Valves to be placed in position by heating contractor.

AIR COMPRESSORS—Specify kind of air compressor (steam, hydraulic, electric or power driven), requiring that the air compressor shall be of sufficient size to operate the system, with a factor of safety not less than 3, and requiring that it be provided with all necessary governing devices, fittings, gage, etc.

HUMIDOSTATS—Specify Johnson Humidostat and Humidifier, stating the kind of humidifier, whether perforated steam or copper evaporating pan.

DAMPERS—Specify that dampers shall be made by the heat regulating contractor, but installed by the galvanized iron contractor, and that dampers shall consist of wrought iron frames, sheet steel blades, strongly cleated, with brass bearings.

GUARANTEE—Require that system be complete in every respect, and that all necessary material and special fittings shall be furnished whether specifically mentioned or not. Require that entire system be guaranteed free from all original defects in material and workmanship, and that any parts proving defective or wearing out within 2 years from date of completion shall be replaced free of charge. Require that thermostats shall operate the valves or dampers to which they are attached, at a variation of not to exceed 1 deg. above or below any given point.

Contracting

This company contracts to furnish and install in complete working order the Johnson System of Temperature Control, including thermostats, valves, piping, etc., and gives annual inspection and prompt service to all plants constantly.

THE POWERS REGULATOR CO.

34 years of specialization in temperature control

GENERAL OFFICES AND FACTORY
CHICAGO, ILL.
2719 GREENVIEW AVENUE

GENERAL EASTERN OFFICES
NEW YORK, N. Y.
126 EAST 44th STREET

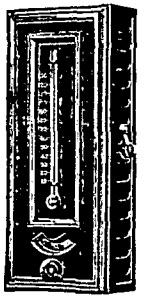
BRANCHES AND SERVICE STATIONS

ATLANTA, GA.
BALTIMORE, MD.
BOSTON, MASS.
BUFFALO, N. Y.
BUTTE, MONT.
CHARLOTTE, N. C.
CHATTANOOGA, TENN.
CINCINNATI, OHIO
CLEVELAND, OHIO
DENVER, COLO.
DES MOINES, IOWA
DETROIT, MICH.
EL PASO, TEXAS
HOUSTON, TEXAS
INDIANAPOLIS, IND.
KANSAS CITY, MO.
LOS ANGELES, CALIF.
MILWAUKEE, WIS.
MINNEAPOLIS, MINN.
NASHVILLE, TENN.
NEW ORLEANS, LA.
PHILADELPHIA, PA.
PITTSBURGH, PA.
PROVIDENCE, R. I.
ROCHESTER, N. Y.
ST. LOUIS, MO.
SAN FRANCISCO, CALIF.
SEATTLE, WASH.

THE CANADIAN POWERS REGULATOR CO., LTD., TORONTO, ONT.

BRANCHES
CALGARY, HALIFAX, MONTREAL, VANCOUVER, WINNIPEG (3306)

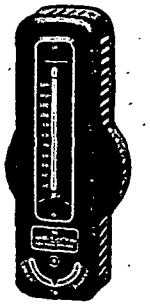
Products


D Thermostat

Automatic Temperature Controlling Systems, applying them, under the supervision of the Powers engineers, to the heating plants, new or old, in residences, offices, factories, schools, institutions, and to any other conditions of artificial heating where uniform temperature is desired.

Automatic Regulators for ACCURATELY controlling temperature and pressure of Liquids, Gases and Air, Pressure Reducing Valves, Steam Traps, Humidity Control Devices, Shower Mixing Valves, Etc.

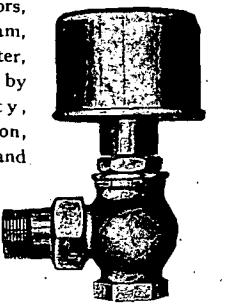
Temperature Controlling Appliances


K Thermostat

Powers thermostats are accurate in their working and will maintain their adjustment. They are of the vapor disc type, exclusive with Powers regulators, and are not thrown out of adjustment by extremes of temperature or long disuse. For over thirty years the accurate control obtained by this method has been the standard of thermostatic control by which all other methods are measured. In design, Powers thermostats are second to none in beauty and perfection of finish; in size, as small as is consistent with the reliability so necessary in such instruments; in operation, sure, with gradual or positive action, as conditions require.

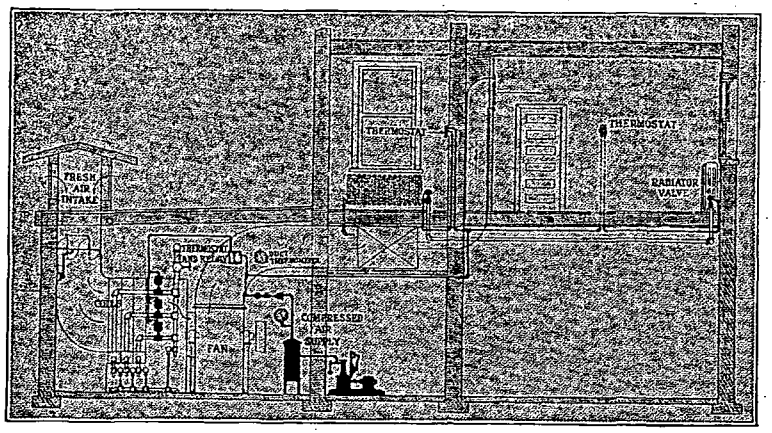
Diaphragm radiator valves, diaphragm motors, mixing dampers and other equipment are especially rugged in construction, dependable and durable; built regardless of expense, whenever strength is needed for efficiency and long service.

Motive power used in these systems is compressed air. The company builds its own air compressors, operated by steam, electricity or water, and characterized by their reliability, noiseless operation, perfect control and long life.


All-Metal Radiator Valve

Installations

Installations of Powers systems are invariably made by this



Application of Powers Control to Combination (Split) System of Heating—Direct radiation supplies the heat; fan supplies warm air for ventilation. Thermostats control valves on radiators to maintain proper room temperature. Ventilating coils are controlled by a thermostat placed in the fan discharge duct.

company. At each branch office is maintained a competent engineering and erecting force, sparing no expense to maintain the highest efficiency. Powers special devices, however, are easily installed by any engineer or contractor.

Prices

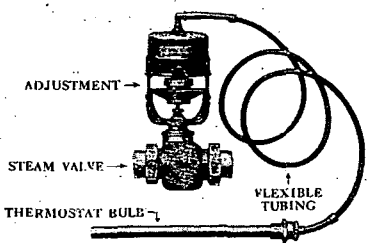
Price for Powers regulation covers the system installed complete, and is only named after a careful study of the requirements. Our price is not lowest, but no other system will be found so efficient and economical. Customers are served with the sole aim of getting results for them; and experience shows that **satisfactory service from a temperature controlling system is of much more importance than its first cost.**

Specifications

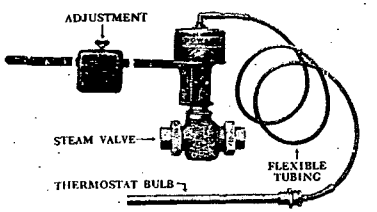
Heating systems, and the requirements for temperature control, vary widely in detail. Much of the dissatisfaction experienced with some systems of temperature regulation is due to the attempt to force a ready-made inflexible system or device to meet special requirements, taking no account of the conditions peculiar to the situation to be treated.

For these reasons we believe special study should be given each case. We shall be glad to submit to any Architect or Engineer a detailed Specification, accompanied by a guaranteed price, to cover complete system of temperature control installed, the price to hold if specification is used. This guarantees full protection to the client against advantage being taken of a close specification. This company will gladly collaborate with Architect or Engineer in preliminary plans. As specialists in temperature control, The Powers Regulator Company has unusual facilities for solving problems in this particular field.

The Powers No. 11 Tank Regulator



Spring Type



Lever Type

Used on steam heated hot water service in hotels, apartment buildings, offices, schools, shops, hospitals, factories, laundries, etc. Because this regulator prevents overheated water, it saves fuel and prolongs the life of valves and packings. Self-operating; easily installed. Of great durability, guaranteed accurate and positive in action.

In ordering, always give size of tank, steam pipe size, steam pressure, and temperature wanted.

The spring type regulator is commonly used for this work, except in sizes larger than 4-inch, when the lever type is used. Smaller sizes will be furnished in lever type if preferred.

The regulator will be furnished to operate at 160 deg. fahr., with adjustability 20 deg. above and below that point, unless otherwise specified.

Flexible connection tube is 6 ft. long for sizes 1½-inch and smaller; 8 ft. for 2-inch to 4-inch, inclusive; and 10 ft. for larger sizes. Additional lengths of tubing will be furnished at $1.00 per ft. A net charge of $2.00 is made for flexible tubing shorter than standard.

The valve in all sizes is of the double seated balanced type. Companion flanges will be furnished, if desired, at market prices. Flanged valves will be drilled standard unless otherwise ordered.

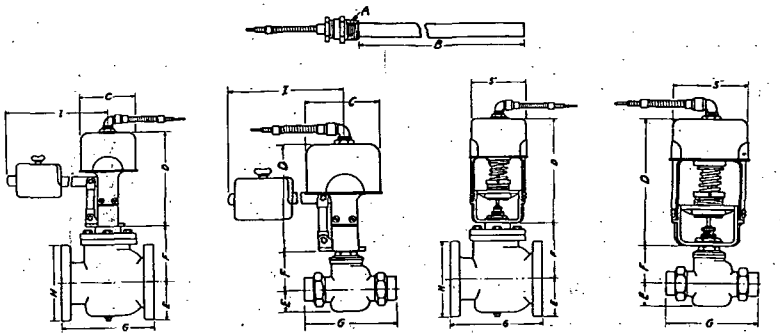
Specify standard valve for steam pressures up to 100 lbs. and monel fitted valve for steam pressures above 100 lbs.

Specifications

In connection with the (steam heated) hot water storage tank, furnish and install Powers No. 11 Tank Regulator with (..... inch) standard (monel fitted) valve with standard length of flexible tubing. Regulator shall maintain the temperature of the water at (..... deg.) with steam pressure at (.....lbs.).

NOTE—Where installation is to control steam coil and auxiliary coal burning heater, specify No. 12 Regulator with chains, pulleys, etc., for the control of dampers on auxiliary heater (see Bulletin No. 129).

For coal burning heaters without steam coils, use Powers No. 13 Regulator (see Bulletin No. 136).



Hot and cold water should always come from the same original source, or at least be under substantially the same pressure. For best results, this pressure should not exceed 100 lbs. Use a pressure reducing valve if necessary.

In ordering, state fully the purpose for which controller is to be used, with temperature required, and range of adjustment desired.

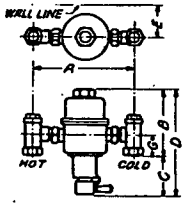
Specifications

In supply to group of showers (fixtures) in shower room (toilet or bathroom), furnish and install Powers Thermostatic Water Controller No. (.....), placing it as close to fixtures as possible.

NOTE—Provide that plumber include stop valves in hot and cold water supplies.

CAPACITIES	Connections, Inches		Shipping Weight, Pounds	Price
	Inlets	Outlets		
No. 1—Individual shower, 15 gallons per minute	½	¾	35	$100
No. 3— 4 shower heads, 25 gallons per minute	¾	1	35	125
No. 4— 8 shower heads, 50 gallons per minute	1	1¼	50	150
No. 5—15 shower heads, 80 gallons per minute	1¼	1½	85	175
No. 6—20 shower heads, 100 gallons per minute	1½	2	90	185

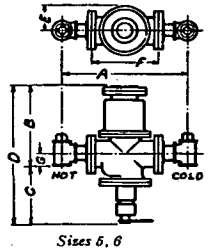
Capacities are based on 40 pounds water pressure.



Sizes 1, 3, 4

SIZE NO.	UNION INLET SIZE	NIPPLE SIZE	A	B	C	D	E	F	G
1	½	¾	9	6⅝	7⅜	14⅜	4	—	1⅞
3	¾	1	10½	6⅞	7⅜	14⅜	4	—	1⅝
4	1	1¼	12¾	8⅜	5¼	14⅜	4	—	2
5	1¼	1½	16	12⅜	9¾	22⅜	4	9	1¾
6	1½	2	16¾	13⅛	9¾	22⅜	4	9	1⅞

ROUGHING-IN DIMENSIONS



Sizes 5, 6

Other Power Specialties

No. 18 Regulator for use with room, factory, and warehouse heating systems, residence heaters, railroad stations, low temperature drying systems, etc. An exceedingly sensitive and durable regulator of the self-contained type for control of air temperatures between 60 and 100 deg. fahr., where such control can be obtained by the operation of a single valve governing the supply of heating medium. Also for control of heat dampers and gas valves. Bulletin No. 145.

No. 10 Damper Regulator for the control of hot water heating apparatus in hotels, apartment buildings, etc., heated by hot water circulation. Bulletin No. 116.

No. 15 Regulator, self-contained, for the control of drying rooms, dry kilns, ovens, etc. Bulletin No. 138.

Dial Thermometers for air ducts and hot water tanks. Accurate, easy to read, reasonably priced. Bulletins No. 140 and No. 155.

Shower Mixing Valve.—Two remarkable features found only in the Powers Shower Mixer make it superior to any other mixing valve made. They are a PRESSURE EQUALIZING VALVE and a SAFETY STOP. They prevent scalding and annoying temperature changes in shower baths caused by: (1) pressure changes in supply lines due to use of nearby showers, faucets and flush valves; (2) failure of cold water supply; (3) "dead ends" in hot water supply line. It saves fuel by eliminating waste of hot water and reduces decorating expenses by preventing steamed-up bathrooms. Bulletin No. 154.

Steam Trap, ⅜-inch and ½-inch sizes only, for pressures from 5 lbs. to 125 lbs. Used on restaurant fixtures, hospital sterilizers, heating coils, cooking kettles, etc. Bigger capacity than any other trap its size. Acts quickly, closes tight. Gives 3 to 6 years of dependable service without replacement of thermostatic element. Bulletin No. 115.

Hospital Sterilizer Control Valve—Makes sterilizer noiseless and saves steam. Bulletin No. 122.

Thermostatic Steam and Water Mixer—Automatically heats cold water with high pressure steam and delivers warm water at any temperature up to 120 deg. fahr. Bulletins No. 137 and No. 137-A.

Style D Steam and Water Mixer—Small, non-thermostatic mixer; supplies warm water for wash sinks, shower baths, and processes requiring a low cost warm water supply. Safe against scalding, easy to install, noiseless. Heats only the amount of water desired at the time. Capacity 10 gals. per min. with 40 lbs. pressure on supply lines. Bulletin No. 137-A.

Pressure Reducing Valve for steam, air and water. Simple, durable, accurate. Bulletin No. 118.

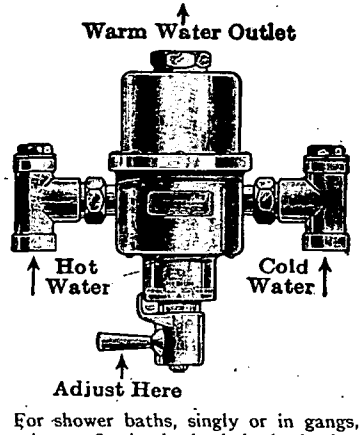
Complete set of bulletins describing the entire Powers line will be sent upon request.

THE POWERS No. 11 TANK REGULATOR—Prices and Principal Dimensions

Valve Size, Inches	½	¾	1	1¼	1½	2	2½
List Price (Standard Valve)	$60	$65	$70	$75	$80	$90	$95
List Price (Monel Valve)	$70	$76	$82	$90	$98	$113	$122
Style of Body	Union	Union	Union	Union	Union	Screwed	Screwed
Material of Body	Brass	Brass	Brass	Brass	Brass	Iron	Iron
Dimension A, Inches	1	1	1	1	1	1	1
B, "	10	10	12	14	14	16	16
C, "	5	5	5	5	5	5	5
D, "	7¼	7¼	7¼	7¼	7¼	8¼	8¼
E, "	2	2⅛	1¾	1¾	2	2⅝	3½
F, "	2⅛	2⅝	2⅜	2⅝	3¼	3⅝	5⅜
G, "	5½	5¼	6⅝	6⅞	7⅛	8	9
H, "							
I, "	29	29	29	29	29	29	29

Valve Size, Inches	3	3½	4	5	6	8
List Price (Standard Valve)	$100	$110	$120	$175	$225	$275
List Price (Monel Valve)	$130	$145	$160			
Style of Body	Screwed	Flanged	Flanged	Flanged	Flanged	Flanged
Material of Body	Iron	Iron	Iron	Iron	Iron	Iron
Dimension A, Inches	1	1	1	1¼	1¼	1¼
B, "	18	20	20	20	20	24
C, "	5	5	5	5⅞	5⅞	5⅞
D, "	8¼	8¼	8¼	13⅜	13⅜	13⅜
E, "	3⅝	4¼	4½	5	5½	6¾
G, "	5⅝	5½	5½	6⅛	8	9
F, "	9	10¼	10¼	12	13⅛	16⅞
H, "		8½	9	10	11	13½
I, "	29	29	29	29	29	29

Thermostatic Water Controller



For shower baths, singly or in gangs, continuous flowing baths, baby baths, hot water-line control, lavatories, factory washrooms, garages, laundries, and various industrial processes where warm water at a constant temperature is required.

This controller is accurate, dependable and reasonably priced. It mixes hot and cold water, and delivers warm water at the temperature for which it is adjusted. Entirely automatic in operation, and positively scald-proof. Failure of cold water supply will instantly cut-off the delivery. Controllers can be furnished for any desired temperature between 70 and 135 deg. fahr. Provided with variable or locked adjustment, as may be preferred. Unless otherwise specified, controller will be furnished with a maximum temperature of 110 deg. fahr.

While extremely hot water may be needed for laundry or kitchen use, bathroom fixtures, for the sake of economy and safety, should be supplied with water at a lower temperature. The Thermostatic Water Controller, installed in the hot water line, may be used to separate bathroom service from the other. Controllers for this purpose should be so specified, and will be set to deliver at a maximum of 135 deg. fahr. For continuous flowing baths specify downward discharge if wanted, otherwise upward discharge will be supplied.

Controllers Nos. 1 to 4, inclusive, are made of brass, in either plain finish or full nickel-plate. Made in special metals if desired—prices on application. Controllers Nos. 5 and 6 have iron bodies, aluminum paint finish, with bronze inner parts. All controllers are furnished with inlet check valves and removable filter screens.

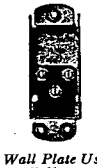
Honeywell Heating Specialties Company

Wabash, Indiana

Manufacturers of Honeywell Temperature Regulators for Residential or other Heating Plants—Hot Water, Vapor, Steam, or Hot Air.



Type R Automatic Thermostat



Wall Plate Used on all Honeywell Thermostats

The HONEYWELL Temperature Regulator is an automatic device which opens and closes the dampers of the heater (any type) whenever the room temperature varies one degree from that for which the Regulator is set.

The HONEYWELL Temperature Regulator has but two parts, the thermostat and the motor. The thermostat is placed on an inside wall at some central location and electrically controls the operation of the motor, which is located near and connected to the heater.

The automatic regulation so effected insures a constant temperature, day and night, minimum fuel consumption and maximum comfort and health. The cost of operation, even with the electric motor models, is negligible.

The Regulator is made in three types, Gravity Motor, Spring Motor, and Electric Motor; and nine models, three of each type. The first model of each type is equipped with plain thermostat, requiring manual adjustment for day and night temperatures. The second model of each type is equipped with one-day clock pattern thermostat which automatically brings the room temperature to the degree for which the Regulator is set, at any predetermined hour. The third model of each type is equipped with eight-day automatic thermostat which automatically regulates both the day and night temperatures, at any predetermined degree and hour, without manual adjustment of any kind.

PRICES

Including all wire, chain, pulleys, brackets, etc., necessary for installation.

These prices are subject to trade discounts.

Gravity Motor Models

TYPE G-Q, with Plain Pattern Thermostat, no clock $38.00

TYPE G-6, with One-day clock pattern thermostat, semi-automatic night-to-day temperature regulation 45.00

TYPE G-R, with 15-20 day Jewelled Balance Clock Thermostat, automatic night-to-day temperature regulation 58.00

Spring Motor Models

TYPE S-Q, with Plain Pattern Thermostat, no clock $45.00

TYPE S-6, with One-day clock pattern thermostat, semi-automatic night-to-day temperature regulation 52.00

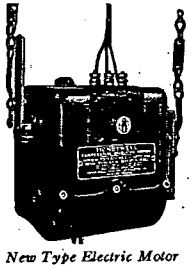
TYPE S-R, with 15-20 day Jewelled Balance Clock Thermostat, automatic night-to-day temperature regulation 65.00

Electric Motor Models

TYPE D-Q, with Plain Pattern Thermostat, no clock $70.00

TYPE D-6, with One-day clock pattern thermostat, semi-automatic night-to-day temperature regulation 77.00

TYPE D-R, with 15-20 day Jewelled Balance Clock Thermostat, automatic night-to-day temperature regulation 90.00



New Type Electric Motor

The Dole Valve Company

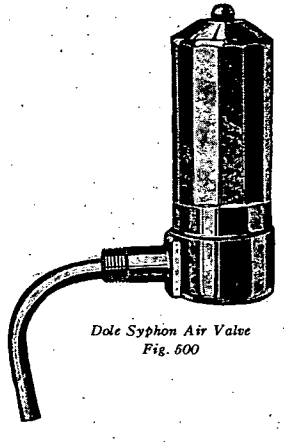
1923-1933 Carroll Avenue, CHICAGO, ILL.

Manufacturers of a Complete Line of High Grade Radiator Valves and Automatic Air Valves

DOLE SYPHON AIR VALVES

Seating Pin—finely machined hard metal seating point, hydraulic pressed to perfect radius, preventing possibility of sticking or binding.

Float—made of light but strong annealed brass, rising when water enters the valve and positively prevents leakage.



Dole Syphon Air Valve Fig. 500

Inner Chamber of Float—contains exactly proper amount of thermostatic liquid, which forms a powerful gas the instant steam comes in contact, expanding diaphragm and closing valve against escape of steam or water.

Diaphragm—made of special spring bronze, convex shape, corrugated. Expands with heat, contracts back when cold, thus opening and closing valve automatically.

Float Rest—one-piece, finely drawn brass, open on four sides to permit water to drain through syphon. Firmly braced into base, forming strong, substantial rest for float.

Venting Seat—heavy construction, threaded and brazed into valve casing, thus preventing possible injury to venting seat after valve is installed.

Syphon Lock Collar—made of extra heavy brass, firmly brazed to syphon, preventing either accidental or intentional removal of syphon from valve.

Base—heavy drawn brass, threaded on interior to meet exterior thread on casing. Firmly braced on casing to insure strength and durability.

Syphon—made of one-piece annealed brass tubing, formed to perfect shape to fit inside of radiator column. Assembled into valve free from obstruction, thus permitting air valve to be attached to radiator syphon. Always hanging in proper position inside of radiator.

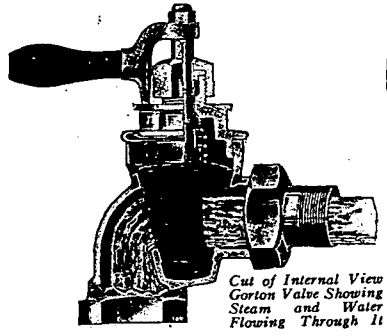
GORTON PRODUCTS

ESTABLISHED 1887

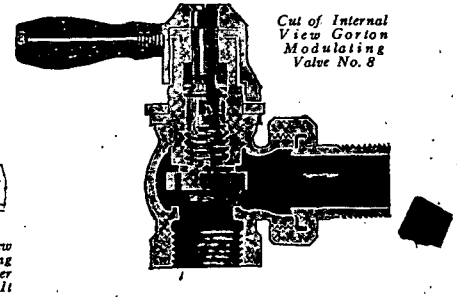
Gorton & Lidgerwood Co.

GENERAL OFFICES
96 Liberty Street NEW YORK CITY

Manufacturers of High-Grade Heating Equipment for over Thirty-five Years



Cut of Internal View Gorton Valve Showing Steam and Water Flowing Through It



Cut of Internal View Gorton Modulating Valve No. 8

Gorton Quarter Turn Packing Lock Radiator Supply Valve for all Systems of Heating.

Made in Sizes from ½ in. to 1½ in.

Gorton Packing Lock Modulating Valve No. 8 for two-pipe Vapor and Vacuum Heating Systems.

Made in sizes from ½ in. to 1¼ in.

All Gorton Valves can be furnished with lock-shield and key, extension stems, straightway pattern, with and without union, wheel and chain pull for overhead operation.

The Packing Lock is patented and an exclusive feature with **Gorton Valves.** It is a superior type of packing and the **Packing Lock Device** will remain tight as long as the valve body lasts.

GORTON SYSTEM

SINGLE PIPE VAPOR HEATING

A Vapor System that anyone can afford, since it is economical to install and maintain while giving practical heating results equal to any system.

Gorton Magazine Feed All Wrought Plate Tubular Heating Boilers

Improved grates and welded seams mark the only improvements necessary in over 40 years of use. The design still marks the height of efficiency in heating boilers.

Literature and Complete Data Gladly Furnished. Specify "Gorton" for Quality

Jenkins Bros.

Manufacturers of Valves and Mechanical Rubber Goods

PRINCIPAL STORES AND OFFICES

80 White Street, NEW YORK, N. Y. — 524 Atlantic Avenue, BOSTON, MASS. — 133 North 7th Street, PHILADELPHIA, PA. — 646 Washington Boulevard, CHICAGO, ILL.

FACTORIES IN ELIZABETH, N. J. AND BRIDGEPORT, CONN.

JENKINS BROS., LIMITED

CANADIAN WORKS AND HEAD OFFICE: MONTREAL, QUE., 103 St. Remi Street
LONDON OFFICE: 6 Great Queen Street, Kingsway, W. C. 2



Fig. 106, Bronze Globe, Screwed



Fig. 352, Bronze Swing Check Valve



Fig. 166, Bronze Radiator Angle, Screwed

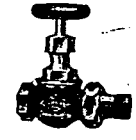


Fig. 167, Bronze Radiator Globe, with Union

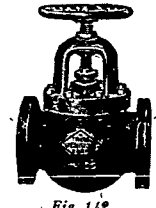


Fig. 142, Iron Body Globe, Flanged

PRODUCTS

Jenkins Globe, Angle, Cross, Check, Hose, Blow-Off, Safety and Gate Valves; Radiator Supply Valves; Automatic Radiator Air Valves.

Also, Rapid Action Valves; Steam Traps; Gage Cocks; Marine Valves; Needle Valves; Valve Discs; Jenkins '96 and Jenarco Sheet Packing, Gaskets, Pump Valves; Compressed Asbestos Jointing.

Renewable Disc, Bronze and Iron Body Valves, Standard Pattern

Jenkins valves, standard pattern, all have a renewable disc which assures absolute tightness, and perfect seat contact. For steam use, the discs are made of hard composition, which becomes pliable under the action of steam; for water, gas and air service, somewhat softer compounds are furnished.

If grit or scale lodges on the seat it does not seriously injure the valve body, but becomes embedded in the composition disc, thus saving the valve seat. Discs worn out in service can be replaced easily and quickly at very little expense. All parts are standardized and perfectly interchangeable. Valves seldom wear out completely.

Radiator Valves

Jenkins globe and angle radiator valves are of the same pattern and construction as the standard pattern valves. They are carefully made of a superior grade of metal, and are unusually heavy and durable.

Finished valves take a rich bronze color when polished, making them particularly desirable for the finer grades of work.

Regularly furnished with black composition wheels, or, if desired, with brass, wire or iron wheels.

Lock shield valves, to be operated with key, designed to prevent tampering, can be supplied in all the different patterns.

Corner valves are made in two patterns—regular and offset. Offset globe and corner valves have the inlet at the lowest point, to avoid trapping of water and hammer on first admission of steam.

For hot water heating, valves may be had, without extra charge, with a small hole drilled through diaphragm to permit slight circulation of water through radiator.

When specified for hot water heating systems *using forced circulation*, valves are specially fitted for the service.

Regular styles of finish follow:

Rough body, finished trimmings, No. 1 screwed, No. 6 with union.
Finished and polished all over, No. 2 screwed, No. 7 with union.
Rough body, nickel-plated trimmings, No. 3 screwed, No. 8 with union
Rough body, nickel-plated all over, No. 4 screwed, No. 9 with union.
Finished and nickel-plated all over, No. 5 screwed, No. 10 with union.

Catalog

A catalog of all the Jenkins valves, giving sizes, styles and list prices, mailed on request.



Fig. 370, Bronze Gate, Screwed

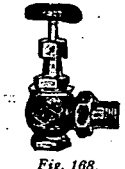


Fig. 168, Radiator Angle, with Union



Fig. 325 Iron Body Gate, Screwed

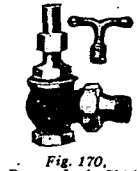


Fig. 170, Bronze Lock Shield Radiator Angle, with Union

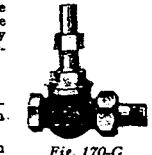


Fig. 170-G, Bronze Lock Shield Radiator Globe, with Union

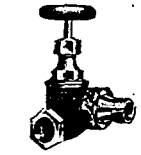


Fig. 180, Bronze Offset Corner, Radiator with Union

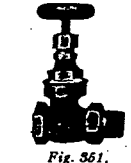


Fig. 351, Bronze Radiator Gate, Screwed



Fig. 165, Bronze Radiator Globe, Screwed

Marsh Valve Company

Plant and General Offices: DUNKIRK, NEW YORK

Exclusive Sales Distributors:

APPLETON & LIPTROTT, INC., 1480 Broadway, New York City

Edward T. Hetherington,
1718 Samson Street, Philadelphia, Pa.

United States Radiator Corporation,
General Offices, Detroit, Mich.

All territory east of West lines of Michigan and Ohio and north of Virginia, except New York and Philadelphia

John W. Mabbs,
431 S. Dearborn Street, Chicago, Ill.

Jas. P. Marsh & Company,
118 S. Clinton Street, Chicago, Ill.

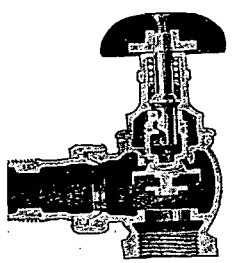
All territory south of Ohio River and west of Michigan and Ohio, except Cook County, Chicago, Ill.

We specialize on high-grade Radiator Valves and make the largest line of any company in the world.

The re-enforced packless feature of our Packless and Modulated lines both steam and water and the upper seat features of our Union Bonnet, Special and Gate lines are distinctive, scientific, mechanical principles, used with these lines exclusively.

MARSH RE-ENFORCED PACKLESS RADIATOR VALVES

Oval Wheel or Lock Shield



Flat-Disc

All sizes and patterns Globes, Angles Corner and Back Offsets

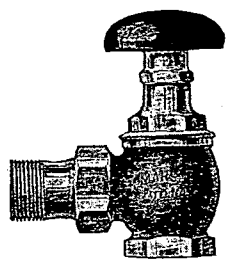


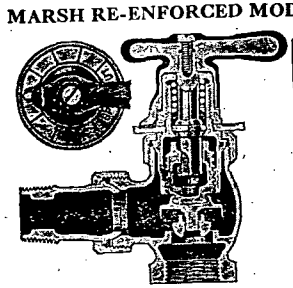
Fig. 135

We call particular attention to the scientific mechanical construction of the Re-enforced Cone Metal Packless Feature of our Modulated and Packless Valves. These are the only Packless Valves in which the Packless feature is re-enforced or in any way protected against leakage due to wear or cracks of so-called Packless parts and are GUARANTEED against wear or defects of Packless construction and leakage through bonnets.

QUICK OPENING

A three-fourths turn will fully open a three-quarter inch valve, and from this up to one and one-quarter turns for balance of line through two inches. These valves, account of low pitch of thread due to large diameter of cylinder, will seal and lock against any pressure.

MARSH RE-ENFORCED MODULATED LEVER HANDLE RADIATOR VALVES



Flat-Disc

These Valves may be had with Oval Wheel in place of Lever Handle same as Fig. 139

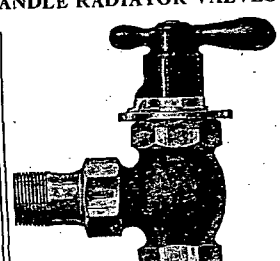
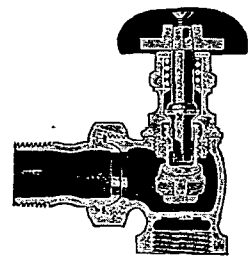


Fig. 131

The Modulation or Graduation is accomplished by a double cone disc nut, regulating volume of steam, according to pressure, until indicator registers valve about two-thirds open, when lower cone on disc nut is brought into use and the further turning of lever handle until indicator registers open, will give full valve capacity; a feature of material value in a valve in which volume or capacity for modulating purposes is choked down, and to meet extreme weather conditions, full pipe capacity is required.

MARSH RE-ENFORCED PACKLESS CONE DISC RADIATOR VALVES

Oval Wheel or Lock Shield



Cone-Disc

These Discs will not crack or leak through valve seat.

No clogging or water hammer from return condensation

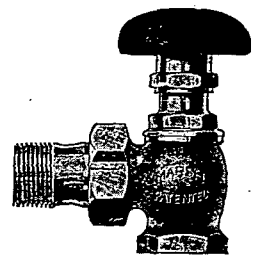
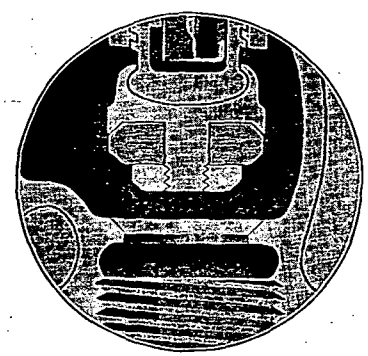


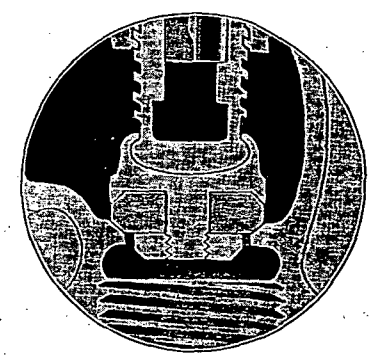
Fig. 141

Marsh Cone Discs are without question the greatest improvement in radiator valve construction in the past fifty years or since the composition disc replacing the old style metal-to-metal disc and seat.

This Cone Disc construction combined with the Marsh Re-enforced Packless Feature is the last word in completing radiator valve maximum efficiency at popular price, all of which will check 100 per cent true upon investigation.



¾ in. Full Size



Positive Seal

The above views showing cone disc and beveled seat are to actual size of a ¾ in. valve and are made to full size to show the following advantages of this construction over the old style flat disc and seat:

First: Through design of disc and protection afforded from disc nut covering under surface they will not warp and crack as will a flat disc which overhangs valve seat.

Second: The compression is at right angles to face of seat, forcing disc compound inward to center, making disc more compact and harder instead of scoring and extruding over seat, opening cracks or seams if any, as with a flat disc.

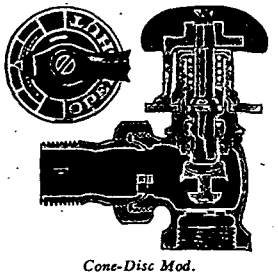
Third: While the life of these cone discs because of construction, as proven by tests, is three to five times the life of a flat disc, and a CRACKED DISC IS IMPOSSIBLE, the matter of exchange if desired is very simple, as to remove disc nut the disc will drop from disc-holder, while with a flat disc it must be dug out, often destroying disc-holder. Further, these cone discs are reversible and can be turned over or replaced with new at the same cost as for a flat disc.

Fourth: The beveled seat is low in valve body, giving perfect drainage and will wash free from sand or scale in system, positively providing against leakage through scale or grit imbedding in disc AS IS COMMON with a raised flat seat and flat disc construction.

Fifth: Through this low beveled seat, to return condensation through valve for a one-pipe system, the flow will hold to the outer wall leaving center of valve throat and pipe free rather than shoot out over a raised seat to the center of pipe as is common with a heavy flow over a flat seat, clogging flow of steam, causing hammer or pounding of system.

The foregoing are all, each and every one, practical points which will prove out in test and practice. Positively a better valve at a less cost than can be had from any other source.

MARSH RE-ENFORCED MODULATED CONE DISC RADIATOR VALVES



Cone-Disc Mod.

Oval Wheel, Lever Handle or Lock Shield

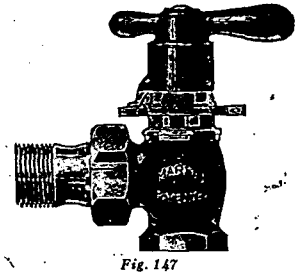


Fig. 147

The Modulation feature of our Cone Disc Line is the same as with our union bonnet flat disc Figure 131.

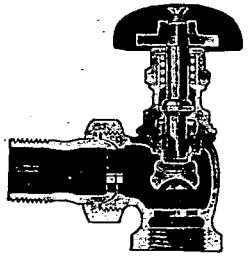
Our Cone Disc Modulated valves unless otherwise ordered are fitted with Oval Wheel, the same as our Graduated Water valve, Figure 139.

With our Oval Wheel Handle you have the same dial and indicator control as with Lever handle and a much stronger and more serviceable CONSTRUCTION than is possible with a Wood wheel as this composition won't break or split as will wood.

Further, this wheel is removable and interchangeable with our Lever handle, effecting a material advantage to customer in matter of convenience of changing from one to the other on job if for any reason change is desired.

MARSH RE-ENFORCED PACKLESS WATER RADIATOR VALVES

Oval Wheel or Lock Shield



Packless

A Genuine Packless Water Valve Guaranteed to hold any pressure required for forced circulation

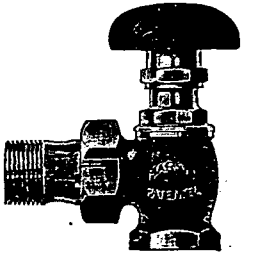


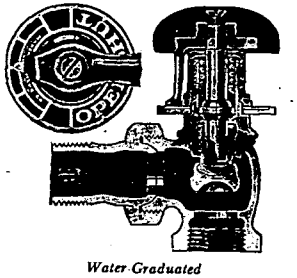
Fig. 137

Marsh re-enforced packless Hot Water Radiator Valves are not only a boon but the answer to hot water heating problems, permitting the same ease of operation and complete temperature control as with steam.

These hot water valves are quick opening, can be operated—opened and closed—with perfect ease by a child and positively will not stick or leak.

They will hold high pressure suitable for forced circulation up to any pressure radiation will stand, and cost no more than the cheap competition valves.

MARSH RE-ENFORCED GRADUATED WATER RADIATOR VALVES



Water Graduated

Oval Wheel, Lever Handle or Lock Shield

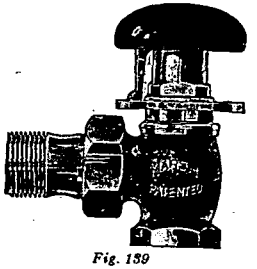


Fig. 139

SOMETHING ENTIRELY NEW IN WATER HEAT REGULATION

We have made a special study of hot water heat regulation and control and are pioneers in the matter of individual radiator control, through a graduated valve, employing the same principle as with steam. If you can modulate, graduate, or regulate individual radiator vapor or vacuum steam heat through a valve (and you can), then why not by the same principle regulate water heat, and, for that matter more consistently than steam, as with water you have something to regulate, while with steam, to allow fire to drop below a given point, you have nothing.

For sleeping rooms, heat regulation with the Marsh Graduated water valves may be controlled with the same ease of operation and certainty of results as is possible with a Modulated valve on a steam system, and at a much less cost than for a vapor or vacuum system installation.

Further, water circulation for each radiator, graduating for same or balancing of system, can be increased from nothing to full pipe capacity and held or locked at any intermediate point, if desired, by simply turning dial so that stop on same will register against indicator or pointer and locking dial in this position, preventing further opening of valve or turning of wheel or lever handle to the left.

These valves cost but little more than our regular water valves and much less than steam modulated valves.

Pierce, Butler & Pierce Mfg. Corp.

41 East 42nd Street **NEW YORK CITY**

Factories

EASTWOOD, SYRACUSE AND OSWEGO, N. Y.; HUNTINGDON, PA.; ZANESVILLE, OHIO

Branch Offices

BALTIMORE	DETROIT	NEW LONDON	PITTSBURGH
BOSTON	JACKSONVILLE	NEW YORK	SAVANNAH
BROOKLYN	NEWARK	PHILADELPHIA	SYRACUSE
CLEVELAND			WORCESTER

Radiator Valves, High Pressure Valves, Hot Water Valves, Hot Water Thermometers, Pressure and Altitude Gages

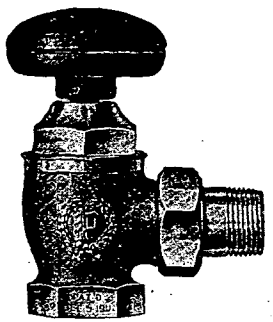


Fig. 136. Angle Valve with Union
(With Genuine Jenkins Bros. Disc)

A Newly Designed PIERCE PACKLESS VALVE for Vapor, Water or Steam

This new addition to the Pierce Packless line of Radiator Valves made by the Pierce, Butler & Pierce Manufacturing Corporation, is an especially compact and pleasing pattern. It is generously proportioned and embodies the best attainable in point of material and workmanship.

Genuine Jenkins Brothers discs are used. The handle is of the mushroom type made of Bakelite, beautifully polished, which is a perfect heat insulator, insuring against discomfort in manipulating the valve.

The body is sturdy in its proportions, and consequently is not likely to be injured or distorted in the process of installation. The nickel plating is unusually heavy and substantial.

This pattern is made in the angle type only, both plain and with modulating dial and button, in sizes ½ to 2 in., inclusive.

The John Call Company

VENTILATING SPECIALISTS

128 North Franklin Street **PHILADELPHIA, PA.**

BRANCHES IN ALL PRINCIPAL CITIES

ROOF VENTILATORS AND WINDOW VENTILATORS



Products

The Liberty Ventilator. A roof ventilator for any type building or enclosure, such as Schools, Hospitals, Foundries, Barns, Churches, Armories, Residences and similar structures.

Also highly efficient for increasing draft in chimneys, flues, stacks, etc. Back drafts impossible, regardless of wind conditions. Rain or snow cannot penetrate. No moving parts to rattle or require attention. Substantially and staunchly built of any metal desired. Large stocks for prompt shipment.

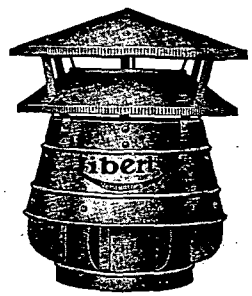
The Pul-Air Impingement Ventilator



The Pul-Air Ventilator

A good practical roof ventilator of the mushroom type, consisting of a double-cone top. Scientific storm band and impingement band. Made in every size and of any metal. Strongly built. Large stocks carried. Will not back draft; maximum of free areas.

THE LIBERTY VENTILATOR



LIBERTY VENTILATOR

Good architectural lines and symmetry



ANATOMY OF LIBERTY VENTILATOR—showing positive venturi action. White arrows indicate outside winds. Black arrows foul air being pulled out

Embraces all four principles of scientific ventilation:—1st, Impingement; 2nd, Positive and Negative sides of Ventilators; 3rd, Siphonage; 4th, Stack Action. A positive and complete venturi action.

The Liberty Ventilator combines the principles of siphonage and air impingement. This in conjunction with the positive and negative sides of the ventilator creates a vacuum to which the air is naturally sucked regardless of the direction of the wind. Stack action, also, is so accommodated as to accelerate this movement. The free areas of the Liberty ventilator create no resistant constant. **Send for copy of tests conducted by Carnegie Institute of Technology, and Massachusetts Institute of Technology.**

Mechanical and Engineering Data, Service Talks, Catalogues and Prices gladly sent on request.

American-Larson Ventilating Co.

324 Fourth Ave., PITTSBURGH, PA.

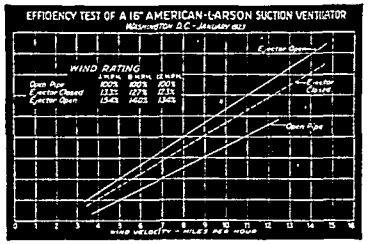
Product: American-Larson Rotary Suction Ventilators—proven, by competitive tests, to be the most efficient ventilator on the market.

Efficiency: In a recent (January, 1923) test conducted by a disinterested party, more than 50 makes of ventilators were tested over a wide range of wind velocities and temperature differences with the result that the American-Larson Ventilator was shown to have the **highest** rating.

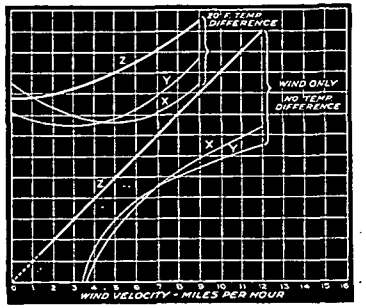
Here are the reasons:

The American-Larson Ventilator offers less resistance to the passage of air than any other ventilator, be it of the stationary or of the rotary type.

The patented ejector tube effects air movement in direct ratio to wind velocities and temperature differences. Most ventilators do not function at all in wind only (no temperature difference) velocities below 3½ miles per hour; furthermore, under temperature differences as great as 20 deg. fahr., the efficiency of these ventilators actually decreases in gentle breeze up to 4 or 5 miles per hour velocity.



Further proof of the efficiency of American-Larson Ventilators is furnished by a comparative test conducted by Professor Trinks of the Carnegie Institute of Technology of Pittsburgh, in 1921. The results are shown below:



X = 18" Stationary Siphon Ventilator.
Y = 18" Rotary Siphon Ventilator.
Z = 18" American-Larson Suction Ventilator.

The official report of the Institute says, in part—"The comparison shows that the American-Larson is far superior to both types at all wind velocities. At very low velocities of wind, it still ventilates while the other types do not move any air. Similarly, the American-Larson Ventilator utilizes wind to increase the effect of temperature differences, while in the other types a gentle breeze actually diminished the ventilating effect."

Number and Size of Ventilators Required

The air supply per person and per hour, or the number of reversals of air contents per hour may be taken from the following table:

Type of Room to be Ventilated	Number of Renewals of Air Contents per Hour
Workshops and barracks	2 to 3
Offices	4
Schools	5 to 8
Hospitals	5 to 8
Churches, theatres	5 to 8
Dining rooms	5 to 10
Kitchens	8 to 12
Toilet and bathrooms	8 to 12
Foundries	10 to 12
Pickling rooms	15 to 20
Tanneries, paint rooms	10 to 12
Restaurants	5 to 6

To obtain effective, uniform ventilation and avoid local drafts, ventilators should be placed not more than 30 ft. apart; 20 ft. is a good average. It is best to locate them at the ridge unless the building exceeds 40 ft. in width, when two rows of smaller ventilators may be used. Where the building is surrounded by higher buildings, it is desirable to extend ventilators above them by mounting on stacks.

Example Showing Method of Calculation—In a building 100 ft. long, 35 ft. wide and 28 ft. average height the air is to be renewed 5 times per hour. How many and what size ventilators are required?

With a spacing of ventilators 20 ft. apart and 10 ft. from the ends, in one row along the ridge, 5 ventilators are required.

$$\frac{(100 \times 35 \times 28 \text{ ft.}) \times 5 \text{ changes hr.}}{5 \text{ ventilators}} = 98{,}000 \text{ cu. ft.}$$

per hour to be exhausted by each ventilator. From the table of capacities of American-Larson ventilators under average wind and temperature conditions, the nearest size is 24-in. size.

Requirements: Five 24-in. ventilators.

For specified conditions of height, temperature and wind, the capacity of the American-Larson ventilator is:

$$Q = A\left[\frac{36\sqrt{H\,(t^1 - t^0)}}{6+V} + 20 \times V\right]$$

where Q is cu. ft. of air exhausted per hour, through a ventilator having the throat area of A sq. in., mounted on a roof at a height of H ft. from the center of the ventilator outlet to the floor, and with a wind velocity of V miles per hour, and average temperatures t^1 inside, and t^0 outside the building.

The above is based on sufficient area of openings in the sides of the building for inlet of fresh air.

Suggested Form of Specification

(1) All ventilators shall be American-Larson Suction Ventilators, as manufactured by the AMERICAN-LARSON VENTILATING COMPANY, of Pittsburgh, Pa., and shall [shall not] be equipped with dampers.

(2) The ventilators shall be made of (*see Note 1*) and shall be of the following gauges:

Below 18-in. diam., No. 24 gauge; 20 to 24-in. diam., No. 22 gauge; 30 to 48-in. diam., No. 20 gauge; 54-in. diam., No. 18 gauge.

(3) Where so indicated the ventilators shall be mounted on extension piping of sufficient height to raise ventilators above surrounding obstruction.

(4) The ventilators shall be erected plumb and in a substantial manner. Where extension pipes are used they shall be anchored to four points with heavy gauge guy wires.

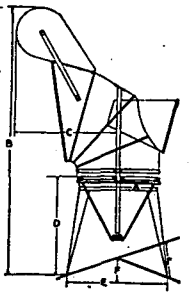
(5) Ventilators for——shall be equipped with fusible links to close dampers automatically in case of fire.

Note 1:

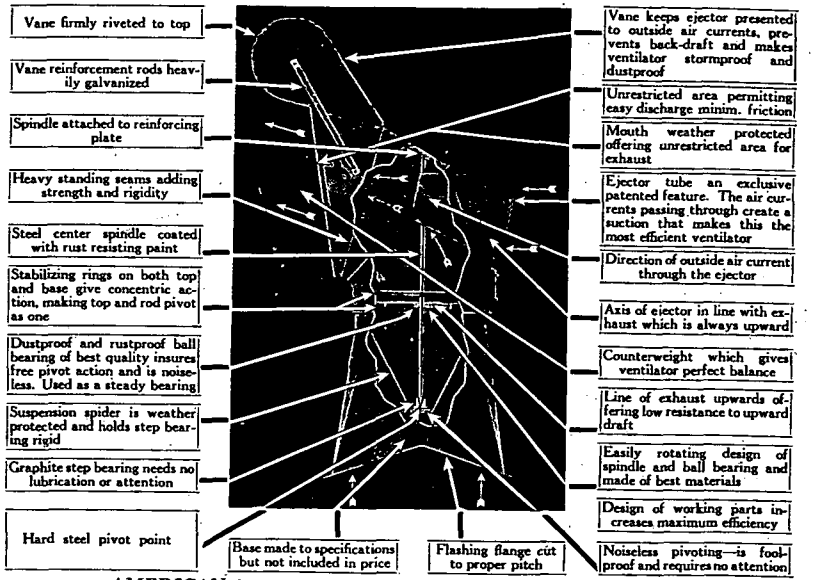
Material of Ventilator	Uses of Ventilator
Galvanized iron	1. All purposes for which no acid or corrosive fumes pass; standard practice.
Copper	2. All purposes for which long life is desired, provided that no strong acid or alkaline fumes pass.
Choice of metal	3. For ventilating buildings or rooms from which acid or other corrosive fumes rise.
Monel metal	4. Same as No. 3; has longer life, but is more expensive.
Zinc	5. Similar to copper, but a little cheaper.

Dimensions, Gauges, Weights, Prices and Capacities

Size (throat diam.), in.	B in.	C in.	D in.	E in.	Iron gauge No.	List price, damper	List price, ventilators only	Net weight, lb.	Crated weight lb.	Average conservative discharge 5 miles velocity
8	27	10	10	10	24	$1.50	$20.00	12	26	11,550 cu. ft. per hr.
10	34	13	12	12	24	2.15	20.00	18	35	17,820 " "
12	41	16	13	13	24	2.90	30.00	26	46	24,800 " "
14	48	18	17	17	24	3.30	35.00	32	57	34,980 " "
16	55	21	20	20	24	3.80	40.00	39	70	46,200 " "
18	62	24	21	21	24	4.30	45.00	49	85	58,410 " "
20	69	26	25	25	22	4.80	50.00	68	115	71,940 " "
24	83	32	30	30	22	5.80	60.00	92	145	103,620 " "
30	104	40	38	38	20	7.15	75.00	146	206	161,700 " "
36	125	48	46	46	20	9.30	110.00	225	325	232,890 " "
40	139	53	51	51	20	11.50	140.00	282	412	287,760 " "
48	167	64	61	61	20	17.00	170.00	390	560	412,500 " "
54	187	72	63	63	18	20.00	220.00	620	820	524,700 " "
60	208	80	76	76	18	25.00	300.00	790	1025	646,800 " "
66	229	88	84	84	18	35.00	375.00	930	1215	782,100 " "



Prices subject to change without notice. Discounts furnished on request.



AMERICAN-LARSON SUCTION VENTILATOR (Patented)
5939 S.E.—2/2—17.5

W. F. Hirschman Co., Inc.

Le Roy, New York

Manufacturers of

EFFICO

Rotary Ball Bearing (Oil Flooded) Roof Ventilators

Product—Effico Fan Equipped Rotary Ball Bearing (Oil Flooded) Roof Ventilators (Patented).

Construction and Principle of Operation—The Effico rotating cowl exterior is covered by wind propelled blades; the interior by suction blades. There are no moving parts. The Effico shaft rotates on ball bearings, fitted with clock precision in solidly enclosed dust-tight and oil-tight housings, and is flooded in inches of non-freezing oil (furnished by us); no oiling required for years (proven), and the Effico is absolutely noiseless.

Great Air Volume Exhaust at Low Wind—All Effico will draw considerable air at a 1-mile breeze (an apparent calm) without stack or heat assistance. The 30-in. size will rotate (standing start) at 0.7-oz. pressure, ½ mile breeze. Cowl outlet is over 50 per cent larger than its stack area which is ample, as no wind enters ventilator to gain the so-called siphonage effect. Suction fan is same size as rotating cowl (note dimension chart). Thus each Effico is equipped with fan over 50 per cent greater in diameter than its stack area. Fan pulls air up stack at even the slowest turning movement and wind blowing across the outlet adds to its efficiency.

Symmetry—The Effico has artistic lines and pleasing appearance. Lowest in height of rotary ventilators by over 50 per cent average. Note dimension chart.

Weatherproofness—The Effico rotary ball-bearing ventilator operates during all kinds of weather—rain, ice, snow or sleet does not affect or hamper its exhausting. No drip pans or bird screens are needed.

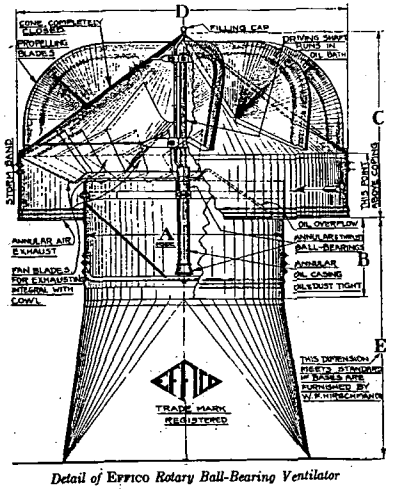


Effico Rotary Ball-Bearing Ventilator Installation

Effico Standardized Ventilators

Dimensions, In.					Gage of Galvanized Steel		Net Weight Lb.	Copper Oz.	Code
A	B	C	D	E	Cowl	Base			
6	4½	5½	13	...	26	26	10	14	Sheck
10	4½	11	16	20½	26	26	18	14	Sachem
12	5	14	21¾	21	24	24	25	14	Scene
18	7	15½	27	23	24	24	38	16	Saturn
24	10	25	42	30	24	24	95	18	Shake

Dimensions, In.					Gage of Galvanized Steel		Net Weight Lb.	Copper Oz.	Code
A	B	C	D	E	Cowl	Base			
30	12	27	52	32	22	20	140	20	Sank
36	12	31	62	32	22	18	180	24	Sergeant
42	19	37	68	43	22	18	300	24	Serpent
48	19	40	76	43	22	18	370	24	Serve
54	19	44	86	43	22	18	525	24	Sham
60	19	48	98	43	20	18	650	..	Shawl
66	25	53	103½	49	20	18	700	..	Sunk
72	30	57	114	54	20	18	750	..	Shop
84	30	58	130	54	18	16	900	..	Slave
96	30	63	153	60	18	16	1025	..	Shekel



Detail of Effico Rotary Ball-Bearing Ventilator

Capacities of Effico Rotary Ball Bearing Ventilators

Cubic Feet of Air Exhausted Per Minute

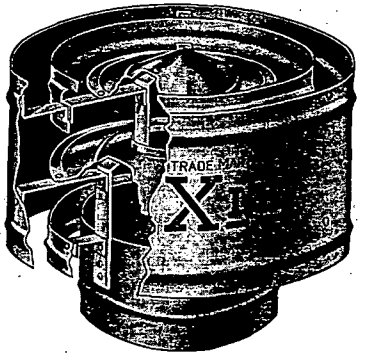
Wind Velocity mi. per hour	Temperature difference in degrees Fahrenheit in building and outside											
	0	10	20	30	0	10	20	30	0	10	20	30
	12-in. Ventilator				18-in. Ventilator				24-in. Ventilator			
5	295	365	430	465	500	740	850	925	900	1325	1500	1590
10	342	437	500	520	755	970	1070	1135	1325	1725	1900	2025
14	400	500	530	580	990	1080	1160	1270	1600	2000	2200	2300
	30-in. Ventilator				36-in. Ventilator				42-in. Ventilator			
5	1400	2080	2386	2600	2075	3000	3375	3650	2770	4090	4550	4950
10	2100	2925	3050	3250	2980	3880	4275	4550	3975	5175	5700	6000
14	2560	3200	3175	3525	3645	4365	4750	4935	4900	6000	6600	6900
	48-in. Ventilator				54-in. Ventilator				60-in. Ventilator			
5	3650	5300	6000	6500	4580	6600	7600	8200	5700	8300	9400	10200
10	5300	7100	7600	8100	6625	8625	9600	10000	8280	10900	12000	12700
14	6445	8050	8900	9200	8000	10000	11000	11600	10000	12600	13800	14500
	72-in. Ventilator				84-in. Ventilator							
5	8200	11800	13000	14800	11000	16300	18500	20000	"Effico" The Highest Developed Ventilator			
10	11900	15500	17000	18300	16300	21600	23600	25000				
14	14400	18000	19800	20800	19600	25000	27000	28500				

Above capacities are guaranteed and conservative. They are based on official test made at Carnegie Institute of Technology, Pittsburgh, Pa., and a great many by ourselves on special and regular installations.

The Iona Ventilator Company, Inc.

2821 W. Dauphin St. :-: PHILADELPHIA, PA.

Designers and Manufacturers of Ventilators for 20 years
"XIT" and "IONA" Ventilators Adapted to Factories, Schools, Theatres, Hospitals, Public and Farm Buildings.



Four basic principles are incorporated in the design and construction of "XIT" Ventilators:

1. Largest area of vertical exits from head.
2. Greatest total exit area from head.
3. No external air can enter ventilator head.
4. Principle of action or suction is like that of chimney or stack, which is doubled by a second or internal band, making two points of suction, always to the lee side of head thereby greatly increasing action through ventilator.

Guaranteed exhaust and storm proof.

Liberal discounts.

Damper and base prices on request.

"XIT" VENTILATORS

Vent Size In.	Outside Dia. In.	Height In.	Gauge Iron or Metal	Approx. Finished Weights Lbs.	Gauge Copper Oz.	List Prices
6	10¾	8¾	26	5	16	$ 12.00
7	12½	10¼	26	6	16	14.00
8	14¼	11	26	8	16	16.00
9	16¼	12	26	10	16	18.00
10	18	13½	24	12	16	20.00
12	21½	15½	24	16	16	24.00
14	25	16¾	24	28	16	28.00
15	26½	17	24	31	18	30.00
16	28¾	18½	22	34	18	32.00
18	30	19½	22	43	18	36.00
20	34	22½	22	50	18	40.00
22	38½	24	22	55	18	44.00
24	43	26	22	61	18	48.00
26	46	28	22	84	20	52.00
28	50	30	22	105	20	56.00
30	54	32	22	131	20	65.00
32	57	34	22	146	20	80.00
34	60	36	22	160	20	100.00
36	64	38½	22	178	20	120.00
40	71¾	42	20	238	20	180.00
42	77	45	20	275	20	190.00
44	79	48	20	305	20	200.00
48	86	51	20	350	20	240.00
54	97	57	18	615	24	300.00
60	107	63	18	757	24	360.00
66	118	69	18	880	24	420.00
72	129	75	18	980	24	480.00

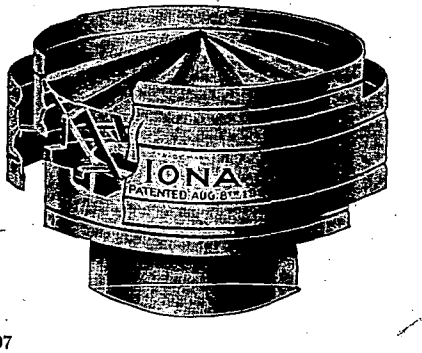
EXHAUST DATA CARD OF "XIT" VENTILATORS

Temp. Inside and Outside	Wind Velocity Mi. per Hour	Cubic Feet of Air Through Ventilator per Hour									
		12	14	16	18	20	24	30	36	40	48
70°	3	20,546	27,783	36,352	45,960	50,804	81,811	127,008	193,287	225,792	326,044
70°	5	24,460	33,075	43,276	54,714	60,480	97,036	151,200	218,198	268,800	388,147
70°	10	34,244	46,305	60,536	79,599	84,672	125,850	211,680	305,477	376,320	543,405
70°	15	47,941	64,827	84,750	111,438	118,540	176,190	296,352	427,667	526,848	760,767
70°	20	67,117	90,757	118,650	156,013	165,956	246,666	414,892	598,733	737,587	1,065,073

Increase in velocity of wind over five miles, increases exhaust 8 per cent per mile.
Higher inside temperature increases exhaust 1 7-10 per cent per degree.
In elevation over 25 feet, exhaust increase varies as square root of height.

"IONA" VENTILATORS

Vent Size In.	Outside Dia. In.	Height In.	Gauge Iron or Metal	Approx. Finished Weights Lbs.	Gauge Copper Oz.	List Prices
6	10	6	26	3	16	$ 3.40
8	14½	7	26	4	16	4.65
10	18	9	24	6	16	5.75
12	21	10	24	8	16	6.75
14	24	12	22	14	18	13.00
16	27	13	22	20	18	20.00
18	31	14	22	26	18	27.00
20	34	15	22	30	18	33.00
24	42	18	22	42	18	40.00
30	51	23	20	75	20	65.00
36	62	27	20	118	20	120.00
42	72	31	18	182	20	190.00
48	82	35	18	275	20	240.00
54	94	38	18	300	24	300.00
60	104	43	18	335	24	360.00
72	130	60	18	630	24	480.00



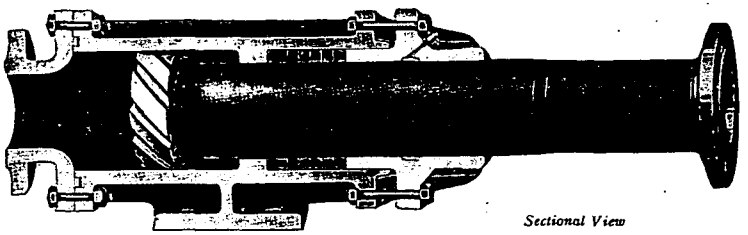
MOGUL

Mogul Machine Company

WITHERSPOON BUILDING

Philadelphia, Pa.

MOGUL
Double-End-Guided Expansion Joints



Sectional View

THE "DOUBLE-END-GUIDED" PRINCIPLE

The Expansion Tube is guided into perfect alignment with the body of the expansion joint by two well-fitted bronze guides. They are described as the Piston-Guide and the Gland-Guide. The expansion tube, at any part of its traverse, is therefore concentrically guided and supported at both ends. All side thrusts or strains are borne by these two bronze guides, and the expansion tube "bridges" the packing. This construction eliminates all tendency to crush or to displace the packing or to partially guide the expansion tube against it. With the "double-end-guided" principle the packing performs its proper function. It packs the joint against leakage without excessive pressure of the packing against the sliding tube, and it will operate continuously without leakage.

The Piston-Guide is made of hard bronze, and is in the form of angular guides and grooves to reduce the mass of metal and the diametrical expansion; thus permitting a close sliding fit of the piston even when operating at high temperatures. The angular guiding surfaces overlap each other to prevent the possibility of wearing grooves in the bearing surfaces.

The Gland-Guide is made of hard bronze, and is externally supported and concentrically guided. It performs the functions of a combination packing gland and a pipe guide. The greater part of the outside surface is exposed and air-cooled, and the inside bearing surface is lubricated.

PACKED WHILE THE LINE IS HOT

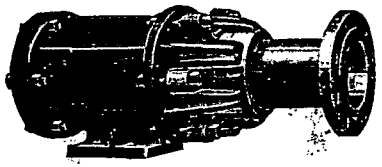
The illustration shows how the MOGUL Double-End-Guided Expansion Joint may be packed promptly after the pressure is shut off and while the line is hot and in an expanded condition.

When the piston-guided end of the expansion tube is at the extreme inner end of its traverse the outer, or flanged end extends well beyond the guide. The gland-guide may therefore be completely withdrawn without interference with the coupling or pipe flange. This eliminates the necessity of waiting for the pipe line to cool and contract, often a matter of several days with the attendant interrupted service.

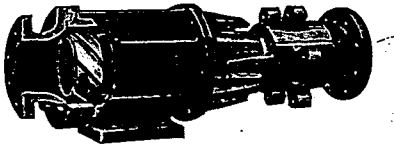
TRAVERSE STOPS

MOGUL Double-End-Guided Expansion Joints have heavy built-in Traverse Stops. The base-ring at the end of the packing chamber forms the forward traverse stop and the body flange, or yoke, is the rear stop. The travel or traverse of the expansion tube is limited between these stops. They are positive traverse stops. They cannot be weakened by corrosion or tampered with or misadjusted. The travel of the expansion tube is therefore limited by the piston-guide coming in contact with the stops. This provides absolute protection against pulling the tube out of the joint and rupturing the pipe line.

MOGUL Double-End-Guided Expansion Joints are made in all standard pipe sizes from 2 in. to 36 in., for saturated steam, superheated steam, and for all fluids, pressures and temperatures.



Exterior View



Packed While the Line is Hot

Complete Information, Dimensions and Prices Upon Request or Our Nearest Agent will Gladly Call

Index to Modern Equipment

AMERICAN SOCIETY *of* HEATING *and* VENTILATING ENGINEERS GUIDE 1925-26

AIR COCKS (*See Cocks, Air*)

AIR CONDITIONING
- American Blower Co.
- Atmospheric Conditioning Corp.
- Badger, E. B., & Sons Co.
- Bayley Mfg. Co.
- Bishop & Babcock Co.
- Buffalo Forge Co.
- Call, John, Co.
- Carrier Engineering Corp.
- Clarage Fan Co.
- Cooling and Air Conditioning Corp.
- Drying Systems, Inc.
- Grinnell Co., Inc.
- Ilg Electric Ventilating Co.
- Langenberg Mfg. Co.
- Midwest Air Filters, Inc.
- Nelson, Herman, Corp.
- New York Blower Co.
- Reed Air Filter Co., Inc.
- Skinner Bros. Mfg. Co., Inc.
- Sturtevant, B. F., Co.
- York Heating & Ventilating Corp.

AIR COOLERS
- Aerofin Corp.
- Lyon Products Co., Inc.

AIR DIFFUSERS (*See Diffusers, Air*)

AIR DRYING (*See Drying Apparatus*)

AIR ELIMINATORS (*See Eliminators, Air*)

AIR FILTERS (*See Filters, Air*)

AIR PUMPS (*See Pumps, Air*)

AIR TESTING INSTRUMENTS
- American Blower Co.
- Hill, E. Vernon, Co.

AIR VALVES (*See Valves, Air*)

AIR WASHERS
- American Blower Co.
- Atmospheric Conditioning Corp.
- Badger, E. B., & Sons Co.
- Bayley Mfg. Co.
- Bishop & Babcock Co.
- Buffalo Forge Co.
- Call, John, Co.
- Carrier Engineering Corp.
- Clarage Fan Co.
- Cooling and Air Conditioning Corp.
- Ilg Electric Ventilating Co.
- Midwest Air Filters, Inc.
- New York Blower Co.
- Reed Air Filter Co., Inc.
- Spray Engineering Co.
- Sturtevant, B. F., Co.

AMMONIA COILS (*See Coils, Ammonia*)

ASBESTOS AND INSULATING PRODUCTS
- American District Steam Co.
- Johns-Manville, Inc.
- National Radiator Co.
- Ric-wil Co.

ASBESTOS—Sheet
- Johns-Manville, Inc.

AUTOMATIC FURNACES (*See Furnaces, Automatic*)

BAKING EQUIPMENT
- Drying Systems, Inc.
- Westinghouse Electric & Mfg. Co.

BLAST GATES (*See Gates, Blast*)

BLOWERS—Centrifugal
- American Blower Co.
- Bayley Mfg. Co.
- Buffalo Forge Co.
- Clarage Fan Co.
- Ilg Electric Ventilating Co.
- Nesbitt, John J., Inc.
- New York Blower Co.
- O-E Specialty Mfg. Co.
- Skinner Brothers Mfg. Co.
- Sturtevant, B. F., Co.
- Westinghouse Electric & Mfg. Co.
- York Heating & Ventilating Corp.

Fan
- American Blower Co.
- Bayley Mfg. Co.
- Bishop & Babcock Co.
- Clarage Fan Co.
- Honeywell Heating Specialties Co
- Ilg Electric Ventilating Co.
- Langenberg Mfg. Co.
- Nash Engineering Co.
- Nesbitt, John J., Inc.
- New York Blower Co.
- Sturtevant, B. F., Co.
- Westinghouse Electric & Mfg. Co.
- Wing, L. J., Mfg. Co.
- York Heating & Ventilating Corp.

Forced Draft
- American Blower Co.
- Buffalo Forge Co.
- Clarage Fan Co.
- Sturtevant, B. F., Co.
- Wing, L. J., Mfg. Co.

Pressure
- American Blower Co.
- Bayley Mfg. Co.
- Buffalo Forge Co.
- Clarage Fan Co.
- Ilg Electric Ventilating Co.
- Nash Engineering Co.
- New York Blower Co.
- Sturtevant, B. F., Co.
- Wing, L. J., Mfg. Co.

Turbine
- American Blower Co.
- Wing, L. J., Mfg. Co.

Ventilating
- American Blower Co.
- Bayley Mfg. Co.
- Bishop & Babcock Co.
- Buffalo Forge Co.
- Clarage Fan Co.
- Ilg Electric Ventilating Co.
- Iona Ventilator Co., Inc.
- Langenberg Mfg. Co.
- Nelson, Herman, Corp.
- New York Blower Co.
- Sturtevant, B. F., Co.
- Westinghouse Electric & Mfg. Co.
- Wing, L. J., Mfg. Co.
- York Heating & Ventilating Corp.

BOILER—Compounds (*See Compounds, Boiler*)

Controllers (*See Controllers*)

Coverings (*See Asbestos and Insulating Products*)

Feeders
- McAlear Mfg. Co.
- McDonnell & Miller

Feed Pumps (*See Pumps*)

Headers (*See Headers*)

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- O-E Specialty Mfg. Co.
- "X" Laboratories

Protecting Devices
- Hoffman Specialty Co.
- McDonnell & Miller
- Marsh, Jas. P., & Co.
- Trane Company, The
- U. S. Radiator Corp.

Scale Remover (*See Scale Remover, Boiler*)

BOILERS—Heating (*Coal Fired*)
- Abendroth Bros.
- American Radiator Co.
- Ames Iron Works
- Bernhard Boiler Mfg. Co.
- Bigelow Company, The
- Brownell Co.
- Burnham Boiler Corp.
- Continental Heater Corp.
- Cox, Abram, Stove Co.
- Fitzgibbons Boiler Co., Inc.
- General Boilers Co.
- Gorton & Lidgerwood Co.
- Handon Boiler Corp.
- Harrisburg Star Boiler Corp.
- International Heater Co.
- Kewanee Boiler Co.
- Lebanon Boiler Works
- National Radiator Co.
- Oil City Boiler Works
- Page, Wm. H., Boiler Co.
- Pierce, Butler & Pierce Mfg. Corp.
- Prox, Frank, Co.
- Reading Heater & Supply Co.
- Richardson & Boynton Co.
- Richmond Radiator Co.
- Sims Company, The
- Smith, H. B., Co.
- Standard Heater Co.
- Titusville Iron Works
- XXth Century Heating & Ventilating Co.
- U. S. Radiator Corp.
- Universal Smokeless Boiler Co.
- Utica Heater Co.
- Weil-McLain Co.

Heating (*Gas Fired*)
- American Radiator Co.
- Ames Iron Works
- Bernhard Boiler Mfg. Co.
- Brownell Co.
- Bryant Heater & Mfg. Co.
- Burnham Boiler Corp.
- Continental Heater Corp.
- Fitzgibbons Boiler Co., Inc.
- General Boilers Co.
- Handon Boiler Corp.
- Kewanee Boiler Co.
- National Radiator Co.
- Oil City Boiler Works
- Page, Wm. H., Boiler Co.
- Pierce, Butler & Pierce Mfg. Corp.
- Prox, Frank, Co.
- Richmond Radiator Co.
- Sims Company, The
- Standard Heater Co.
- Titusville Iron Works
- U. S. Radiator Corp.
- Universal Smokeless Boiler Co.

Heating (*Oil Fired*)
American Radiator Co.
Ames Iron Works
Bernhard Boiler Mfg. Co.
Bigelow Company, The
Brownell Co.
Burnham Boiler Corp.
Caloroil Burner Corp.
Continental Heater Corp.
Cox, Abram, Stove Co.
Fitzgibbons Boiler Co., Inc.
General Boilers Co.
Handon Boiler Corp.
Harrisburg Star Boiler Corp.
International Heater Co.
Kewanee Boiler Co.
Lebanon Boiler Works
Oil City Boiler Works
Page, Wm. H., Boiler Co.
Pierce, Butler & Pierce Mfg. Corp.
Prox, Frank, Co.
Richmond Radiator Co.
Sims Company, The
Smith, H. B., Co.
Standard Heater Co.
Sturtevant, B. F., Co.
Titusville Iron Works
U. S. Radiator Corp.
Universal Smokeless Boiler Co.
Utica Heater Co.
Weil-McLain Co.

Tubular
Ames Iron Works
Bigelow Company, The
Brownell Co.
Bryant Heater & Mfg. Co.
Burnham Boiler Corp.
Fitzgibbons Boiler Co., Inc.
Gorton & Lidgerwood Co.
Harrisburg Star Boiler Corp.
Kewanee Boiler Co.
Lebanon Boiler Works
Oil City Boiler Works
Pierce, Butler & Pierce Mfg. Corp.
Sims Company, The
Standard Heater Co.
Titusville Iron Works

BRACKETS (*See Hangers, Pipe and Radiator, and Radiator Brackets*)

BURNERS—Oil (*For Heating Boilers and Furnaces*)
Automatic Burner Corp.
Caloroil Burner Corp.
Winslow Boiler & Engineering Co.

CALORIMETERS—Steam
Ellison, Lewis M.

CEMENT—Asbestos (*See Asbestos and Insulating Products*)

Fire Brick
Johns-Manville, Inc.

Pipe Joint
Grinnell Co., Inc.
Johns-Manville, Inc.

Water Proof
Johns-Manville, Inc.

CENTRIFUGAL DRYERS (*See Drying Apparatus*)

COAL SAVER
Combustion Specialties Corp.
Monarch Metal Products Co.
O-E Specialty Mfg. Co.

COCKS—Air
Bishop & Babcock Co.
Mueller Co.

Boiler Drain
Mueller Co.

Boiler Supply
Mueller Co.

Gage
Bishop & Babcock Co.
Jenkins Bros.
Marsh, Jas. P., & Co.
O-E Specialty Mfg. Co.

COILS—Ammonia
Badger, E. B., & Sons Co.
Grinnell Co., Inc.
Whitlock Coil Pipe Co.

Blast
Aerofin Corp.
Lyon Products Co., Inc.
New York Blower Co.
Rome-Turney Radiator Co.
Stickle Steam Specialties Co.
York Heating & Ventilating Corp.

Pipe
American Blower Co.
Badger, E. B., & Sons
Bayley Mfg. Co.
Grinnell Co., Inc.
Whitlock Coil Pipe Co.
York Heating & Ventilating Corp.

Tank
Badger, E. B., & Sons
Kewanee Boiler Co.
Sims Company, The
Whitlock Coil Pipe Co.
York Heating & Ventilating Corp.

COLLECTORS, DUST (*See Dust Collectors*)

COLUMNS—Water
American Radiator Co.
Oil City Boiler Works
Page, Wm. H., Boiler Co.
Titusville Iron Works

COMPOUNDS—Boiler
O-E Specialty Mfg. Co.
Richardson & Boynton Co.
"X" Laboratories

COMPRESSORS
Bishop & Babcock Co.
Nash Engineering Co.
O-E Specialty Mfg. Co.
Powers Regulator Co.
Sturtevant, B. F., Co.
Trane Co.
Worthington Pump & Machinery Corp.

CONDENSERS
Alberger Heater Co.
Buffalo Steam Pump Co.
Carrier Engineering Corp.
Frank, O. E., Heater & Engineering Co., Inc.
Westinghouse Electric & Mfg. Co.
Whitlock Coil Pipe Co.
Worthington Pump & Machinery Corp.

CONDUIT—Underground
American District Steam Co.
Johns-Manville, Inc.
O-E Specialty Mfg. Co.
Ric-wil Co.
Sharon, R. W., Co.

Control Equipment
Honeywell Heating Specialties Co.
Johnson Service Co.
Powers Regulator Co.

CONTROL SWITCHES (*See Switches, Control*)

CONTROLLERS—Boiler
Davis, G. M., Regulator Co.
Honeywell Heating Specialties Co.
Klipfel Mfg. Co.
Sarco Co., Inc.
Sterling Engineering Co.
Stickle Steam Specialties Co.
Taylor Instrument Companies

Electric Heat
American Radiator Co.
Johnson Service Co.
Powers Regulator Co.
Taylor Instrument Companies
Westinghouse Electric & Mfg. Co.

Fan Engine
Clarage Fan Co.
Klipfel Mfg. Co.
Mason Regulator Co.
McAlear Mfg. Co.
Mueller Co.

Feed Water
Davis, G. M., Regulator Co.
McAlear Mfg. Co.
McDonnell & Miller
O-E Specialty Mfg. Co.
Stickle Steam Specialties Co.
Taylor Instrument Companies

Motor
American Radiator Co.
Economy Machinery Co.
Mason Regulator Co.
Reliance Electric & Engineering Co.
Taylor Instrument Companies
Trane Co.
Westinghouse Electric & Mfg. Co.

Pump
Buffalo Steam Pump Co.
Davis, G. M., Regulator Co.
Economy Pumping Machinery Co.
Klipfel Mfg. Co.
Mason Regulator Co.
McAlear Mfg. Co.
O-E Specialty Mfg. Co.
Sterling Engineering Co.
Stickle Steam Specialties Co.
Westinghouse Electric & Mfg. Co.

Shower Bath
Mueller Co.
Powers Regulator Co.

Tank
American Radiator Co.
Davis, G. M., Regulator Co.
Klipfel Mfg. Co.
Mason Regulator Co.
McAlear Mfg. Co.
Powers Regulator Co.
Sarco Co., Inc.
Stickle Steam Specialties Co.
Taylor Instrument Companies

Temperature (*See Regulators, Temperature*)

CONVEYING SYSTEMS (*See Systems, Dust Collecting and Exhaust*)

COOLING EQUIPMENT—Building
Atmospheric Conditioning Corp.
Carrier Engineering Corp.
Cooling & Air Conditioning Corp.
Drying Systems, Inc.

COOLING TOWERS
Buffalo Forge Co.
Carrier Engineering Corp.
Spray Engineering Co.

Cooling Ponds
Spray Engineering Co.

COUPLINGS
Mogul Machine Co.

COVERING—Boiler (*See Asbestos and Insulating Products*)

Magnesia
Johns-Manville, Inc.

Pipe and Tank
American District Steam Co.
Johns-Manville, Inc.
Ric-wil Co.

DAMPER—Quadrants
York Heating & Ventilating Corp.

DAMPER REGULATORS
(*See Regulators, Damper*)

DEHUMIDIFYING APPARATUS
American Blower Co.
Atmospheric Conditioning Corp.
Bayley Mfg. Co.
Buffalo Forge Co.
Call, John, Co.
Carrier Engineering Corp.
Clarage Fan Co.
Cooling and Air Conditioning Corp.
Drying Systems, Inc.
New York Blower Co.
Reed Air Filter Co.
Skinner Bros. Mfg. Co., Inc.
Spray Engineering Co.
Stickle Steam Specialties Co.
Sturtevant, B. F., Co.

DIFFUSERS—Air
American Metal Products Corp.
Carrier Engineering Corp.
Knowles Mushroom Ventilator Co.
Lyon Products Co., Inc.
Spray Engineering Co.
Sturtevant, B. F., Co.

DRAFT GAGES (*See Gages, Draft*)

DRYING APPARATUS
American Blower Co.
Atmospheric Conditioning Corp.
Bayley Mfg. Co.
Bishop & Babcock Co.
Buffalo Forge Co.
Call, John, Co.
Carrier Engineering Corp.
Clarage Fan Co.
Cooling and Air Conditioning Corp.
Drying Systems, Inc.
Economy Pumping Machinery Co.
Grinnell Co., Inc.
Ilg Electric Ventilating Co.
Langenberg Mfg. Co.
Lebanon Boiler Works
Moncrief Furnace Co.
New York Blower Co.
Skinner Bros. Mfg. Co.
Stickle Steam Specialties Co.
Sturtevant, B. F., Co.
York Heating & Ventilating Corp.

DUST COLLECTING SYSTEMS (*See Systems, Dust Collecting*)

DUST COLLECTORS
Bayley Mfg. Co.
Buffalo Forge Co.
Call, John, Co.
Carrier Engineering Corp.
Midwest Air Filters, Inc.
New York Blower Co.
Skinner Bros. Mfg. Co., Inc.
Sturtevant, B. F., Co.
York Heating & Ventilating Corp.

DUST COUNTERS
Hill, E. Vernon, Co.

DUST SEPARATORS (*See Separators, Dust*)

ELBOWS—Radiator
American District Steam Co.
American Radiator Co.
Burnham Boiler Corp.
Fulton Co.
U. S. Radiator Corp.

ELECTRIC MOTORS (*See Motors, Electric*)

ELIMINATORS—Air
American District Steam Co.
Badger, E. B., & Sons Co.
Bishop & Babcock Co.
Call, John, Co.
Dunham, C. A., Co.
Gorton & Lidgerwood Co.
Hoffman Specialty Co., Inc.
Marsh, Jas. P., & Co.
McAlear Mfg. Co.
Monash-Younker Co., Inc.
Mouat Vapor Heating Co.
New York Blower Co.
O-E Specialty Mfg. Co.
Skinner Bros. Mfg. Co.
Sterling Engineering Co.
Sturtevant, B. F., Co.
Trane Co.

ENGINES—Fan
American Blower Co.
Bayley Mfg. Co.
Brownell Co.
Clarage Fan Co.
New York Blower Co.
Sturtevant, B. F., Co.

Steam (*Automatic, High Speed, Throttling, Una-Flow, and Vertical*)
American Blower Co.
Ames Iron Works
Brownell Co.
Clarage Fan Co.
Pierce, Butler & Pierce Mfg. Corp.
Sturtevant, B. F., Co.
Titusville Iron Works

EXHAUST FANS (*See Fans, Exhaust*)

EXHAUST HEADS
Buffalo Forge Co.
Illinois Engineering Co.
McAlear Mfg. Co.
Patterson-Kelley Co.
Skinner Bros. Mfg. Co., Inc.
Sturtevant, B. F., Co.

EXHAUST SYSTEMS
American Blower Co.
Bayley Mfg. Co.
Buffalo Forge Co.
Call, John, Co.
Carrier Engineering Corp.
Clarage Fan Co.
Cooling and Air Conditioning Corp.
Ilg Electric Ventilating Co.
New York Blower Co.
Skinner Bros. Mfg. Co., Inc.
Sturtevant, B. F., Co.
Wing, L. J., Mfg. Co.
York Heating & Ventilating Corp.

EXPANSION JOINTS (*See Joints, Expansion*)

FANS—Blower (*See Blowers, Fan*)

Booster
Honeywell Heating Specialties Co.

Exhaust
American Blower Co.
Bayley Mfg. Co.
Bishop & Babcock Co.
Buffalo Forge Co.
Clarage Fan Co.
Ilg Electric Ventilating Co.
Langenberg Mfg. Co.
Nelson, Herman, Corp.
New York Blower Co.
Skinner Bros. Mfg. Co., Inc
Sturtevant, B. F., Co.
Westinghouse Electric & Mfg. Co.
Wing, L. J., Mfg. Co.
York Heating & Ventilating Corp.

Ventilating
American Blower Co.
Bayley Mfg. Co.
Bishop & Babcock Co.
Buffalo Forge Co.
Clarage Fan Co.
Ilg Electric Ventilating Co.
Langenberg Mfg. Co.
New York Blower Co.
O-E Specialty Mfg. Co.
Skinner Bros. Mfg. Co., Inc.
Stickle Steam Specialties Co.
Sturtevant, B. F., Co.
Westinghouse Electric & Mfg. Co.
Wing, L. J., Mfg. Co.
York Heating & Ventilating Corp.

FEEDERS (*See Boiler Feeders*)

Boiler
McDonnell & Miller

Water
McDonnell & Miller

FILTERS—Air
Bayley Mfg. Co.
Call, John, Co.
Drying Systems, Inc.
Midwest Air Filters, Inc.
Nelson, Herman, Mfg. Co.
Reed Air Filter Co., Inc.
Spray Engineering Co.
Sturtevant, B. F., Co.

Water
Sims Company, The

FIRE BRICK CEMENT (*See Cement, Fire Brick*)

FITTINGS—Flanged
American District Steam Co.
Grinnell Co., Inc.

Furnace
Grinnell Co., Inc.
International Heater Co.
Langenberg Mfg. Co.
XXth Century Heating & Ventilating Co.

Pipe
Grinnell Co., Inc.
International Heater Co.

Union
Grinnell Co., Inc.

FOG ELIMINATORS
Carrier Engineering Corp.
Ilg Electric Ventilating Co.
Wing, L. J., Mfg. Co.
York Heating & Ventilating Corp.

FURNACES—Automatic
Detroit Stoker Co.
New York Blower Co.
Sanford Riley Stoker Co.

Electric
Westinghouse Electric & Mfg. Co.

Gas
Cox, Abram, Stove Co.
Bryant Heater & Mfg. Co.
XXth Century Heating & Ventilating Co.

Pipeless
Abendroth Brothers
Cox, Abram, Stove Co.
International Heater Co.
Langenberg Mfg. Co.
Moncrief Furnace Co.
New York Blower Co.
XXth Century Heating & Ventilating Co.
Utica Heater Co.

Warm Air
Caloroil Burner Corp.
Cox, Abram, Stove Co.
International Heater Co.
Langenberg Mfg. Co.
Moncrief Furnace Co.
New York Blower Co.
Sturtevant, B. F., Co.
XXth Century Heating & Ventilating Co.
Utica Heater Co.

GAGE—Boards
Bishop & Babcock Co.
Dunham, C. A., Co.
Marsh, Jas. P., & Co.
Warren Webster & Co.

Cocks (*See Cocks, Gage*)

Glasses (*See Glasses, Gage*)

Valves (*See Valves, Gage*)

GAGES—Draft
Combustion Specialties Corp.
Ellison, Lewis M.
Higgin Mfg. Co.
Hoffman Specialty Co., Inc.
Taylor Instrument Companies
Warren Webster & Co.

Compound
Hoffman Specialty Co., Inc.

Pressure
Bishop & Babcock Co.
Dunham, C. A., Co.
Marsh, Jas. P., & Co.
Mouat Vapor Heating Co.
O-E Specialty Mfg. Co.
Pierce, Butler & Pierce Mfg. Corp.
Taylor Instrument Companies
Trane Co.
U. S. Radiator Corp.
Warren Webster & Co.

Steam
American Radiator Co.
Dunham, C. A., Co.
Hoffman Specialty Co.
Marsh, Jas. P., & Co.
O-E Specialty Mfg. Co.
Pierce, Butler & Pierce Mfg. Corp.
Taylor Instrument Companies
Trane Co.
U. S. Radiator Corp.
Warren Webster & Co.

Vacuum
Bishop & Babcock Co.
Dunham, C. A., Co.
Hoffman Specialty Co.
Illinois Engineering Co.
Marsh, Jas. P., & Co.
O-E Specialty Mfg. Co.
Pierce, Butler & Pierce Mfg. Co.
Taylor Instrument Companies
Trane Co.
U. S. Radiator Corp.
Warren Webster & Co.

Water
American Radiator Co.
Marsh, Jas. P., & Co.
National Radiator Co.
Pierce, Butler & Pierce Mfg. Co.
Taylor Instrument Companies
U. S. Radiator Corp.

GAS—Burners
XXth Century Heating & Ventilating Co.

Furnaces (*See Furnaces, Gas*)

Heaters—Room (*See Heaters, Gas*)

Heating Systems (*See Heating Systems, Gas*)

Water Heaters
Alberger Heater Co.
Brownell Co.
Bryant Heater & Mfg. Co.
Page, Wm. H., Boiler Co.
Sims Company, The
Smith, H. B., Co.
Stickle Steam Specialties Co.
Universal Smokeless Boiler Co.

GASKETS—Asbestos
Jenkins Bros.
Johns-Manville, Inc.

Boiler
Johns-Manville, Inc.

Metallic
Johns-Manville, Inc.

Rubber
Jenkins Bros.
Johns-Manville, Inc.

GATES—Blast
American Blower Co.
Bayley Mfg. Co.
Buffalo Forge Co.
Clarage Fan Co.
New York Blower Co.
Sturtevant, B. F., Co.
York Heating & Ventilating Corp.

GENERATOR COOLING SYSTEMS
American Blower Co.
Bayley Mfg. Co.
Buffalo Forge Co.
Carrier Engineering Corp.
Drying Systems, Inc.
Reed Air Filter Co.
Spray Engineering Co.
Sturtevant, B. F., Co.

GENERATORS—Electric
Honeywell Heating Specialties Co.
Reliance Electric & Engineering Co.
Sturtevant, B. F., Co.
Westinghouse Electric & Mfg. Co.

Heat (*See Boilers, Furnaces and Heaters*)

Hot-Water
Alberger Heater Co.
Brownell Co.
Burnham Boiler Corp.
D. & T. Mfg. Co.
Excelso Specialty Works, Inc.
Frank, O. E., Heater & Engineering Co., Inc.
Honeywell Heating Specialties Co.
Page, Wm. H., Boiler Co.
Reading Heater & Supply Co.

Vacuum
Illinois Engineering Co.
McAlear Mfg. Co.
O-E Specialty Mfg. Co.
Trane Co.

GLASSES—Gage
O-E Specialty Mfg. Co.

GOVERNORS—Condensation
Klipfel Mfg. Co.
McAlear Mfg. Co.
Trane Company, The
Warren Webster & Co.

Pump (*See Regulators, Pump*)

Vacuum (*See Regulators, Vacuum*)

GRATES—Dumping
Abendroth Bros.
Brownell Co.
Fitzgibbons Boiler Co., Inc.
Kewanee Boiler Co.
Oil City Boiler Works
Universal Smokeless Boiler Co.

Rocking
Abendroth Bros.
Brownell Co.
Kewanee Boiler Co.
Oil City Boiler Works
Universal Smokeless Boiler Co.

Shaking
Abendroth Bros.
Brownell Co.
Kewanee Boiler Co.
Oil City Boiler Works
Titusville Iron Works
Universal Smokeless Boiler Co.

GRILLES AND REGISTERS (*See Registers and Grilles*)

HANGERS—Adjustable Pipe
Farley Sleeve & Hanger Co.
Fitzgibbons Boiler Co., Inc.
Grinnell Co., Inc.
Smith, H. B., Co.

Pipe
Grinnell Co., Inc.
Healy-Ruff Co.
Kewanee Boiler Co.
Midwest Air Filters, Inc.
National Radiator Co.
Pierce, Butler & Pierce Mfg. Co.
Sharon, R. W., Co.
York Heating & Ventilating Corp.

Radiator
American Radiator Co.
Farley Sleeve & Hanger Co.
Gleockle, A. F., Jr.
Grinnell Co., Inc.
Healy-Ruff Co.
Kewanee Boiler Co.
National Radiator Co.
Pierce, Butler & Pierce Mfg. Co.
Sharon, R. W., Co.
Smith, H. B., Co.
U. S. Radiator Corp.
York Heating & Ventilating Corp.

HEADERS
Alberger Heater Co.
Bayley Mfg. Co.
Grinnell Co., Inc.

HEAT INTERCHANGERS
American Blower Co.
Buffalo Forge Co.
Carrier Engineering Corp.
Drying Systems, Inc.
Frank, O. E., Heater & Engineering Co., Inc.
Whitlock Coil Pipe Co.

HEATERS—Air
Frank, O. E., Heater & Engineering Co., Inc.
Nelson, Herman, Co.
Nesbitt, John J., Inc.
New York Blower Co.
Standard Heater Co.
Sturtevant, B. F., Co.
Warren Webster & Co.
Westinghouse Electric & Mfg. Co.

Automatic Hot Water
Bryant Heater & Mfg. Co.
Caloroil Burner Corp.
Excelso Specialty Works, Inc.
Ilg Electric Ventilating Co.
Kewanee Boiler Co.
Mueller Co.

Blast
Aerofin Corp.
American Blower Co.
Bayley Mfg. Co.
Buffalo Forge Co.
Clarage Fan Co.
Lyon Products Co., Inc.
New York Blower Co.
O-E Specialty Mfg. Co.
Sturtevant, B. F., Co.
Wing, L. J., Mfg. Co.
York Heating & Ventilating Corp.

Fan System
Aerofin Corp.
American Blower Co.
Bayley Mfg. Co.
Buffalo Forge Co.
Clarage Fan Co.
Ilg Electric Ventilating Co.
Lyon Products Co., Inc.
New York Blower Co.
O-E Specialty Mfg. Co.
Sturtevant, B. F., Co.
Wing, L. J., Mfg. Co.
York Heating & Ventilating Corp.

Feed Water
Alberger Heater Co.
Brownell Co.
Frank, O. E., Heater & Engineering Co., Inc.
Patterson-Kelley Co.
Sims Company, The
Stickle Steam Specialties Co.
Warren Webster & Co.
Whitlock Coil Pipe Co.
Worthington Pump & Machinery Corp.

Gas
Bryant Heater & Mfg. Co.
Cox, Abram, Stove Co.
XXth Century Heating & Ventilating Co.
Universal Smokeless Boiler Co.

Hot Water Service
Abendroth Bros.
Alberger Heater Co.
American Radiator Co.
Brownell Co.
Bryant Heater & Mfg. Co.
Excelso Specialty Works, Inc.
Frank, O. E., Heater & Engineering Co., Inc.
International Heater Co.
Kewanee Boiler Co.
Page, Wm. H., Boiler Co.
Patterson-Kelley Co.
Prox, Frank, Co.
Reading Heater & Supply Co.
Richardson & Boynton Co.
Sims Company, The
Smith, H. B., Co.
Standard Heater Co.
U. S. Radiator Corp.
Weil-McLain Co.
Whitlock Coil Pipe Co.

Indirect
Aerofin Corp.
American Blower Co.
Bayley Mfg. Co.
Bryant Heater & Mfg. Co.
Buffalo Forge Co.
Excelso Specialty Works, Inc.
Handon Boiler Corp.
Ilg Electric Ventilating Co.
Lyon Products Co., Inc.
Skinner Bros. Mfg. Co., Inc.
Smith, H. B., Co.
Whitlock Coil Pipe Co.
York Heating & Ventilating Corp.

Industrial
Bayley Mfg. Co.
Bryant Heater & Mfg. Co.
Buffalo Forge Co.
Drying Systems, Inc.
Ilg Electric Ventilating Co.
Langenberg Mfg. Co.
Lebanon Boiler Works
Moncrief Furnace Co.
Sims Company, The
Skinner Bros. Mfg. Co., Inc.
Sturtevant, B. F., Co.
Westinghouse Electric & Mfg. Co.
Wing, L. J., Mfg. Co.
York Heating & Ventilating Corp.

Instantaneous Hot Water
Alberger Heater Co.
American District Steam Co.
Frank, O. E., Heater & Engineering Co., Inc.
Patterson-Kelley Co.
Powers Regulator Co.
Sims Company, The
Whitlock Coil Pipe Co.

Room
Bayley Mfg. Co.
Buffalo Forge Co.
International Heater Co.
Langenberg Mfg. Co.
Moncrief Furnace Co.

Tank
Abendroth Bros.
Alberger Heater Co.
Brownell Co.
Burnham Boiler Corp.
Cox, Abram, Stove Co.
Frank, O. E., Heater & Engineering Co., Inc.
Handon Boiler Corp.
International Heater Co.
Kewanee Boiler Co.
National Radiator Co.
O-E Specialty Mfg. Co.
Page, Wm. H., Boiler Co.
Patterson-Kelley Co.
Prox, Frank, Co.
Reading Heater & Supply Co.
Sims Company, The
Smith, H. B., Co.
Standard Heater Co.
Universal Smokeless Boiler Co.
Weil-McLain Co.

Unit
Aerofin Corp.
American Blower Co.
Bayley Mfg. Co.
Buffalo Forge Co.
Clarage Fan Co.
Ilg Electric Ventilating Co.
Langenberg Mfg. Co.
Lyon Products Co., Inc.
Moncrief Furnace Co.
Nelson, Herman, Corp.
Nesbitt, John J., Inc.
New York Blower Co.
O-E Specialty Mfg. Co.
Skinner Bros. Mfg. Co., Inc.
Sturtevant, B. F., Co.
Wing, L. J., Mfg. Co.
York Heating & Ventilating Corp.

Water (*Incinerator*)
Alberger Heater Co.
Handon Boiler Corp.
Kewanee Boiler Co.
Lebanon Boiler Works
Sims Company, The

HEATING AND VENTILATING APPARATUS
Abendroth Bros.
Aerofin Corp.
American Blower Co.
American Radiator Co.
Barnes & Jones
Bayley Mfg. Co.
Bishop & Babcock Co.
Buffalo Forge Co.
Burnham Boiler Corp.
Caloroil Burner Corp.
Carrier Engineering Corp.
Clarage Fan Co.
Cooling and Air Conditioning Corp.
Davis, G. M., Regulator Co.
Fitzgibbons Boiler Co., Inc.
Gorton & Lidgerwood Co.
Grinnell Co., Inc.
Ilg Electric Ventilating Co.
International Heater Co.
Langenberg Mfg. Co.
Lyon Products Co., Inc.
Marsh, Jas. P., & Co.
Midwest Air Filters, Inc.
Nash Engineering Co.
New York Blower Co.
O-E Specialty Mfg. Co.
Reading Heater & Supply Co.
Reed Air Filter Co.
Richmond Radiator Co.
Savo Mfg. Co.
Sharon, R. W., Co.
Skinner Bros. Mfg. Co.
Smith, H. B., Co.
Spray Engineering Co.
Stickle Steam Specialties Co.
Sturtevant, B. F., Co.
U. S. Radiator Corp.
Utica Heater Co.
Warren Webster & Co.
Wing, L. J., Mfg. Co.
York Heating & Ventilating Corp.

HEATING SPECIALTIES
American District Steam Co.
American Radiator Co.
Barnes & Jones
Bishop & Babcock Co.
Buffalo Forge Co.
Burnham Boiler Corp.
Caloroil Burner Corp.
Combustion Specialties Corp.
Davis, G. M., Regulator Co.
Dunham, C. A., Co.
Fulton Co.
Gorton & Lidgerwood Co.
Grinnell Co., Inc.
Handon Boiler Corp.
Hoffman Specialty Co., Inc.
Honeywell Heating Specialties Co.
Illinois Engineering Co.
McAlear Mfg. Co.
McDonnell & Miller
Marsh, Jas. P., & Co.
Mason Regulator Co.
Monash-Younker Co., Inc.
Mouat Vapor Heating Co.
Nash Engineering Co.
National Radiator Co.
O-E Specialty Mfg. Co.
Page, Wm. H., Boiler Co.
Powers Regulator Co.
Reading Heater & Supply Co.
Sarco Co., Inc.
Savo Mfg. Co.
Sterling Engineering Co.
Stickle Steam Specialties Co.
Trane Co.
U. S. Radiator Corp.
Warren Webster & Co.
Young Pump Co.

HEATING SYSTEMS—Gas
Bryant Heater & Mfg. Co.
Carrier Engineering Corp.
McAlear Mfg. Co.
Marsh, James P., & Co.
Mueller Co.
Nelson, Herman, Corp.
New York Blower Co.
O-E Specialty Mfg. Co.
Savo Mfg. Co.
Sharon, R. W., Co.
Standard Heater Co.
Sturtevant, B. F., Co.
Trane Co.
XXth Century Heating & Ventilating Co.
Warren Webster & Co.

Hot Blast
Aerofin Corp.
American Blower Co.
Bayley Mfg. Co.
Buffalo Forge Co.
Carrier Engineering Corp.
Clarage Fan Co.
Grinnell Co., Inc.
Ilg Electric Ventilating Co.
Langenberg Mfg. Co.
Lyon Products Co., Inc.
Moncrief Furnace Co.
New York Blower Co.
O-E Specialty Mfg. Co.
Skinner Bros. Mfg. Co., Inc.
Stickle Steam Specialties Co.
Sturtevant, B. F., Co.
XXth Century Heating & Ventilating Co.
Wing, L. J., Mfg. Co.
York Heating & Ventilating Corp.

Hot Water
Abendroth Bros.
Barnes & Jones
Bryant Heater & Mfg. Co.
Buffalo Forge Co.
Burnham Boiler Corp.
Cox, Abram, Stove, Co.
D. & T. Mfg. Co.
Gorton & Lidgerwood Co.
Grinnell Co., Inc.
Handon Boiler Co.
Honeywell Heating Specialties Co.
International Heater Co.
Kewanee Boiler Co.
Mueller Co.
National Radiator Co.
Page, Wm. H., Boiler Co.
Prox, Frank, Co.
Reading Heater & Supply Co.
Richardson & Boynton Co.
Richmond Radiator Co.
Sharon, R. W., Co.
Sims Company, The
Smith, H. B., Co.
Standard Heater Co.
XXth Century Heating & Ventilating Co.
U. S. Radiator Corp.
York Heating & Ventilating Corp.

Steam
Abendroth Bros.
American District Steam Co.
Barnes & Jones
Bayley Mfg. Co.
Bishop & Babcock Co.
Bryant Heater & Mfg. Co.
Buffalo Forge Co.
Burnham Boiler Corp.
Caloroil Burner Corp.
Carrier Engineering Corp.
Cox, Abram, Stove Co.
Dunham, C. A., Co.
Gorton & Lidgerwood Co.
Grinnell Co., Inc.
Handon Boiler Corp.
Hoffman Specialty Co., Inc.
Illinois Engineering Co.
International Heater Co.
Kewanee Boiler Co.
McAlear Mfg. Co.
Marsh, Jas. P., & Co.
National Radiator Co.
O-E Specialty Mfg. Co.
Page, Wm. H., Boiler Co.
Richardson & Boynton Co.
Richmond Radiator Co.
Smith, H. B., Co.
Standard Heater Co.
Stickle Steam Specialties Co.
Trane Co.
XXth Century Heating & Ventilating Co.
U. S. Radiator Corp.
Warren Webster & Co.
Wing, L. J., Mfg. Co.
York Heating & Ventilating Corp.

Steam (*Exhaust*)
American District Steam Co.
Barnes & Jones
Bayley Mfg. Co.
Bishop & Babcock Co.
Buffalo Forge Co.
Carrier Engineering Corp.
Dunham, C. A., Co.
Gorton & Lidgerwood Co.
Grinnell Co., Inc.
Hoffman Specialty Co.
Illinois Engineering Co.
Marsh, Jas. P., & Co.
McAlear Mfg. Co.
O-E Specialty Mfg. Co.
Page, Wm. H., Boiler Co.
Smith, H. B., Co.
Sterling Engineering Co.
Stickle Steam Specialties Co.
Trane Co.
Warren Webster & Co.
York Heating & Ventilating Corp.

Steam (*Vacuum*)
Abendroth Bros.
Barnes & Jones
Bayley Mfg. Co.
Bishop & Babcock Co.
Burnham Boiler Corp.
Caloroil Burner Corp.
Carrier Engineering Corp.
Cox, Abram, Stove Co.
Dunham, C. A., Co.
Gorton & Lidgerwood Co.
Grinnell Co., Inc.
Hoffman Specialty Co.
Illinois Engineering Co.
McAlear Mfg. Co.
Marsh, Jas. P., & Co.
Monash-Younker Co.
Mueller Co.
Nash Engineering Co.
O-E Specialty Mfg. Co.
Page, Wm. H., Boiler Co.
Smith, H. B., Co.
Standard Heater Co.
Sterling Engineering Co.
Stickle Steam Specialties Co.
Sturtevant, B. F., Co.
Trane Co.
U. S. Radiator Corp.
Warren Webster & Co.
York Heating & Ventilating Corp.

Steam (*Vapor*)
Abendroth Bros.
American District Steam Co.
Barnes & Jones
Bishop & Babcock Co.
Bryant Heater & Mfg. Co.
Burnham Boiler Corp.
Caloroil Burner Corp.
Carrier Engineering Corp.
Cox, Abram, Stove Co.
Dunham, C. A., Co.
Gorton & Lidgerwood Co.
Grinnell Co., Inc.
Handon Boiler Corp.
Hoffman Specialty Co.
Illinois Engineering Co.
International Heater Co.
Kewanee Boiler Co.
McAlear Mfg. Co.
Marsh, Jas. P., & Co.
Monash-Younker Co.
Mouat Vapor Heating Co.
Nelson, Herman, Corp.
O-E Specialty Mfg. Co.
Page, Wm. H., Boiler Co.
Smith, H. B., Co.
Standard Heater Co.
Sterling Engineering Co.
Stickle Steam Specialties Co.
Trane Co.
XXth Century Heating & Ventilating Co.
U. S. Radiator Corp.
Warren Webster & Co.
York Heating & Ventilating Corp.

Warm-Air
Buffalo Forge Co.
Caloroil Burner Corp.
Carrier Engineering Corp.
Cox, Abram, Stove Co.
International Heater Co.
Langenberg Mfg. Co.
Moncrief Furnace Co.
New York Blower Co.
Skinner Bros. Mfg. Co., Inc.
Sturtevant, B. F., Co.
XXth Century Heating & Ventilating Co.

HOT BLAST HEATING SYSTEMS (*See Heating Systems, Hot Blast*)

HOT WATER CIRCULATING PUMPS (*See Pumps, Circulating*)

HOT WATER HEATERS, AUTOMATIC (*See Heaters, Automatic Hot Water*)

HOT WATER HEATERS, INSTANTANEOUS (*See Heaters, Instantaneous Hot Water*)

HOT WATER HEATERS, SERVICE (*See Heaters, Hot Water Service*)

HOT WATER HEATING SYSTEMS (*See Heating Systems, Hot Water*)

HUMIDIFIERS
American Blower Co.
Atmospheric Conditioning Corp.
Bayley Mfg. Co.
Bishop & Babcock Co.
Buffalo Forge Co.
Call, John, Co.
Carrier Engineering Corp.
Cooling and Air Conditioning Corp.
Drying Systems, Inc.
Grinnell Co., Inc.
Ilg Electric Ventilating Co.
Johnson Service Co.
Langenberg Mfg. Co.
Midwest Air Filters, Inc.
New York Blower Co.
Powers Regulator Co.
Reed Air Filter Co.
Savo Mfg. Co.
Skinner Bros. Mfg. Co., Inc.
Spray Engineering Co.
Sturtevant, B. F., Co.
XXth Century Heating & Ventilating Co.

HUMIDITY CONTROL
American Blower Co.
Atmospheric Conditioning Corp.
Bayley Mfg. Co.
Bishop & Babcock Co.
Carrier Engineering Corp.
Cooling and Air Conditioning Corp.
Drying Systems, Inc.
Grinnell Co., Inc.
Johnson Service Co.
Klipfel Mfg. Co.
Midwest Air Filters, Inc.
New York Blower Co.
Powers Regulator Co.
Sarco Co., Inc.
Savo Mfg. Co.
Skinner Bros. Mfg. Co., Inc.
Sturtevant, B. F., Co.
Taylor Instrument Companies

INCINERATORS, Hot Water (*See Heaters, Water, Incinerator*)

INSTRUMENTS—Air Testing (*See Air Testing Instruments*)

Indicating
American District Steam Co.
Combustion Specialties Corp.
Ellison, Lewis M.
Hill, E. Vernon, Co.
Marsh, Jas. P., & Co.
Sarco Co., Inc.
Taylor Instrument Companies

Recording
American District Steam Co.
Marsh, Jas. P., & Co.
Taylor Instrument Companies

INSULATING MATERIALS (*See Asbestos and Insulating Products*)

Cold
Johns-Manville, Inc.

Heat
American District Steam Co.
Johns-Manville, Inc.
Ric-wil Co.

JOINTS—Expansion
Alberger Heater Co.
Badger, E. B., & Sons Co.
Fulton Co.
Grinnell Co., Inc.
Illinois Engineering Co.
Mogul Machine Co.
Sharon, R. W., Co.
Warren Webster & Co.

Pipe
Grinnell Co., Inc.

KILNS, DRY
American Blower Co.
Buffalo Forge Co.
Carrier Engineering Corp.
Drying Systems, Inc.
New York Blower Co.
Sturtevant, B. F., Co.

LIQUID, BOILER (*See Boiler Liquid*)

MACHINES, REFRIGERATING (*See Refrigerating Machinery*)

MAGNESIA PRODUCTS (*See Asbestos and Insulating Products*)

MECHANICAL DRAFT APPARATUS
American Blower Co.
Bayley Mfg. Co.
Buffalo Forge Co.
Carrier Engineering Corp.
Clarage Fan Co.
Combustion Specialties Corp.
Ilg Electric Ventilating Co.
Mason Regulator Co.
New York Blower Co.
Sturtevant, B. F., Co.
Taylor Instrument Companies
Wing, L. J., Mfg. Co.

METAL WEATHER STRIPS (*See Weather Strips, Metal*)

METERS—Feed Water
Johns-Manville, Inc.
Sharon, R. W., Co.

Flow
American District Steam Co.
Spray Engineering Co.

Steam
American District Steam Co.

Water
Johns-Manville, Inc.
Sharon, R. W., Co.
Worthington Pump & Machinery Corp.

MICA
Westinghouse Electric & Mfg. Co.

MOISTENERS, AIR (*See Humidifiers*)

MOTOR CONTROLLERS (*See Controllers, Motor*)

MOTORS—Electric
Honeywell Heating Specialties
Ilg Electric Ventilating Co.
Johnson Service Co.
Reliance Electric & Engineering Co.
Sturtevant, B. F., Co.
Westinghouse Electric & Mfg. Co.

NOZZLES—Brine Spray
Atmospheric Conditioning Corp
Badger, E. B., & Sons Co.
Buffalo Forge Co.
Grinnell Co., Inc.
Spray Engineering Co.

Spray
American Blower Co.
Atmospheric Conditioning Corp.
Badger, E. B., & Sons Co.
Bayley Mfg. Co.
Buffalo Forge Co.
Clarage Fan Co.
Grinnell Co., Inc.
New York Blower Co.
Spray Engineering Co.
Sturtevant, B. F., Co.

OIL BURNERS
Automatic Burner Corp.
Caloroil Burner Corp.
Winslow Boiler & Engineering Co.

PACKING—Asbestos
Jenkins Bros.
Johns-Manville, Inc.
New York Blower Co.

Metallic
Johns-Manville, Inc

Rubber
Jenkins Bros.
Johns-Manville, Inc.

PIPE—Bending
Badger, E. B., & Sons Co.
Grinnell Co., Inc.
Sharon, R. W., Co.

Cast Iron
Abendroth Bros.
Grinnell Co., Inc.

Coils (*See Coils, Pipe*)

Covering (*See Covering, Pipe and Tank; also, Conduits*)

Fittings
Abendroth Bros.
American District Steam Co.
Grinnell Co., Inc.

Hangers (*See Hangers, Pipe*)

Joint Cement (*See Cement, Pipe Joint*)

Plugs (*See Plugs, Pipe*)

Wrought Iron and Steel
Grinnell Co., Inc.

PIPELESS FURNACES (*See Furnaces, Pipeless*)

PITOT TUBES AND GAGES
Clarage Fan Co.
Higgin Mfg. Co.
Hill, E. Vernon, Co.

PLATES—Floor
Farley Sleeve & Hanger Co.
Grinnell Co., Inc.
National Radiator Co.

PLUGS—Fusible
Grinnell Co., Inc.

Pipe
Grinnell Co., Inc.

POWER PLANT SUPPLIES
Buffalo Forge Co.
Davis, G. M., Regulator Co.
Dunham, C. A., Co.
Grinnell Co., Inc.
Illinois Engineering Co.
Johns-Manville, Inc.
Klipfel Mfg. Co.
McAlear Mfg. Co.
Mason Regulator Co.
Sharon, R. W., Co.
Sturtevant, B. F., Co.
Taylor Instrument Companies
Westinghouse Electric & Mfg. Co.

PRESSURE GAGES (*See Gages, Pressure*)

PROTECTORS—Radiator
American Metal Products Corp.
American Radiator Co.
Fulton Co.
U. S. Radiator Corp.

PSYCHROMETERS
Higgin Mfg. Co.
Hill, E. Vernon, Co.
Taylor Instrument Companies

PUBLICATIONS
Heating & Ventilating Magazine
Warren Webster & Co.

PUMPS—Air
Bishop & Babcock Co.
Buffalo Steam Pump Co.
Chicago Pump Co.
Economy Pumping Machinery Co.
McAlear Mfg. Co.
Nash Engineering Co.
O-E Specialty Mfg. Co.
Powers Regulator Co.
Sterling Engineering Co.
Trane Co.
Worthington Pump & Machinery Corp.

Automatic Electric
Chicago Pump Co.
Economy Pumping Machinery Co.
Goulds Mfg. Co., The
Nash Engineering Co.
Trane Co.
Westinghouse Electric & Mfg. Co.
Worthington Pump & Machinery Corp.
Yeomans Brothers Co.
Young Pump Co.

Boiler Feed
Buffalo Steam Pump Co.
Chicago Pump Co.
Economy Pumping Machinery Co.
Goulds Mfg. Co.
Grinnell Co., Inc.
Nash Engineering Co.
O-E Specialty Mfg. Co.
Skidmore Corp.
Trane Co.
Worthington Pump & Machinery Corp.
Yeomans Brothers Co.
Young Pump Co.

Centrifugal
Buffalo Steam Pump Co.
Chicago Pump Co.
Economy Pumping Machinery Co.
Goulds Mfg. Co.
Nash Engineering Co.
Skidmore Corp.
Trane Co.
Worthington Pump & Machinery Corp.
Yeomans Brothers Co.
Young Pump Co.

Circulating
Chicago Pump Co.
Economy Pumping Machinery Co.
Goulds Mfg. Co.
Nash Engineering Co.
Trane Company
Worthington Pump & Machinery Corp.
Yeomans Brothers Co.

Condensation
Buffalo Steam Pump Co.
Chicago Pump Co.
Economy Pumping Machinery Co.
Goulds Mfg. Co.
Nash Engineering Co.
O-E Specialty Mfg. Co.
Skidmore Corp.
Sterling Engineering Co.
Trane Co.
Worthington Pump & Machinery Corp.
Yeomans Brothers Co.
Young Pump Co.

Electric
Buffalo Steam Pump Co.
Chicago Pump Co.
Economy Pumping Machinery Co.
Goulds Mfg. Co.
Nash Engineering Co.
Skidmore Corp.
Trane Co.
Westinghouse Electric & Mfg. Co.
Worthington Pump & Machinery Corp.
Yeomans Brothers Co.
Young Pump Co.

Rotary
Buffalo Steam Pump Co.
Economy Pumping Machinery Co.
Goulds Mfg. Co.
Nash Engineering Co.
Worthington Pump & Machinery Corp.

Steam
Buffalo Steam Pump Co.
Nash Engineering Co.
Worthington Pump & Machinery Corp.

Sump
Buffalo Steam Pump Co.
Chicago Pump Co.
Economy Pumping Machinery Co.
Goulds Mfg. Co.
Nash Engineering Co.
Trane Co.
Worthington Pump & Machinery Corp.
Yeomans Brothers Co.

Turbine
Buffalo Steam Pump Co.
Economy Pumping Machinery Co.
Goulds Mfg. Co.
Nash Engineering Co.
Trane Co.
Westinghouse Electric & Mfg. Co.
Worthington Pump & Machinery Corp.
Yeomans Brothers Co.

Vacuum
Buffalo Forge Co.
Buffalo Steam Pump Co.
Chicago Pump Co.
Economy Pumping Machinery Co.
Goulds Mfg. Co.
McAlear Mfg. Co.
Nash Engineering Co.
O-E Specialty Mfg. Co.
Skidmore Corp.
Trane Co.
Westinghouse Electric & Mfg. Co.
Worthington Pump & Machinery Corp.
Young Pump Co.

RADIATOR—Air Valves (*See Valves, Air*)

Brackets
American Radiator Co.
Continental Heater Corp.
Gleockle, A. F., Jr.
Grinnell Co., Inc.
Handon Boiler Corp.
Healy-Ruff Co.
Hoffman Specialty Co.
Kewanee Boiler Co.
National Radiator Co.
Pierce, Butler & Pierce Mfg. Co.
Sharon, R. W., Co.
Smith, H. B., Co.
U. S. Radiator Corp.
York Heating & Ventilating Corp.

Covers
American Metal Products Co.
American Radiator Co.
Reed Air Filter Co.
U. S. Radiator Corp.

ELBOWS (*See Elbows, Radiator*)

Hangers (*See Hangers, Radiator*)

Humidifiers (*See Humidifiers*)

Return Line Valves (*See Valves, Return Line*)

Shields (*See Protectors, Radiator*)

Traps (*See Traps, Radiator*)

Valves (*See Valves, Radiator*)

RADIATORS—Fan System
Aerofin Corp.
Buffalo Forge Co.
Lyon Products Co., Inc.
O-E Specialty Mfg. Co.
Rome-Turney Radiator Co.
Smith, H. B., Co.

Hot Water
Abendroth Brothers
Aerofin Corp.
American Radiator Co.
Bayley Mfg. Co.
Burnham Boiler Corp.
Continental Heater Corp.
Handon Boiler Corp.
Ilg Electric Ventilating Co.
Kewanee Boiler Co.
National Radiator Co.
O-E Specialty Mfg. Co.
Page, Wm. H., Boiler Co.
Pierce, Butler & Pierce Mfg. Corp.
Richmond Radiator Co.
Rome-Turney Radiator Co.
Smith, H. B., Co.
Sturtevant, B. F., Co.
U. S. Radiator Corp.
Utica Heater Co.
Weil-McLain Co.
York Heating & Ventilating Corp.

Steam
Abendroth Brothers
Aerofin Corp.
American Radiator Co.
Bayley Mfg. Co.
Buffalo Forge Co.
Burnham Boiler Corp.
Continental Heater Corp.
Handon Boiler Corp.
Kewanee Boiler Co.
National Radiator Co.
O-E Specialty Mfg. Co.
Page, Wm. H., Boiler Co.
Pierce, Butler & Pierce Mfg. Corp.
Richmond Radiator Co.
Rome-Turney Radiator Co.
Smith, H. B., Co.
U. S. Radiator Corp.
Utica Heater Co.
Weil-McLain Co.

Wall
Abendroth Brothers
American Radiator Co.
Burnham Boiler Corp.
Continental Heater Corp.
Kewanee Boiler Co.
National Radiator Co.
Page, Wm. H., Boiler Co.
Pierce, Butler & Pierce Mfg. Corp.
Richmond Radiator Co.
Smith, H. B., Co.
U. S. Radiator Corp.
Utica Heater Co.
Weil-McLain Co.

RECEIVERS—Air
Buffalo Steam Pump Co.
Illinois Engineering Co.
Kewanee Boiler Co.
Klipfel Mfg. Co.
O-E Specialty Mfg. Co.
Sims Company, The
Titusville Iron Works
Trane Co.
Whitlock Coil Pipe Co.

Ammonia
Titusville Iron Works
Whitlock Coil Pipe Co.

Condensation
Bishop & Babcock Co.
Economy Pumping Machinery Co.
Illinois Engineering Co.
Klipfel Mfg. Co.
McAlear Mfg. Co.
Mason Regulator Co.
Nash Engineering Co.
Titusville Iron Works
Trane Co.

REFRIGERATING MACHINERY
Carrier Engineering Corp.
Worthington Pump & Machinery Corp.

REFRIGERATING SECTIONS
American Radiator Co.

REGISTERS AND GRILLES
Knowles Mushroom Ventilator Co.
Lyon Products Co., Inc.
Sturtevant, B. F., Co.

REGULATORS—Damper
American District Steam Co.
American Radiator Co.
Bishop & Babcock Co.
Burnham Boiler Corp.
Carrier Engineering Corp.
D. & T. Mfg. Co.
Dunham, C. A., Co.
Fulton Co.
Gorton & Lidgerwood Co.
Handon Boiler Corp.
Hoffman Specialty Co., Inc.
Honeywell Heating Specialties Co.
Illinois Engineering Co.
Klipfel Mfg. Co.
McAlear Mfg. Co.
Marsh, Jas. P., & Co.
Mason Regulator Co.
Mouat Vapor Heating Co.
Mueller Co.
National Radiator Co.
Nelson, Herman Corp.
O-E Specialty Mfg. Co.
Powers Regulator Co.
Sarco Co., Inc.
Stickle Steam Specialties Co.
Taylor Instrument Companies
Trane Co.
U. S. Radiator Corp.
Warren Webster & Co.
Wing, L. J., Mfg. Co.
York Heating & Ventilating Corp.

Feed Water
American Radiator Co.
Jenkins Bros.
McAlear Mfg. Co.
McDonnell & Miller
Powers Regulator Co.
Sarco Co., Inc.
Stickle Steam Specialties Co.
Taylor Instrument Companies
Warren Webster & Co.

Humidity
Carrier Engineering Corp.
Johnson Service Co.
Klipfel Mfg. Co.
Powers Regulator Co.
Taylor Instrument Companies

Pressure
American Radiator Co.
Bishop & Babcock Co.
Davis, G. M., Regulator Co.
Dunham, C. A., Co.
Fulton Co.
Hoffman Specialty Co.
Honeywell Heating Specialties Co.
Illinois Engineering Co.
Johnson Service Co.
Klipfel Mfg. Co.
McAlear Mfg. Co.
Mason Regulator Co.
Mueller Co.
O-E Specialty Mfg. Co.
Powers Regulator Co.
Stickle Steam Specialties Co.
Taylor Instrument Companies

Pump
Bishop & Babcock Co.
Davis, G. M., Regulator Co.
Dunham, C. A., Co.
Economy Pumping Machinery Co.
Illinois Engineering Co.
Klipfel Mfg. Co.
Mason Regulator Co.
McAlear Mfg. Co.
Mueller Co.
Stickle Steam Specialties Co.
Trane Company, The

Steam
American Radiator Co.
Bishop & Babcock Co.
Davis, G. M., Regulator Co.
Dunham, C. A., Co.
Fulton Co., The
Honeywell Heating Specialties Co.
Illinois Engineering Co.
Jenkins Bros.
Klipfel Mfg. Co.
Mason Regulator Co.
McAlear Mfg. Co.
Mueller Co.
Powers Regulator Co.
Sarco Co., Inc.
Stickle Steam Specialties Co.
Taylor Instrument Companies
Trane Co.
U. S. Radiator Corp.
Warren Webster & Co.
Wing, L. J., Mfg. Co.

Temperature
American Radiator Co.
Bishop & Babcock Co.
Burnham Boiler Corp.
Carrier Engineering Corp.
D. & T. Mfg. Co.
Fulton Co.
Honeywell Heating Specialties Co.
Illinois Engineering Co.
Johnson Service Co.
Klipfel Mfg. Co.
National Radiator Co.
O-E Specialty Mfg. Co.
Powers Regulator Co.
Reading Heater & Supply Co.
Sarco Co., Inc.
Sterling Engineering Co.
Stickle Steam Specialties Co.
Taylor Instrument Companies
U. S. Radiator Corp.
Westinghouse Electric & Mfg. Co.

Vacuum
American Radiator Co.
Bishop & Babcock Co.
Davis, G. M., Regulator Co.
Dunham, C. A., Co.
Economy Pumping Machinery Co.
Hoffman Specialty Co.
Honeywell Heating Specialties Co.
Illinois Engineering Co.
Klipfel Mfg. Co.
McAlear Mfg. Co.
Mason Regulator Co.
Mueller Co.
National Radiator Co.
O-E Specialty Mfg. Co.
Sterling Engineering Co.
Stickle Steam Specialties Co.
Trane Co.
U. S. Radiator Corp.
Warren Webster & Co.

Vapor
American District Steam Co.
American Radiator Co.
Bishop & Babcock Co.
Davis, G. M., Regulator Co.
Dunham, C. A., Co.
Hoffman Specialty Co., Inc.
Honeywell Heating Specialties Co.
Illinois Engineering Co.
Klipfel Mfg. Co.
McAlear Mfg. Co.
Mason Regulator Co.
Mouat Vapor Heating Co.
Nelson, Herman, Corp.
O-E Specialty Mfg. Co.
Powers Regulator Co.
Trane Co.
U. S. Radiator Corp.

Water
American Radiator Co.
Bishop & Babcock Co.
Davis, G. M., Regulator Co.
Fulton Co.
Honeywell Heating Specialties Co.
Jenkins Bros.
Klipfel Mfg. Co.
McAlear Mfg. Co.
Mason Regulator Co.
Mueller Co.

Powers Regulator Co.
Reading Heater & Supply Co.
Taylor Instrument Companies
U. S. Radiator Corp.

Water Level (*See Controllers*)

REHEATERS—Air
Aerofin Corp.
Bayley Mfg. Co.
Buffalo Forge Co.
Ilg Electric Ventilating Co.
Lyon Products Co., Inc.
New York Blower Co.
Stickle Steam Specialties Co.
Sturtevant, B. F., Co.
York Heating & Ventilating Corp.

RELAY SWITCHES (*See Switches, Control and Relay*)

ROOF VENTILATORS (*See Ventilators, Roof*)

ROTARY DRYERS (*See Drying Apparatus*)

ROTARY HACK SAW TOOLS
Excelso Specialty Works, Inc.

SCALE REMOVER—Boiler
O-E Specialty Mfg. Co.
"X" Laboratories

SCRUBBERS, AIR
Bayley Mfg. Co.
Buffalo Forge Co.

SEPARATORS—Dust
Bayley Mfg. Co.
Buffalo Forge Co.
Call, John, Co.
Carrier Engineering Corp.
New York Blower Co.
Sims Company, The
Sturtevant, B. F., Co.
York Heating & Ventilating Corp.

Steam and Oil
Bishop & Babcock Co.
Dunham, C. A., Co.
Illinois Engineering Co.
McAlear Mfg. Co.
Patterson-Kelley Co.
Stickle Steam Specialties Co.
Warren Webster & Co.

SHEETS—Asbestos
Johns-Manville, Inc.
New York Blower Co.

SHIELDS (*See Protectors, Radiator*)

SHOWER BATH CONTROLLERS (*See Controllers, Shower Bath*)

SLEEVES—Adjustable
Farley Sleeve & Hanger Co.

SMOKE CONSUMER
Combustion Specialties Corp.
Universal Smokeless Boiler Co.

SOFTENERS, WATER (*See Water Softeners*)

SPECIALTIES, HEATING (*See Heating Specialties*)

SPECIALTIES—Sheet Metal
Call, John, Co.
Sturtevant, B. F., Co.
York Heating & Ventilating Corp.

SPECIALTIES, STEAM (*See Steam Specialties*)

SPRAY COOLING SYSTEMS
Atmospheric Conditioning Corp.
Badger, E. B., & Sons Co.
Bayley Mfg. Co.
Buffalo Forge Co.
Carrier Engineering Corp.
Grinnell Co., Inc.
New York Blower Co.
Spray Engineering Co.

SPRAY NOZZLES (*See Nozzles, Spray*)

STEAM CALORIMETERS (*See Calorimeters, Steam*)

STEAM ENGINES (*See Engines, Steam*)

STEAM HEATING SYSTEMS (*See Heating Systems, Steam*)

STEAM SPECIALTIES
American District Steam Co.
Barnes & Jones
Bishop & Babcock Co.
Davis, G. M., Regulator Co.
Dunham, C. A., Co.
Fulton Co.
Gorton & Lidgerwood Co.
Hoffman Specialty Co.
Illinois Engineering Co.
Johns-Manville, Inc.
Klipfel Mfg. Co.
McAlear Mfg. Co.
Marsh, Jas. P., & Co.
Mason Regulator Co.
O-E Specialty Mfg. Co.
Sarco Co., Inc.
Sharon, R. W., Co.
Sims Company, The
Stickle Steam Specialties Co.
U. S. Radiator Corp.
Trane Co.
Warren Webster & Co.

STOKERS
Detroit Stoker Co.
Riley Stoker Corp.
Sturtevant, B. F., Co.
Westinghouse Electric & Mfg. Co.

STRAINERS—Oil
Davis, G. M., Regulator Co.
Illinois Engineering Co.
McAlear Mfg. Co.
Mason Regulator Co.
Mueller Co.
Sarco Co., Inc.
Sterling Engineering Co.

Steam
Bishop & Babcock Co.
Davis, G. M., Regulator Co.
Illinois Engineering Co.
McAlear Mfg. Co.
Mason Regulator Co.
Mueller Co.
Sarco Co., Inc.
Sterling Engineering Co.

Water
Davis, G. M., Regulator Co.
Dunham, C. A., Co.
Illinois Engineering Co.
McAlear Mfg. Co.
Mason Regulator Co.
Mueller Co.
Sarco Co., Inc.
Spray Engineering Co.
Sterling Engineering Co.

SUPPLIES—Power Plant (*See Power Plant Supplies*)

SUPPORTS (*See Hangers, Pipe and Radiator*)

SWITCHES—Control-Relay
Powers Regulator Co.
Trane Co.
Westinghouse Electric & Mfg. Co.

SYSTEMS—Air Washing and Cooling (*See Air Conditioning*)

Domestic Hot Water
Bryant Heater & Mfg. Co.
Caloroil Burner Corp.
Cox, Abram, Stove Co.
Excelso Specialty Works, Inc.
Honeywell Heating Specialties Co.
International Heater Co.
Sims Company, The
Smith, H. B., Co.
Standard Heater Co.
U. S. Radiator Corp.

Dust Collecting
American Blower Co.
Bayley Mfg. Co.
Buffalo Forge Co.
Call, John, Co.
Carrier Engineering Corp.
Clarage Fan Co.
Midwest Air Filters, Inc.
New York Blower Co.
Reed Air Filter Co.
Skinner Bros. Mfg. Co., Inc.
Sturtevant, B. F., Co.
York Heating & Ventilating Corp.

Exhaust (*See Exhaust Systems*)

Hot Blast
Aerofin Corp.
American Blower Co.
Bayley Mfg. Co.
Buffalo Forge Co.
Carrier Engineering Corp.
Clarage Fan Co.
Ilg Electric Ventilating Co.
Langenberg Mfg. Co.
Lyon Products Co., Inc.
Moncrief Furnace Co.
New York Blower Co.
O-E Specialty Mfg. Co.
Sturtevant, B. F., Co.
XXth Century Heating & Ventilating Co.
York Heating & Ventilating Corp.

Spray Cooling (*See Spray Cooling Systems*)

Temperature Control
American Blower Co.
Bishop & Babcock Co.
Buffalo Forge Co.
Caloroil Burner Corp.
Carrier Engineering Corp.
Clarage Fan Co.
Fulton Co.
Honeywell Heating Specialties Co.
Illinois Engineering Co.
Johnson Service Co.
Klipfel Mfg. Co.
Mueller Co.
Powers Regulator Co.
Sterling Engineering Co.
Sturtevant, B. F., Co.
Taylor Instrument Companies

Ventilating (*See Ventilating Systems*)

TANK—Coils (*See Coils, Tank*)

Covering (*See Covering, Pipe and Tank*)

Heaters (*See Heaters, Tank*)

Regulators
American Radiator Co.
Bishop & Babcock Co.
Davis, G. M., Regulator Co.
Fulton Co.
Johnson Service Co.
Klipfel Mfg. Co.
McAlear Mfg. Co.
Mason Regulator Co.
Mueller Co.
Page, Wm. H., Boiler Co.
Powers Regulator Co.
Stickle Steam Specialties Co.
Taylor Instrument Companies

TANKS—Blow-Off
Economy Pumping Machinery Co.
Lebanon Boiler Works Co.
Oil City Boiler Works
Sims Company, The
Titusville Iron Works

Cast Iron
Bishop & Babcock Co.
Economy Pumping Machinery Co.

Pressure
Ames Iron Works
Brownell Co.
Harrisburg Star Boiler Corp.
Kewanee Boiler Co.
Klipfel Mfg. Co.
Lebanon Boiler Works Co.
Oil City Boiler Works
Sims Company, The
Titusville Iron Works

Storage
Ames Iron Works
Brownell Co.
Frank, O. E., Heater & Engineering Co.
Harrisburg Star Boiler Corp.
Kewanee Boiler Co.
Lebanon Boiler Works Co.
National Radiator Co.
Oil City Boiler Works
Page, Wm. H., Boiler Co.
Sims Company, The
Titusville Iron Works

TEMPERATURE REGULATORS (*See Regulators, Temperature*)

THERMOMETERS
American Radiator Co.
Bishop & Babcock Co.
Burnham Boiler Corp.
Hill, E. Vernon, Co.
Marsh, Jas. P., & Co.
National Radiator Co.
Pierce, Butler & Pierce Mfg. Corp.
Powers Regulator Co.
Sarco Co., Inc.
Taylor Instrument Companies
U. S. Radiator Corp.

THERMOSTATS
American Radiator Co.
Bishop & Babcock Co.
Burnham Boiler Corp.
Fulton Co.
Honeywell Heating Specialties Co.
Johnson Service Co.
Klipfel Mfg. Co.
Powers Regulator Co.
Sarco Co., Inc.
Taylor Instrument Companies
Westinghouse Electric & Mfg. Co.

TRAPS—Blast
Barnes & Jones
Dunham, C. A., Co.
Hoffman Specialty Co., Inc.
Illinois Engineering Co.

Radiator
American District Steam Co.
Barnes & Jones
Bishop & Babcock Co.
Dunham, C. A., Co.
Grinnell Co., Inc.
Hoffman Specialty Co., Inc.
Illinois Engineering Co.
Johns-Manville, Inc.
McAlear Mfg. Co.
Marsh, Jas. P., & Co.
Monash-Younker Co., Inc.
Mouat Vapor Heating Co.
Mueller Co.
National Radiator Co.
O-E Specialty Mfg. Co.
Sarco Co., Inc.
Sterling Engineering Co.
Stickle Steam Specialties Co.
Trane Co.
U. S. Radiator Corp.
Warren Webster & Co.

Return
American Blower Co.
Barnes & Jones
Bishop & Babcock Co.
Dunham, C. A. Co.
Hoffman Specialty Co.
Illinois Engineering Co.
Johns-Manville, Inc.
McAlear Mfg. Co.
Marsh, Jas. P., & Co.
Monash-Younker Co., Inc.
Mouat Vapor Heating Co.
O-E Specialty Mfg. Co.
Sterling Engineering Co.
Trane Co.
U. S. Radiator Corp.
Warren Webster & Co.

Return (*Siphon*)
Bishop & Babcock Co.
Marsh, Jas. P., & Co.

Steam
American Blower Co.
American District Steam Co.
Barnes & Jones
Bayley Mfg. Co.
Bishop & Babcock Co.
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Warren Webster & Co.

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American Blower Co.
American District Steam Co.
Barnes & Jones
Bishop & Babcock Co.
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Stickle Steam Specialties Co.
Trane Co.
U. S. Radiator Corp.
Warren Webster & Co.

TURBINES—Steam
Sturtevant, B. F., Co.
Westinghouse Electric & Mfg. Co.
Wing, L. J., Mfg. Co.

TURBO-BLOWERS
Buffalo Forge Co.
New York Blower Co.
Sturtevant, B. F., Co.
Wing, L. J., Mfg. Co.

UNDERGROUND PIPE CONDUIT (*See Conduits, Underground Pipe*)

VACUUM—Cleaning Apparatus
Buffalo Forge Co.
Nash Engineering Co.
Sturtevant, B. F., Co.

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Gages (*See Gages, Vacuum*)

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VALVES—Air
American Radiator Co.
Bishop & Babcock Co.
Burnham Boiler Corp.
Davis, G. M., Regulator Co.
Dole Valve Co.
Dunham, C. A., Co.
Fulton Co.
Gorton & Lidgerwood Co.
Grinnell Co., Inc.
Healy-Ruff Co.
Hoffman Specialty Co., Inc.
Honeywell Heating Specialties Co.
Jenkins Bros.
Klipfel Mfg. Co.
McAlear Mfg. Co.
Marsh, Jas. P., & Co.
Monash-Younker Co., Inc.
Mueller Company
National Radiator Co.
O-E Specialty Mfg. Co.
Page, Wm. H., Boiler Co.
Pierce, Butler & Pierce Mfg. Corp.
Powers Regulator Co.
Smith, H. B., Co.
Sterling Engineering Co.
Trane Co.
U. S. Radiator Corp.

Angle, Check and Globe
American Radiator Co.
Davis, G. M., Regulator Co.
Dole Valve Co.
Grinnell Co., Inc.
Illinois Engineering Co.
Jenkins Bros.
McAlear Mfg. Co.
National Radiator Co.
O-E Specialty Mfg. Co.
Pierce, Butler & Pierce Mfg. Corp.
Powers Regulator Co.
U. S. Radiator Corp.

Back-Pressure
Bishop & Babcock Co.
Davis, G. M., Regulator Co.
Grinnell Co., Inc.
Illinois Engineering Co.
Jenkins Bros.
Klipfel Mfg. Co.
McAlear Mfg. Co.
O-E Specialty Mfg. Co.
Stickle Steam Specialties Co.

Blow-Off
Davis, G. M., Regulator Co.
Grinnell Co., Inc.
Jenkins Bros.
Mueller Co.
U. S. Radiator Corp.

Float
Davis, G. M., Regulator Co.
Grinnell Co., Inc.
Illinois Engineering Co.
Klipfel Mfg. Co.
McAlear Mfg. Co.
Mason Regulator Co.
O-E Specialty Mfg. Co.
Stickle Steam Specialties Co.
Trane Co.

Gage
Bishop & Babcock Co.
Grinnell Co., Inc.
O-E Specialty Mfg. Co.
Stickle Steam Specialties Co.
U. S. Radiator Corp.

Gate
American District Steam Co.
American Radiator Co.
Dole Valve Co.
Gorton & Lidgerwood Co.
Grinnell Co., Inc.
Jenkins Bros.
Marsh, Jas. P., & Co.
Marsh Valve Co.
National Radiator Co.
O-E Specialty Mfg. Co.

Graduating
American District Steam Co.
Barnes & Jones
Bishop & Babcock Co.
Burnham Boiler Corp.
Dole Valve Co.
Dunham, C. A., Co.
Gorton & Lidgerwood Co.
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Monash-Younker Co., Inc.
Mouat Vapor Heating Co.
National Radiator Co.
O-E Specialty Mfg. Co.
Sterling Engineering Co.
Trane Co.
U. S. Radiator Corp.

Hot Water
American Radiator Co.
Barnes & Jones
Burnham Boiler Corp.
Davis, G. M., Regulator Co.
Dole Valve Co.
Gorton & Lidgerwood Co.
Grinnell Co., Inc.
Honeywell Heating Specialties Co.
Jenkins Bros.
Marsh, Jas. P., & Co.
Marsh Valve Co.
National Radiator Co.
Pierce, Butler & Pierce Mfg. Corp.
U. S. Radiator Corp.

Modulating
American District Steam Co.
American Radiator Co.
Barnes & Jones
Bishop & Babcock Co.
Burnham Boiler Corp.
Dole Valve Co.
Dunham, C. A., Co.
Gorton & Lidgerwood Co.
Grinnell Co., Inc.
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Sarco Co., Inc.
Sterling Engineering Co.
Trane Co.
U. S. Radiator Corp.
Warren Webster & Co.

Packless
American District Steam Co.
American Radiator Co.
Barnes & Jones
Bishop & Babcock Co.
Burnham Boiler Corp.
Davis, G. M., Regulator Co.
Dole Valve Co.
Dunham, C. A., Co.
Fulton Co.
Gorton & Lidgerwood Co.
Grinnell Co., Inc.
Illinois Engineering Co.
McAlear Mfg. Co.
Marsh, Jas. P., & Co.
Marsh Valve Co.
Monash-Younker Co., Inc.
Mouat Vapor Heating Co.
National Radiator Co.
O-E Specialty Mfg. Co.
Pierce, Butler & Pierce Mfg. Corp.
Powers Regulator Co.
Sarco Co., Inc.
Sterling Engineering Co.
Trane Co.
U. S. Radiator Corp.
Warren Webster & Co.

Radiator
American District Steam Co.
American Radiator Co.
Barnes & Jones
Bishop & Babcock Co.
Burnham Boiler Corp.
Davis, G. M., Regulator Co.
Dole Valve Co.
Dunham, C. A., Co.
Fulton Co.
Gorton & Lidgerwood Co.
Grinnell Co., Inc.
Hoffman Specialty Co., Inc.
Honeywell Heating Specialties Co.
Illinois Engineering Co.
International Heater Co.
Jenkins Bros.
McAlear Mfg. Co.
Marsh, Jas. P., & Co.
Marsh Valve Co.
Monash-Younker Co., Inc.
Mouat Vapor Heating Co.
National Radiator Co.
O-E Specialty Mfg. Co.
Pierce, Butler & Pierce Mfg. Corp.
Powers Regulator Co.
Sarco Co., Inc.
Sterling Engineering Co.
Trane Co.
U. S. Radiator Corp.
Warren Webster & Co.

Reducing
American District Steam Co.
Bishop & Babcock Co.
Davis, G. M., Regulator Co.
Dunham, C. A., Co.
Fulton Co.
Grinnell Co., Inc.
Illinois Engineering Co.
Jenkins Bros.
Klipfel Mfg. Co.
McAlear Mfg. Co.
Mason Regulator Co.
Mueller Co.
O-E Specialty Mfg. Co.
Powers Regulator Co.
Stickle Steam Specialties Co.
Taylor Instrument Companies

Regrinding
Grinnell Co., Inc.
Jenkins Bros.

Relief
Davis, G. M., Regulator Co.
Illinois Engineering Co.
Klipfel Mfg. Co.
McAlear Mfg. Co.
Mueller Co.
O-E Specialty Mfg. Co.
Powers Regulator Co.
Stickle Steam Specialties Co.
Titusville Iron Works

Return Line
American Radiator Co.
Barnes & Jones
Bishop & Babcock Co.
Dunham, C. A., Co.
Fulton Co.
Grinnell Co., Inc.
Hoffman Specialty Co., Inc.
Illinois Engineering Co.
Jenkins Bros.
McAlear Mfg. Co.
Marsh, Jas. P., & Co.
Mouat Vapor Heating Co.
National Radiator Co.
O-E Specialty Mfg. Co.
Stickle Steam Specialties Co.
Trane Co.
U. S. Radiator Corp.
Warren Webster & Co.

Safety
American District Steam Co.
American Radiator Co.
Burnham Boiler Corp.
Davis, G. M., Regulator Co.
Grinnell Co., Inc.
Jenkins Bros.
Marsh, Jas. P., & Co.
Mueller Co.
National Radiator Co.
O-E Specialty Mfg. Co.
Titusville Iron Works Co.
U. S. Radiator Corp.

Steam Feed
Grinnell Co., Inc.
Jenkins Bros.
McAlear Mfg. Co.
O-E Specialty Mfg. Co.

Thermostatic
American Radiator Co.
Barnes & Jones
Bishop & Babcock Co.
Dole Valve Co.
Dunham, C. A., Co.
Fulton Co.
Grinnell Co., Inc.
Hoffman Specialty Co.
Illinois Engineering Co.
McAlear Mfg. Co.
Marsh, Jas. P., & Co.
Monash-Younker Co., Inc.
O-E Specialty Mfg. Co.
Powers Regulator Co.

Sarco Co., Inc.
Sterling Engineering Co.
Stickle Steam Specialties Co.
Taylor Instrument Companies
Trane Co.

Vacuum
American Radiator Co.
Barnes & Jones
Bishop & Babcock Co.
Burnham Boiler Corp.
Davis, G. M., Regulator Co.
Dole Valve Co.
Dunham, C. A., Co.
Gorton & Lidgerwood Co.
Grinnell Co., Inc.
Hoffman Specialty Co., Inc.
Illinois Engineering Co.
Klipfel Mfg. Co.
McAlear Mfg. Co.
Marsh, Jas. P., & Co.
Marsh Valve Co.
Monash-Younker Co., Inc.
O-E Specialty Mfg. Co.
Sarco Co., Inc.
Sterling Engineering Co.
Stickle Steam Specialties Co.
Titusville Iron Works
Trane Co.
U. S. Radiator Corp.
Warren Webster & Co.

Vapor
American District Steam Co.
American Radiator Co.
Barnes & Jones
Bishop & Babcock Co.
Burnham Boiler Corp.
Davis, G. M., Regulator Co.
Dole Valve Co.
Dunham, C. A., Co.
Gorton & Lidgerwood Co.
Grinnell Co., Inc.
Hoffman Specialty Co.
Illinois Engineering Co.
McAlear Mfg. Co.
Marsh, Jas. P., & Co.
Marsh Valve Co.
Monash-Younker, Co.
Mouat Vapor Heating Co.
O-E Specialty Mfg. Co.
Sarco Co., Inc.
Sterling Engineering Co.
Stickle Steam Specialties Co.
Trane Co.
U. S. Radiator Corp.

VAPOR HEATING SYSTEMS (*See Heating Systems, Steam*) (*Vapor*)

VENTILATING—Blowers (*See Blowers, Ventilating*)

Fans (*See Fans, Ventilating*)

Systems
Aerofin Corp.
American Blower Co.
Bayley Mfg. Co.
Buffalo Forge Co.
Carrier Engineering Corp.
Clarage Fan Co.
Cooling and Air Conditioning Corp.
Ilg Electric Ventilating Co.
Knowles Mushroom Ventilator Co.
Lyon Products Co., Inc.
Midwest Air Filters, Inc.
Moncrief Furnace Co.
Nelson, Herman, Corp.
Nesbitt, John J., Co.
New York Blower Co.
O-E Specialty Mfg. Co.
Skinner Bros. Mfg. Co., Inc.
Sturtevant, B. F., Co.
Westinghouse Electric & Mfg. Co.
Wing, L. J., Mfg. Co.
York Heating & Ventilating Corp.

VENTILATORS—Mushroom
American Metal Products Co.
American Blower Co.
Call, John, Co.
Knowles Mushroom Ventilator Co.
New York Blower Co.
Sturtevant, B. F., Co.

Roof
American-Larson Ventilating Co.
Buffalo Forge Co.
Call, John, Co.
Hirschman Co., W. F.
Ilg Electric Ventilating Co.
Iona Ventilator Co., Inc.
Johns-Manville, Inc.
New York Blower Co.
O-E Specialty Mfg. Co.
Skinner Bros. Mfg. Co., Inc.
Sturtevant, B. F., Co.
York Heating & Ventilating Corp.

Window
Call, John, Co.
Hirschman Co., W. F.
Iona Ventilator Co., Inc.
Sturtevant, B. F., Co.

VENTS—Air
American Radiator Co.
Bishop & Babcock Co.
Burnham Boiler Corp.
Call, John, Co.
Dole Valve Co., The
Dunham, C. A., Co.
Fulton Co., The
Higgin Mfg. Co.
Hirschman Co., W. F.
Hoffman Specialty Co., Inc.
Iona Ventilator Co., Inc.
McAlear Mfg. Co.
Marsh, Jas. P., & Co.
O-E Specialty Mfg. Co.
Sturtevant, B. F., Co.
Trane Co.

WARM-AIR FURNACES (*See Furnaces, Warm Air*)

WARM-AIR HEATING SYSTEMS (*See Heating Systems, Warm Air*)

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Higgin Mfg. Co.
Monarch Metal Products Co.

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AMERICAN SOCIETY *of* HEATING *and* VENTILATING ENGINEERS

1925-1926

Contains Lists of Members Arranged Alphabetically and Geographically also Lists of Officers and Committees, Past Officers and Local Chapter Officers

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Committee to Confer with the International Exposition of Modern Decorative and Industrial Arts, Paris, France, June, 1925: Henry S. Downe and Auguste Beaurrienne.

Committee to Develop a Ventilation Safety Code under the Procedure of the American Engineering Standards Committee: W. S. Timmis, *Chairman;* W. H. Carrier, E. V. Hill, F. C. Houghten, D. D. Kimball, J. R. McColl, R. R. Sayers, F. R. Still, A. C. Willard.

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1925-26

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1925-26

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(Asterisk indicates authorship of papers)

(Junior 1916; Associate 1918; 1923) indicates, Elected Junior Member 1916; Elected Associate Member 1918; Elected Member 1923.

(Pres. 1923) indicates, Elected President in 1923 and is now a Presidential Member.

A

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ANGUS, Harry H. (1918), Consulting Engr., 2 Bloor St., W., and (for mail) 32 Sidney St., Toronto, Ont.

ANGUS, Robert A. (1920), Service Equipt. Engr. (for mail) Dwight P. Robinson & Co., Inc., 125 East 46th St., New York, and 19 Rich Ave., Mt. Vernon, N. Y.

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BARTH, Herbert E. (1920), Dist. Mgr. (for mail) American Blower Co., 2539 Woodward Ave., and 456 Webster Hall, Detroit, Mich.

BARTLETT, Amos C. (1919), N. E. Dist. Mgr. (for mail) B. F. Sturtevant Co., 555 Massachusetts Trust Bldg., Boston, and 10 Dunbarton Rd., Wollaston, Mass.

BARTLETT, C. Edwin (1922), Mgr., Bartlett & Co., Inc., 1938 Market St., Philadelphia, and 209 Creswell St., Ridley Park, Pa.

BARTLETT, Clarence D. (1923), Estimator and Supt. Constr. (for mail) W. G. Cornell Co., 153 Hudson St., Newark, and 22 Davey St., Bloomfield, N. J.

BARTLEY, John S., Jr. (1924), Archt. (for mail) 903 L. & J. National Bank Bldg., and 608 Elm St., Waterloo, Iowa.

BARTON, Royal Elton (1922), Engr., McLean & Cousins Co., Chandler and St. Charles Sts., Boston, and 4 Lyman Terrace, Dorchester, Mass.

BARWICK, Thomas. (1920), Consulting Engr. (for mail) Buchman & Kahn Archts., 49 West 45th St., New York, N. Y., and 408 Rutland Ave., West Englewood, N. J.

BASSLER, Edwin M. (1923), Gen. Mgr. (for mail) D. J. Murray Mfg. Co., 1002-1024 Third St., and 901 First St., Wausau, Wis.

BASTEDO, Albert E. (1919), Vice-Pres. and Treas. (for mail) Burnham Boiler Corp., Irvington, and 12 Wilson Pl., Hastings-on-Hudson, N. Y.

BATEMAN, William H., Jr. (1921), Heat. Engr. (for mail) C. J. Doyle, 2056 Pine St., and 2519 South 19th St., Philadelphia, Pa.

BAUM, Albert L. (1916), Consulting Engr., Jaros & Baum, 116 West 39th St., and (for mail), 562 West 113th St., New York, N. Y.

BAXTER, Robt. A. (1923), Heat. Engr. and Sales Rep. (for mail) Utica Heater Co., P. O. Box 8, and 51 Watson Pl., Utica, N. Y.

BAYSE, Harry V. (1923), Pres., American Furnace Co., 2725 Morgan St., St. Louis, Mo.

BEAHM, Robert B., 2nd (1919), Treas., Eagan & Beahm, Inc., 304-5-6 Stephen Girard Bldg., Philadelphia, and Haverford, Pa.

BEATTY, David J. (1918), Heat. and Vent. Engr. (for mail) Chas. Schneider Co., 492 East 163rd St., N. Y., and 1274 New York Ave., Brooklyn, N. Y.

BEAURRIENNE, Auguste* (1912), Contr., and Consulting Engr., 25 Rue des Marguettes, Paris, 12th Arr., France.

BEEBE, Frederick E. W. (Associate 1915), Sales Engr. (for mail) Johnson Service Co., 118 East 28th St., New York, N. Y., and 543 Chilton St., Elizabeth, N. J.

BEECHER, Philip M. (1908), Mgr. Promotion of Sales, Samuel Sloan & Co., 67 Exchange St., and 83 Yarmouth Rd., Rochester, N. Y.

BEGGS, Douglas T. (1922), Mgr. (for mail) Wm. Gordon Corp., 516 Bona Allen Bldg., Atlanta, and 612 W. College Ave., Decatur, Ga.

BENDER, Charles P. (1923), Gen. Mgr. (for mail) C. & J. Bender, 1734 Flatbush Ave., and 2045 East 19th St., Brooklyn, N. Y.

BENNITT, George E. (1918), Utilization Dept., Consolidated Gas Co., 130 East 15th St., New York, N. Y.

BENOIT, William E. (Associate 1919), Vice-Pres., (for mail) Gallaher & Speck, 219 W. Congress St., Chicago, and 225 S. Harvey Ave., Oak Park, Ill.

BENTZ, Harry (1915), Pres. (for mail) Bentz Engr. Corp., 661 Frelinghuysen Ave., Newark, and Montclair, N. J.

BERG, A. Herman (1919), Pres. (for mail) Berg Heat. & Vent. Co., 752 Laura Ave., and 140 N. Stafford, Huntington Park, Calif.

BERGER, Clyde D. (1922), Sup. Engr., Heat & Power Corp., 30 Light St., and (for mail) 2604 Overland Ave., Baltimore, Md.

BERGNER, William G. (Associate 1923), Heat. Contr., Bergner Plbg., Heat. & Supply Co., 1925 State St., and 2435 C St., Granite City, Ill.

BERMAN, Louis K. (1908), Secy., Raisler Heat. Co., 129 Amsterdam Ave., New York, N. Y.

BEVERLEY, R. Carter (1905), Pres. and Treas., R. C. Beverley Heat. Co., Inc., 308 E. Main St., and (for mail) 3812 Chamberlayne Ave., Richmond, Va.

BEYER, Jack E. (Junior 1924), Weiss Heat. & Plbg. Co., 5604 Cedar Ave., and (for mail) 1317 East 112th St., Cleveland, O.

BIDWELL, Raymond E. (Associate 1924), Vice-Pres. (for mail) The Kellogg-Mackay Co., 2030 Walnut St., and 7310 Madison, Kansas City, Mo.

BIGGIN, Frank (1918), Mgr. (for mail) Heat. & Vent. Dept., Wicker Iron Works, Sheffield, and 19 Rupert Rd., Sheffield, England.

BINDER, Charles G. (1920), Mgr. Heat. Dept., Warren Webster & Co., 17th and Federal Sts., Camden, and (for mail) 115 Oak Terrace, Merchantville, N. J.

BINDER, Irving (Junior 1920; 1922), Engr. and Estimator, Walker & Chambers, 222 East 41st St., and (for mail) 900 Riverside Dr., New York, N. Y.

BIRCH, Herbert A. (1922), Sales Engr., U. S. Radiator Corp., 101 Park Ave., and 875 West 181st St., New York, N. Y.

BIRKHOLZ, H. E. (Associate 1925), National Air Filter Co., 9 S. Clinton St., Chicago, Ill.

BIRRELL, Allan Lloyd (Associate 1925), Engr. (for mail) Chapman & Oxley, 506 Harbor Commission Bldg., and 201 Pacific Ave., Toronto, Canada.

BISHOP, Charles R. (1901), (Council 1916), Vice-Pres. (for mail) Caloroil Burner Corp., 5 East 40th St., New York, and 413 Locust St., Lockport, N. Y.

BISHOP, Frederick R. (1921), Salesman and Engr., Furnace Dept., Michigan Stove Co., 3306 E. Jefferson Ave., and (for mail) 3247 Carter Ave., Detroit, Mich.

BLACK, Edgar Newbold, 3rd (1922), Mgr. Kewanee Boiler Co., Inc., 510 Real Est. Trust Bldg., Broad and Chestnut Sts., and (for mail) 1533 Locust St., Philadelphia, Pa.

BLACK, Fred C. (1919), Mgr., M. H. Crane Estate (for mail) 28 N. Desplaines St., and 4535 N. Ashland Ave., Chicago, Ill.

BLACK, George E. (1915), Factory Mgr., H. H. Robertson Co., Ambridge, and (for mail) 709 Broad St., Sewickley, Pa.

BLACK, Harry G. (1917), P. Gormly Co. (for mail) 155 North 10th St., and 927 North 65th St., Philadelphia, Pa.

BLACK, John J. A. (Junior 1922; Associate 1925), Vice-Pres. John Black & Son, 134 Prospect St., Trenton, N. J.

BLACKHALL, Wilmot R. (1922), Sales Engr., Gurney Foundry Co., Ltd., 500 King St., West., and (for mail) 332 Waverly Rd., Toronto, Ont.

BLACKMAN, Alfred O. (1911), Supt. Power and Plant (for mail) The Yale & Towne Mfg. Co., and 48 Hillcrest Ave., Stamford, Conn.

BLACKMORE, F. H. (1923), U. S. Radiator Corp., Edwardsville, Ill.

BLACKMORE, George C. (Charter Member), 435 Maple Ave., Edgewood Park, Allegheny County, Pa.

BLACKMORE, J. J.* (Charter Member), (Council 1896; Board of Governors 1904; Secretary 1914, 1915), 32 West 40th St., New York, N. Y.

BLADON, James B. (1909), Ch. Engr., Darling Bros., Ltd., Montreal, Que.

BLAIR, Wm. B. (Associate 1923), c/o Taplin Furnace Co., 3006 First Ave., S., Minneapolis, Minn.

BLANDING, George H. (1919), Sales Engr., Johnson Service Co., 1355 W. Washington St., Chicago, and (for mail) 729 Hayes Ave., Oak Park, Ill.

BLANEY, Charles A. (1914), Wheeler-Blaney Co., 223 N. Burdick St., Kalamazoo, Mich.

BLANKIN, Merrill F. (Junior 1919), Secy., Haynes Selling Co., 1711 Sansom St., and (for mail), 470 Lyceum Ave., Roxborough, Philadelphia, Pa.

BLEST, Frank S. (1923), Treas. (for mail) Blest & Emery Co., Inc., 784 Coney Island Ave., and 226 Argyle Rd., Brooklyn, N. Y.

BLIZARD, John* (1921), Research Engr., Power Specialty Co., 111 Broadway, New York, and 87 Davis Ave., West New Brighton, Staten Island, N. Y.

BLODGETT, Will H. (Junior 1923), Salesman (for mail) U. S. Radiator Corp., 1412 West 12th St., and 5429 Tillman Ave., Kansas City, Mo.

BLOMFELDT, A. A. (1914), Br. Mgr. (for mail) Ilg Elec. Vent. Co., 901 Union Central Bldg., Cincinnati, O., and 543 E. Fourth St., Newport, Ky.

BLOOM, Samuel C. (1915), Vice-Pres. and Research Engr., Atmospheric Conditioning Corp., 1030 Monadnock Block, and (for mail) 1953 East 72nd St., Chicago, Ill.

BLOOM, William (1924), (for mail) Bloom Heat. Systems, 245 W. Broadway, New York, and 701 Ave. C, Brooklyn, N. Y.

BOALES, William G. (Associate 1923), Repr., Hoffman Specialty Co., Webster Hall, Detroit, Mich.

BOARDMAN, Wallace E. (1923), Heat. and Vent. Engr. (for mail) Stone & Webster, Inc., 147 Milk St., Boston, and 54 Pleasant St., Wakefield, Mass.

BOEDDNER, George (Associate 1923), Asst. Mgr., National Supply Co., 1 St. Clair St., and (for mail) 3005 Park Wood Ave., Toledo, O.

BOGATY, Herman S. (1921), Consulting Engr. (for mail) Proctor & Schwartz, Inc., Seventh and Tabor Rd., and 5243 North 10th St., Philadelphia, Pa.

BOLLING, J. Esten* (Junior 1918; 1921), Consulting Engr., 1044 Catalpa Ave., Chicago, Ill.

BOLSINGER, Raymon C. (1916), Secy. (for mail) Fowler & Wolf Mfg. Co., 521 Bulletin Bldg., Philadelphia, Pa., and 238 E. Madison Ave., Collingswood, N. J.

BOLTON, Reginald Pelham* (1897; Pres. 1911), (Board of Gov. 1901; 2nd Vice-Pres. 1903; 1st Vice-Pres. 1905-10; Board of Gov. 1912, 1913) Pres. (for mail) The R. P. Bolton Co., 116 East 19th St., and 638 West 158th St., New York, N. Y.

BOON, George (1915), Vice-Pres. and Gen. Mgr. (for mail) Boon & Sample, Inc., 3008-10 Ludlow St., and 6428 Morris Pk. Rd., Philadelphia, Pa.

BOOTH, Charles A. (1917), Sales Mgr. (for mail) Buffalo Forge Co., and 142 Summit Ave., Buffalo, N. Y.

BOOTH, Harry N. (Associate 1917; 1924), Mgr., New York Br., U. S. Radiator Corp., 101 Park Ave., New York, and 40 Mansuring Ave., Rye, N. Y.

BORNEMAN, Walter A. (Junior 1923; 1924), Sales Engr. (for mail) Carrier Engr. Corp., 2021 Land Title Bldg., and 4934 Boudinot St., Philadelphia, Pa.

BOSCHKE, Franklyn G. (1925), 1111 West 51st St., Los Angeles, Calif.

BOSTAIN, James C. (1923), Sales and Service Engr. (for mail) Williamson Heater Co., 337 W. Fifth St., Cincinnati, and 3910 Floral Ave., Norwood, O.

BOSTWICK, Clinton G. (1924), Braman, Dow & Co., 239 Causeway St., Boston, Mass.

BOSWIN, George A. (1917), Secy. (for mail) R. B. Hayward Co., 1714 Sheffield Ave., and 902 Diversey Parkway, Chicago, Ill.

BOWDEN, Frank (Associate 1924), Chief Engr. and Instructor (for mail) Windsor & Walkerville Tech. School, Giles Blvd., and 1609 Dougall Ave., Windsor, Ont.

BOWERS, A. F. (Associate 1919), Pres. and Treas. (for mail) Industrial Heat. & Eng. Co., 490 Broadway, and 607 Hackett Ave., Milwaukee, Wis.

BOWERS, J. S. (1921), Sales Engr. (for mail) Hoffman Specialty Co., 2525a W. St. Louis Ave., St. Louis, Mo.

BOYD, D. Knickerbacker* (1921), Otis Bldg., 112 South 16th St., and Coronado Apts., 22nd and Chestnut Sts., Philadelphia, Pa.

BOYD, William R. (Junior 1924), Heat. Sales Engr. (for mail) Turner Supply Co., 8 W. Sixth St., and 702 East 19th St., Chester, Pa.

BOYDEN, Davis S.* (1909), (Council 1917), Supt. Steam Heat. Service Dept. (for mail) Edison Elec. Ill. Co., 39 Boylston St., Boston, and 72 Gardner St., Allston, Mass.

BOYLSTON, A. W. (1918), (for mail) Boylston Steam Spec. Co., 116 W. Illinois St., Chicago, and 1521 Lake Ave., Wilmette, Ill.

BOYLSTON, John (Associate 1906), Pres. (for mail) Boylston Steam Specialty Co., 116 W. Illinois St., Chicago, and 1302 Chestnut Ave., Wilmette, Ill.

BRADBURY, Clifford R. (1904), Supv. Archt's Office, U. S. Treasury Dept., and (for mail) 1843 Lamont St., N.W., Washington, D. C.

BRADBURY, Geo. L. (1921), Mgr. (for mail) Bradbury Bros. Heat. Co., 1219 Stout St., and 1254 Race St., Denver, Colo.

BRADLEY, Eugene P.* (1906), Pres. Hester-Bradley Co., 4200 Forest Pk. Blvd., St. Louis, and 6935 Pershing Ave., University City, Mo.

BRADLEY, John T. (1908), (Board of Governors, 1911), Pres. (for mail) Bradley Heat Co., 3834 Olive St., St. Louis, and 4 Yale Ave., University City, Mo.

BRADLEY, Royal H. (1915), Pres. and Treas., Kelsey Heat. Co., The Alhambra Bldg., Syracuse, N. Y.

BRAEMER, William G. R. (1915), Consulting Engr., 213 Warwick Rd., Haddonfield, N. J.

BRANDELES, H. J. (1921), Pres. and Mgr. (for mail) H. J. Brandeles Corp., 435 Lafayette St., and 66 Prospect St., Utica, N. Y.

BRASSINGTON, Arthur F. (Associate 1918), (for mail) 520-24 West 41st St., New York, and 337 Richmond Ave., Port Richmond, N. Y.

BRAUN, Louis T. (1921), Secy., Chicago Master Steam Fitters Association, 1213 Chamber of Commerce, and (for mail) 1418 Jonquil Terrace, Chicago, Ill.

BRAY, Daniel S. (Associate 1920), Local Mgr., (for mail) Peerless Heater Co., 1235-45 St., Clair Ave., and 9925 Olivet Ave., Cleveland, O.

BRECKENRIDGE, L. P. (1920), Prof. Mech. Engr. (Emeritus) Sheffield Scientific School, Yale University, New Haven, Conn., and (for mail) The Brackens, North Ferrisburg, Vt.

BREDESON, Clarence R. (Junior 1921; Associate 1925), Salesman (for mail) American Radiator Co., Prior Ave. and Minnehaha St., St. Paul, and 53 Melbourne Ave., S. E., Minneapolis, Minn.

BREEN: Joseph W. (1916), Heat. Engr., Wyalusing Ave. and Fallon St., and (for mail) 957 Fallon St., W. Philadelphia, Pa.

BREITENBACH, Walter J. (Junior 1923; Associate 1925), Designer and Estimator, Langenberg Mfg. Co., 4519-33 N. Euclid Ave., and (for mail) 1525a Mallinckrodt St., St. Louis, Mo.

BRENDER, Peter E. (1920), Engr., c/o Albert Kahn, Detroit, and (for mail) 1327 Geddes Ave., Ann Arbor, Mich.

BRESNAHAN, James J. (1919), Pres. and Treas., James J. Bresnahan, Inc., 37-41 Pearl St., and 92 Linwood Ave., Buffalo, N. Y.

BRICKEY, Joel P. (Associate 1924), 665 S. Pearl St., Denver, Colo.

BRIDGES, Frank G. (1919), Heat. Engr., Powers Regulator Co., 1863 Reyburn Rd., Cleveland, O.

BRINTON, J. W. (1920), Mgr., American Blower Co., 10 High St., Boston, Mass.

BRODERICK, Jos. F. (Junior 1914; 1918), Thompson-Starrett Co., 245 Hunters Point Ave., Long Island City and (for mail) P. O. Box 388, Springdale, Conn.

BRONSON, Carlos E. (1919), Mech. Engr., Kewanee Boiler Co., Kewanee, Ill.

BROOKS, Henry W. (1924), Consulting Engr., (for mail) Fuller Lehigh Co., Fullerton, Lehigh County, Pa. and 1300 McPherson Blvd., Fremont, O.

BROOKS, T. C. (1923), Treas., T. C. Brooks Co., and (for mail) 101 W. Dedham St., Boston, Mass.

BROWN, Aubrey, I. (1923), Ohio State University, Columbus, O.

BROWN, Edward R. (1920), (for mail) The Brown Co., 1053 Baltimore Ave., W., and 2290 La Mothe Ave., Detroit, Mich.

BROWN, Fred C. (Associate 1919), Supervisor of Bldgs. (for mail) Bd. of Educ., 245 Ninth Ave., N., and 2425 Chicago Ave., Minneapolis, Minn.

BROWN, John H. (1920), Br. Mgr. (for mail) Keasbey & Mattison Co., 429 N. Washington Ave., and 3704 Blaisdell St., Minneapolis, Minn.

BROWN, Stephen J. (Associate 1919), Pres., Globe Vent. Co., 205 River St., Troy, N. Y.

BROWN, William H. (Associate 1923), Mgr. Plbg. & Heat. Dept., C. E. Armstrong & Sons, 238 Fifth Ave., and (for mail) 710 Seventh Ave., Clinton, Ia.

BROWNE, Alfred L. (1923), Engr. and Sales Mgr., Illinois Eng. Co., 3514 Grand Central Terminal, New York, N. Y.

BROWNELL, Chester D. (1923), Mgr. and Engr. (for mail) Reliable Plbg. & Heat. Co., 109 W. University Ave., and 307 W. White St., Champaign, Ill.

BRUEGGEMAN, Arthur R. (1920), Pres. (for mail) The A. R. Brueggeman Co., Keith Bldg., and 17220 Aldersyde Drive, Shaker Heights, Cleveland, O.

BRUNETT, Adrian L. (1923), Mech. Engr., P. O. Box 16, Rockville, Md.

BRUNNER, Herbert (1924), Consulting Engr. (for mail) 320 West 48th St., and 830 Seventh Ave., New York, N. Y.

BRUNT, T. Bayard (1917), Ch. Engr. and Mgr., Mechanical Equipment Co., 214 South 12th St., Philadelphia, Pa., and 405 Eighth St., Riverton, N. J.

BRUSMAN, Harry M. (1923), Heat. and Sanitary Engr., National Cash Register Co., Dayton, O.

BRYANT, Dr. Alice G.* (1921), 502 Beacon St., Boston, Mass.

BRYANT, Percy J. (1915), Ch. Engr. (for mail) U. S. Military Academy, West Point, and Newburgh, N. Y.

BRYCE, Stephen D. (1921), (for mail) Bryce Heat. & Vent. Co., 415 Spitzer Bldg., and 2907 Rockwood Pl., Toledo, O.

BUCK, Mitchell S. (1922), Engr. (for mail) Vapor Heating Co., 215 South 17th St., and 213 Rex Ave., Philadelphia, Pa.

BUCKLEY, Roy B. (Associate 1924), (for mail) The American Cornice Works Co., 237-41 N. Waters St., and 161 S. Belmont Ave., Wichita, Kan.

BUDER, Charles G.* (1919), Chief Engr. (for mail) Langenberg Mfg. Co., 4525 N. Euclid Ave., and 1441 Hamilton Ave., St. Louis, Mo.

BUEL, H. G. (Associate 1921), Vice-Pres., Tilghman Moyer Co., 141 N. Ninth St., and (for mail) 2135 Chew St., Allentown, Pa.

BUENGER, Albert* (Junior 1917; 1920) Mech. Engr., C. H. Johnston, Archt., 715 Capital Bank Bldg., and (for mail) 1666 Stanford Ave., St. Paul, Minn.

BUENSOD, Alfred C. (1918), Sales Engr. (for mail) Carrier Engr. Corp., 39 Cortlandt St., and 125 West 12th St., New York, N. Y.

BULKELEY, Claude A. (1923), Sup. Mech. Exp. Engr. (for mail) E. I. DuPont de Nemours & Co., DuPont Bldg., and 1313 W. Eighth St., Wilmington, Del.

BUNNELL, Ercell W. (Junior 1923; 1924), Sales Engr. (for mail) C. A. Dunham Co., 1631-33 Second Ave., N., and 812 Cotton Ave., Birmingham, Ala.

BURGER, John C. (1919), Contr. (for mail) Gallaher & Speck, 219 W. Congress St., and 7201 Champlain Ave., Chicago, Ill.

BURNAP, Chas. W. (1922), Herman Nelson Corp., 724 Commercial St., Emporia, Kan.

BURNETT, Earle S. (1920), Mech. Engr., Bureau of Mines, U. S. Helium Production Plant (for mail) Fort Worth P. O. Box 602, and 1628 Westmoreland Pl., Forth Worth, Tex.

BURNS, Edward J. (1923), Supt. (for mail) H. Kelly & Co., 925 Plymouth Bldg., and 4716 Aldrich Ave., S., Minneapolis, Minn.

BURNS, Willard A. (1924), Collins & Burns Co., 1728 Farwell Ave., Chicago, Ill.

BURR, Ralph J. (Associate 1919), Heat. Contr., Standish, Mich.

BURRITT, Charles G. (Associate 1916), Mgr., Johnson Service Co. (for mail) 922 Second Ave. S., and 1425 La Salle Ave., Minneapolis, Minn.

BURT, John E. (Associate 1924), J. E. Burt & Son, 2442 South 16th St., Philadelphia, Pa.

BURTON, Clarence A. (1919), Mgr., Kewanee Boiler Co.; 2020 Wyandotte St., and 3534 Virginia Ave., Kansas City, Mo.

BUSHNELL, Carl D. (Associate 1921), Pres. (for mail) Bushnell Machinery Co. 206 Wood St., Pittsburgh, and 94 Pilgrim Rd., Rosslyn Farms, Carnegie, Pa.

BUTLER, Charles (1920), 108½ W. Second St., Oklahoma City, Okla.

BUTLER, Peter D. (1922), Salesman, U. S. Rad. Corp., 101 Park Ave., New York, N. Y., and (for mail) 1131 Summit Ave., Jersey City, N. J.

BUTLER, Thomas F. (Associate 1919), Heat. Vent. and Plbg. (for mail) 545 Broadway, and W. Erie and Madison Aves., Lorain, O.

BYRNES, Thos. F. (Junior 1924; Associate 1925), Heat. and Vent. Engr., Baker Smith & Co., 572 Greenwich St., New York, N. Y. (for mail) 42 Edson Ave., Waterbury, Conn.

BYSOM, Leslie L. (1915), Public Works Dept., Puget Sound Navy Yard, and (for mail) 618 Boston St., Bremerton, Wash.

C

CADMUS, Raymond (1922), Engr. and Estimator, Johnston Heat. Co., 131 East 26th St., New York, N. Y., and (for mail) 11 Park Ave., Maplewood, N. J.

CADWELL, William H. (1916), Pres. (for mail) The Beaton & Cadwell Mfg. Co., P. O. Box 1012, and 130 W. Main St., New Britain, Conn.

CADZOW, William S. (1923), Mgr., Y. N. Welamb Co., 2313 Walnut St., and (for mail) 1812 W. Tioga St., Philadelphia, Pa.

CALAHAN, John J. (1915), Supervising Engr. (for mail) Bd. of Education, Administration Bldg., 2 Harrison Ave., and 78 Bartholdi Ave., Jersey City, N. J.

CALEB David* (1923), Engr., Kansas City Power & Light Co. (for mail) 1330 Grand Ave., and 141 Spruce St., Kansas City, Mo.

CALLAHAN, Michael J. (1914), Pres. and Treas. Peerless Unit Ventilation Co., Skillman Ave. and Hulst St., Long Island City, N. Y.

CALLAHAN, Thomas H. (Junior 1924), Pres. (for mail) Callahan Engr. Co., Inc., 20 Grove St., and 74 Central Ave., White Plains, N. Y.

CALVERT, Norman W.* (1921), Engr. of Steam Distribution (for mail) The Detroit Edison Co., 2000 Second Ave., and 3297 Clements Ave., Detroit, Mich.

CAMPBELL, Everett K.* (1920), Pres. and Treas., E. K. Campbell Heat. Co., 2445 Charlotte St., and 3717 Harrison Blvd., Kansas City, Mo.

CANTWELL, William T. (1920), Plbg. and Heat. Contr. (for mail) 306 Bleecker St., and 1302 Brinckerhoff Ave., Utica, N. Y.

CARDER, Wm. W. (Associate 1923), Sales Engr., Johnson Service Co., 206 Bona Allen Bldg., Atlanta, Ga.

CAREY, Jeremiah J. (1923), Supr. of Plans, No. 2 State House, Boston, Mass.

CARNAHAN, Glen C. (1924), Peoples Gas Light Bldg., 122 S. Michigan Ave., Chicago, Ill.

CARPENTER, B. Harold (Charter Member). (Board of Managers 1899; Board of Governors 1905), Pres. (for mail) B. G. Carpenter Co., 508 S. Main St., and 65 W. Union St., Wilkes-Barre, Pa.

CARPENTER, R. H. (1921), Mgr. (for mail) Nash Eng. Co., 350 Madison Ave., New York, and 10 First St., White Plains, N. Y.

CARR, Clifford H. (Associate 1924), Pres. (for mail) C. H. Carr Machinery Co., 411 Mutual Bldg., and 5108 Main St., Kansas City, Mo.

CARRIER, Willis H.* (1913), (Council 1923-1924), Pres., Carrier Eng. Corp., 750 Frelinghuysen Ave., Newark, and (for mail) Rensselaer Rd., Essex Fells, N. J.

CARROLL, W. J. (Associate 1925), Kewanee Boiler Co., 402½ Michigan Trust Bldg., and (for mail) 339 Burton St., S. E., Grand Raipds, Mich.

CARRUTHERS, Keith L. (Junior 1923; Associate 1925), Dept. Mgr. (for mail) Gurney Foundry Co., 500 King St., W., and 603 Huron St., Toronto, Ont.

CARSTEN, W. H. (1923), Pres. and Mgr. (for mail) Majestic Furnace & Mfg. Co., Inc., 600 Terry Ave., N., and 102 W. Canal St., Seattle, Wash.

CARSTENS, Emil (Junior 1922; Associate 1925), H. B. Smith Co., 17th and Arch Sts., and (for mail) 512 W. Cornell St., Philadelphia, Pa.

CARTLAND, Silas (Junior 1923), Sales Engr. (for mail) Junio Heater Corp., 30 North Dearborn, Chicago, Ill., and Box 84, Pentwater, Mich.

CARTY, Thomas (1924), Pres. (for mail) Carty Heat. Corp., 29 Audubon Ave., and 635 West 174th St., New York, N. Y.

CARY, Albert A.* (Charter Member), (Board of Managers 1894; Council 1896; Board of Managers 1899). Consulting Engr., 95 Liberty St., New York, N. Y.

CASE, Edward W. (Associate 1916), Vice-Pres. and Secy., W. A. Case & Son Mfg. Co., 31 Main St., Buffalo, N. Y.

CASEY, Byron L. (1921), Sales Engr. (for mail) Ilg Electric Vent. Co., 324 W. Monroe St., Chicago, and 501 Clifton Ave., Park Ridge, Ill.

CASSELL, John D.* (1913), Supt. of Bldgs. (for mail) Bd. of Public Education, Keystone School Bldg., 19th and Chestnut Sts., Philadelphia, Pa., and 740 Garfield Ave., Palmyra, N. J.

CASSERLY, T. D. (Associate 1923), (for mail) Weil-McLain Co., 641 W. Lake St., and 5339 Winthrop Ave., Chicago, Ill.

CAVILEER, James V. (Associate 1921), Office Mgr. (for mail) Lewis, Robinson & Gant, 1302 Land Title Bldg., and 2938 North 27th St., Philadelphia, Pa.

CHADEAYNE, Geo. D. (Junior 1924), (for mail) Gorton & Lidgerwood Co., 96 Liberty St., New York, and 308 Stratford Rd., Brooklyn, N. Y.

CHALLMAN, Samuel A. (1919), Comm. of School Bldg., State Dept. of Education, State Capitol, St. Paul, and (for mail) 1107 Seventh St., S.E., Minneapolis, Minn.

CHALMERS, Chas. H. (1925), Mgr. (for mail) Chalmers Oil Burner Co., 1234 Central Ave., and 523 Seventh St., S. E., Minneapolis, Minn.

CHAMBERS, Wm. E. (Associate 1923), 1025 Franklin St., Williamsport, Pa.

CHAPMAN, D. Witt (1914), Consulting Engr., D. W. Chapman Eng. & Supply Co., 30 Euclid Arcade, Cleveland, and (for mail) 1230 Jackson Ave., Lakewood, O.

CHAPMAN, Frank T. (1909), (Bd. of Governors 1913; Council 1914; 2nd Vice-Pres. 1915; 1st Vice-Pres. 1916), Mgr. of Sales (for mail) Fitzgibbons Boiler Co., Inc., 47 West 42nd St., New York, N. Y., and Montclair, N. J.

CHASE, J. D. (1921), Providence Vent. Co., Providence, R. I.

CHASE, John M. (Associate 1916), Vice-Pres. and Eastern Repr. (for mail) W. A. Case & Son Mfg. Co., 50 East 42nd St., and 468 Riverside Drive, New York, N. Y.

CHATTERDON, B. W. (Associate 1921), Salesman (for mail) 528 S. Grove Ave., Oak Park, Ill., and 1445 Congress St., Cleveland, O.

CHENOWETH, William H. (1911), Dist. Mgr. (for mail) Warren Webster & Co., 549 W. Washington St., Chicago, and 256 Keystone Ave., River Forest, Ill.

CHERRY, Lester A. (1921), (for mail) Industrial Planning Corp., 80 W. Genesee St., and 155 Euclid Ave., Buffalo, N. Y.

CHERVEN, Victor W. (Associate 1920), Heat. Engr. (for mail) Holland Furnace Co., and 326 Maple Ave., Holland, Mich.

CHESTER, Thomas* (1917), Consulting Engr. 718 B. Copeland St., Pittsburgh, Pa.

CHEYNEY, Charles C. (Junior 1913; Associate 1925), (for mail) Buffalo Forge Co., 562 W. Washington Blvd., Chicago, and Glencoe, Ill.

CHILDRESS, Worthie Lee (1925), (for mail) E. G. Harris & Co., 3312 W. Cary St., and 609 West 27th St., Richmond, Va.

CHOFFIN, C. C. (1919), Secy. and Treas., W. J. Scholl & Co., Mahoning Ave. and Hogue St., Youngstown, O.

CHRISTIAN, Charles W. (1913), Heat. and Vent. Engr. and Contr., Box 292, 1016 Johnston Bldg., and Myers Park, Charlotte, N. C.

CHUBB, John E. (Associate 1917), Gen. Mgr., Kelvinator Chicago Inc., 209 N. Michigan Ave., Chicago, and (for mail) 806 Colfax St., Evanston, Ill.

CHURCH, Herbert J. (1922), Mgr. (for mail) Darling Bros. Ltd., Rm. 30, 77 York St., Toronto, and Weston, Ont.

CLAFFEY, Edward J. (1913), Pres. (for mail) E. J. Claffey Co., 10 W. Illinois St., and 439 Melrose St., Chicago, Ill.

CLARK, E. Harold (1922), Dist. Mgr., J. D. Swartwout Co., 400 Penobscot Bldg., and (for mail) 475 Peterboro St., Detroit, Mich.

CLARK, Fred C. (1923), Pres. (for mail) F. C. Clark Heat. Co., 5941 Baum Blvd., and 906 Chislet St., Pittsburgh, Pa.

CLARK, Homer J. (1919), Dist. Mgr. (for mail) Bayley Mfg. Co., 523 Penton Bldg., and 1372 Phelps Ave., Cleveland, O.

CLARK, W. Chas. M. (1915), Consulting Engr. (Heat. Vent. Power Plants), (for mail) 130 Engineers Bldg., and 1344 East 85th St., Cleveland, O.

CLARK, William D. (1908), Heat. and Vent. Engr., Richardson & Boynton Co., 260 Fifth Ave., New York, and (for mail) 8613 110th St., Richmond Hill, N. Y.

CLARK, W. H. (1921), 916 Berkshire Ave., Pittsburgh, Pa.

CLARKE, H. W. (Associate 1923), J. Spear Stove & Heat. Co., 1823 Market St., Philadelphia, and (for mail) 117 Sylvan Ave., Rutledge, Pa.

CLARKE, Samuel S. (1909), Heat. & Vent. Engr. (for mail) Imperial Radiator Co., and Canadian Sirocco Co., 605 Second St., W., and 603 Second St., W. Calgary, Alberta.

CLARKSON, Robert C., Jr. (1921), Asst. Engr., Turner Construction Co., 1713 Sansom St., and (for mail) 821 South 49th St., Philadelphia, Pa.

CLARKSON, William B. (1919), Director of Research, King Vent. Co., 251 Broadway, Owatonna, Minn.

CLEGG, Carl (1922), Mgr. (for mail) American Blower Co., 310 Mutual Bldg., and 3433 Holmes St., Kansas City, Mo.

CLEMENT, Eugene R. (Associate 1924), Hoffman Specialty Co., 1559 Laurel Ave., Bridgeport, Conn.

CLIFTON, W. F. (1923), 313 Brock Ave., Toronto, Ont.

CLINE, Edgar A. (1914), Secy. (for mail) General Heat. Supply Co., Rm. 1 Reliance Bldg., and 11 West 68th St., Terrace, Kansas City, Mo.

CLOUD, Oscar E. (Associate 1924), (for mail) Western Sheet Metal Works, 450 N. Main St., and 527 Madison Ave., Wichita, Kan.

CLOUGH, Leslie (1922), Engr., Stubbs Bros., 16 Ash St., Boston, and (for mail) 17 Pierce Rd., P. O. Box 34, Weymouth, Mass.

COCHRAN, Moncrieff M. (1908), Pres., Cochran-Sargent Co., Fifth and Sibley Sts., and 59 Western Ave., St. Paul, Minn.

COCKBURN, Leslie S. (1920), Asst. Works Engr. (for mail) Fisher Body Corp., General Motors Bldg., Detroit, 106 Cedar St., Wyandotte, Mich.

COE, Ivan B. (1918), Secy. and Treas. (for mail) Blower Systems Corp., 362 Plymouth Ave., S., and 122 Penhurst St., Rochester, N. Y.

COE, Ralph T. (1917), (for mail) The R. T. Coe Companies, 5th floor, Cutler Bldg., and 235 Chili Ave., Rochester, N. Y.

COHAGEN, Chandler C. (1919), Archt. (for mail) McIver & Cohagen, Box 1305, Hedden Bldg., and 127 Wyoming Ave., Billings, Mont.

COLBY, Clyde W. (1915), Pres. (for mail) Colby-Merrill Co., Superior Ave., N.E., at 17th St., Cleveland, and 1755 Northfield Ave., East Cleveland, O.

COLEMAN, John B. (1920), Ch. Engr. (for mail) Grinnell Co., Inc., 260 W. Exchange St., and 152 Taber Ave., Providence, R. I.

COLLAMORE, Ralph (1904), (Board of Governors 1913), Secy., Smith, Hinchman & Grylls, 800 Marquette Bldg., and (for mail) 679 Pingree Ave., Detroit, Mich.

COLLIER, William I. (1921), Consulting Engr. (for mail) W. I. Collier & Co., 15 E. Fayette St., Baltimore, and Ellicott City, Md.

CONES, Benjamin (1911), (for mail) Secy. and Treas., National Eng. Co., 2607 E. Washington St., and 420 N. Keystone Ave., Indianapolis, Ind.

CONNELL, Harry E. (1922), Mgr., U. S. Radiator Corp., 136 Federal St., Boston, and (for mail) 60 Randolph St., Arlington, Mass.

CONNELL, Richard F. (1916), Mgr. Capitol Test Lab., U. S. Radiator Corp., 127 Campbell Ave., and (for mail) 2970 Burlingame Ave., Detroit, Mich.

CONNOR, Michael (Associate 1922), 1134 Vincent Ave., Minneapolis, Minn.

COOGAN, Jesse (1915), Ch. Engr. (for mail) Jesse Coogan Engr. Co., 404-408 Boston Bldg., and Commercial Club, Salt Lake City, Utah.

COOK, Benjamin F. (1920), Consulting Engr., Cook & White, 308 Mutual Bldg., Kansas City, and (for mail) Route 6, Box 452, Independence, Mo.

COOK, Chester D. (1921), (for mail) D. F. Edwards Heating Co., 2340 Pine St., and 4264 Botanical Ave., St. Louis, Mo.

COOK, Harris R. (Associate 1924), Dist. Mgr. (for mail) American Foundry & Furnace Co., 805 36th St., and 1194 44th St., Milwaukee, Wis.

COOLEY, Maxwell S.* (1911), Bureau of Yards and Docks, Navy Dept., Washington, D. C. and (for mail) 5 E. Irving St., Chevy Chase, Md.

COON, Thurlow E. (1916), Pres., The Coon-DeVisser Co., 2051 W. Lafayette Blvd., and (for mail) 826 Edison Ave., Detroit, Mich.

COOPER, Frank I. (1911), (Council 1914-1916), Pres., Frank Irving Cooper Corp., Archts. and Engrs., 172 Tremont St., Boston, Mass.

COOPER, Harry (Associate 1924), Pres. (for mail) Harry Cooper Supply Co., 223 Water St., and 590 E. Walnut St., Springfield, Mo.

COOPER, John W. (Junior 1921; Associate 1925), (for mail) Buffalo Forge Co., 515 Chemical Bldg., and 4305 Lindell Blvd., St. Louis, Mo.

COOPER, Thos. R. (1923), Shanghai Waterworks Co., Shanghai, China.

COOPER, Thomas W. (Associate 1922), Mgr. (for mail) Utica Heater Co., 629 Chestnut St., and 5117 N. Mervine St., Philadelphia, Pa.

CORNWALL, George T. (1919), Mgr., Boiler Dept. (for mail) Hitchings & Co., Cor. Spring and Louisa Sts., and 633 Madison Ave., Elizabeth, N. J.

CORNWELL, F. E. (Associate 1923), Salesman (for mail) National Heat. & Vent. Co., Wausau, and 1463 Murray Ave., Milwaukee, Wis.

COSGROVE, Wallace M. (1923), Br. Mgr. (for mail) American Radiator Co., 40 West 40th St., New York, N. Y., and 94 Kensington Ave., Jersey City, N. J.

COUSENS, Walter S. (1924), Treas., McLean & Cousens Co., 65 Chandler St., Boston, and (for mail) 70 Elm St., W. Newton, Mass.

COWARD, Herbert (1921), Mgr. Wash. Office (for mail) Buffalo Forge Co., 418 Wash. Loan & Trust Bldg., Washington, D. C., and East Falls Church, Va.

COWLES, Benjamin E. (1919), Heat. Engr. (for mail) Kellogg-Mackay Co., 824 S. Fourth St., Minneapolis, and 3711 Colfax Ave., N. Minneapolis, Minn.

COX, Christopher, J. (1919), (for mail) C. J. Cox Eng. Co., 625 Putnam Ave., Cambridge, and 1412 Com'l Ave., Allston, Mass.

COX, W. F. (1924), Specialty Engr., Crane Co., 1328 West 12th St., Kansas City, Mo.

COX, William W. (1923), Dist. Mgr. (for mail) Warren Webster & Co., 326 Columbia St., and 5416 Kirkwood Pl., Seattle, Wash.

CRAIG, F. Broadhurst (1922), Director (for mail) Broadhurst Craig & Ching, Ltd., 1 Fitzroy St., London, W.1., and 28 Clarence Rd., Windsor, England.

CRANNELL, Chas. A. (1922), Secy.-Treas., Inland Engr. Corp., 365 State St., and 1011 Park Pl., Hammond, Ind.

CRAWFORD, W. B. (1921), Consulting Engr., J. P. Marsh & Co., 114-124 S. Clinton St., and (for mail) 1516 N. Mayfield Ave., North Austin, Chicago, Ill.

CRIQUI, Albert A.* (1919), Heat., Vent. and Fan Engr., Buffalo Forge Co., 490 Broadway, and (for mail) 250 Blaine Ave., Buffalo, N. Y.

CROFT, Terrell (1924), Directing Engr. (for mail) T. Croft Eng. Co., 6600 Delmar Blvd., and 6925 Amherst Ave., University City, St. Louis, Mo.

CRONE, Chas. E., Jr. (1922), Secy. and Treas., Wendt & Crone Co., 1131 N. Wells St., and 5432 Woodlawn Ave., Chicago, Ill.

CRONE, Thomas E. (1920), Dist. Mgr., Clarence O. Baring, Inc., 34 Park Pl., R. 11, Newark, and (for mail) 11 Prospect St., E. Orange, N. J.

CRUTCHLEY, Edward, Jr. (1920), Heat Contr. (for mail) E. Crutchely, Jr., 477 83rd St., and 8509 10th Ave., Brooklyn, N. Y.

CULBERT, Warren G. (Associate 1911), 3042 Chestnut St., and (for mail) Ridley Park, Philadelphia, Pa.

CULLEN, Harry J. (1923), Heat. and Vent. Engr., Warren & Wetmore, 16 East 47th St., New York, and (for mail) 15 Scutt Pl., Jamaica, N. Y.

CULLYFORD, Francis S. (1915), Pres. and Mgr., (for mail) Cullyford Plbg. & Heat. Co., 1210 California St., and 517 Josephine St., Denver, Colo.

CUMMINS, George H. (1919), Sales Engr. (for mail) Morgan-Gerrish Co., 800-6 La Salle Ave., and 4944 Logan Ave., S., Minneapolis, Minn.

CUMMINGS, Gerald J. (1923), Supt., Scott Co., 113 Tenth St., and 201 Orange St., Oakland, Calif.

CURRIER, Charles H. (1919), Vice-Pres. (for mail) Drying Systems, Inc., 50 Church St., New York, N. Y., and 608 Prospect St., Maplewood, N. J.

CUTHBERT, Ivan Norman (1925), Engr. (for mail) Cuthbert & Cuthbert, Archt. & Engr., 327 East Huron St., and R. R. 6, Ann Arbor, Mich.

CUTLER, Joseph A. (1916), (Council 1917-1924) Mgr. (for mail) Johnson Service Co., 1355 Washington Blvd., and Drake Hotel, Chicago, Ill.

CUTTER, Edward H. (Associate 1923), Special Distributor, Hoffman Steam Specialties (for mail) 179 W. Washington St., Chicago, and Elgin, Ill.

CUYLER, David H. (1917), Engr., Wolff Mfg. Corp., 300 N. Robey St., Chicago, and (for mail) 536 Hinman Ave., Evanston, Ill.

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DAILEY, James A. (Associate 1920), Heat. Contr., 661 72nd St., Brooklyn, N. Y.

DAILEY, James F. (1924), Vice-Pres., Typhoon Fan Co., 345 West 39th St., and (for mail) 819 West 180th St., New York, N. Y.

DALY, John H. (1915), Pres. and Mgr. (for mail) Daly Co., 1425 16th St., and Denver Athletic Club, Denver, Colo.

DAMBLY, A. Ernest (Junior 1921; 1924), Asst. (for mail) H. B. Hackett, 505 Chestnut St., Philadelphia, Pa.

DANE, Irving Stillman (1925), Sales Engr., 9 Mason St., Medford Hillside, 57, Mass.

DANFORTH, N. Loring (1919), Pres., John W. Danforth Co., 72 Ellicott St., Buffalo, N. Y.

DARTS, John A. (1919), Sales Mgr. (for mail) Kewanee Boiler Co., Inc., 47 West 42nd St., and 272 Manhattan Ave., New York, N. Y.

DAUGH, Emil O. (1921), Detroit Repr., Continental Heater Corp., 400 Penobscot Bldg., Bldrs. and Traders Ex., and (for mail) 81 Montana Ave., W. Detroit, Mich.

DAUGHERTY, Fred M. (1919), Contrg. Engr., Grinnell Co., Inc., 407 Society for Savings Bldg., Cleveland, O.

DAVENPORT, Edwin A. (1916), Heat. & Vent. Engr., American Warming & Vent. Co., 317-319 Pennsylvania Ave., Elmira, N. Y.

DAVIDSON, H. MacD. (Junior 1922), Local Sales Office Mgr., C. A. Dunham Co., 226 Main St., and 1611 Madison St., La Crosse, Wis.

DAVIDSON, Philip L. (Junior 1921; 1924), Sales Engr., Carrier Engr. Corp., 176 Federal St., Boston, Mass.

DAVIES, George W. (1918), Heat. and Vent. Engr., G. W. Davies & Co., 79 McLaggan St., Dunedin, New Zealand.

DAVIS, Arthur C. (1920), Mech. Engr., 73 Preston St., Ridgefield Park, N. J.

DAVIS, Benjamin H. (1923), 30 W. Lynwood Ave., Glenside, Pa.

DAVIS, Bert C. (1904), Pres. and Treas. (for mail) American Warming & Vent. Co., 317 Pennsylvania Ave., and 603 W. Church St., Elmira, N. Y.

DAVIS, James H. (1899), (Board of Governors 1911), 816 S. Michigan Ave., Chicago, Ill.

DAVIS, Leo J. (1917), Supt. (for mail) John J. Davis & Sons, Inc., 2728 Baker St., Detroit, and Philbrick Ave., Redford, Mich.

DAVIS, P. Lloyd (1912), Pres. and Treas., Davis-Billings Corp., 92-20 150th St., and (for mail) 148-15 Hillside Ave., Jamaica, L. I., N. Y.

DAVIS, Rowland G. (Associate 1921), Salesman, Spohn Heat. & Vent. Co., 1775 East 45th St., Cleveland, and (for mail) 887 Nala View Rd., Cleveland Heights, O.

DAY, Vincent S.* (1924), Research Asst. Prof. Mech. Eng. Dept., 104 M. E. Lab., University of Illinois, and (for mail) Urbana, Ill.

DECKER, Edward M. (Associate 1917), (for mail) American Radiator Co., 400 Barlum Bldg., and 197 Rhode Island Ave., Detroit, Mich.

DEEX, Charles J. (1920), Secy. (for mail) Mount-Vapor Heat. Co., 1246 W. Fourth St., and 4364 Rockey River Dr., Cleveland, O.

DEGAN, James E. (Associate 1916), Pres. (for mail) J. E. Degan Co., 242-4 Larned St., W., and 2428 Blaine Ave., Detroit, Mich.

DELAND, Chas. W. (Junior 1923; 1924), Secy. (for mail) C. W. Johnson, Inc., 211 N. Desplaines St., and 2021 Estes Ave., Chicago, Ill.

DeLONG, Maj. Harry B. (1915), (for mail) H. B. DeLong Co., W. 409 First Ave., and 231 East 24th Ave., Spokane, Wash.

DeLONG, F. B. (Associate 1923), Walworth Mfg. Co., 414 First Ave., Seattle, S., Wash.

DEMPSEY, Harry P. (1919), Consulting Mech. Engr. (for mail) 34 Delaware Ct., 232 Delaware Ave., Buffalo, and 394 Pleasant Ave., Hamburg, N. Y.

DeNEILLE, J. Lawrence (1920), Contrg. Engr. (for mail) Eichler Heat. Co., 2011 Railway Exchange Bldg., St. Louis, and 733 Limit Ave., University City, Mo.

DENNIS, C. K. (Junior 1923), Salesman, Standard Heater Co., 931 O. C. S. Bk. Bldg., Syracuse, N. Y.

DENSMORE, Edward D. (1906), Archt. and Engr., Densmore, LeClear & Robbins, Park Sq. Bldg., 31 St. James Ave., Boston, and 26 Downing Rd., Brookline, Mass.

DENSON, Walter (1922), Heat. Contr. (for mail) 7 West 12th St., and 2205 St. Elmo Dr., Columbus, Ga.

DERANLEAU, Raymond L. (Junior 1922; 1924), Heat. Engr. (for mail) Wm. N. Bowman Co., 612 Insurance Bldg., Denver, Colo.

DEVENDORF, W. F. (1910), (for mail) Wm. F. Devendorf & Co., 112 Clinton Ave., S., and 719 Park Ave., Rochester, N. Y.

DEWAR, John G. (1920), Dewar & Carrington, 153 N. Desplaines St., Chicago, Ill.

DeWOLF, Roger D. (1915), Ch. Operating Engr. (for mail) Rochester Gas and Electric Corp., 34 Clinton Ave., N., and 15 Werner Park, Rochester, N. Y.

DEXTER, MacD. (1924), P. O. Box 33, Columbus, Ga.

DIBBLE, Albert B. (Associate 1922), Pres. and Mgr. (for mail) S. E. Dibble & Son, Inc., 521-525 Grand Ave., P. O. Box 299, and 869 Elm St., New Haven, Conn.

DIBBLE, Samuel E. (1917; Pres. 1925), (Council 1921-1924; 2nd Vice-Pres. 1922; 1st Vice-Pres. 1924), Consulting Engr. and Prof. Heat. and Vent. Dept., Carnegie Institute of Technology, and 514 Hastings St., Pittsburgh, Pa.

DICKEY, Arthur J. (1921), Vice-Pres. and Gen. Mgr., C. A. Dunham Co., Ltd., 1523-41 Davenport Rd., and (for mail) 9 Mossom Pl., Toronto, Ont.

DICKINSON, Dr. Hobart C. (1919), Ch. Heat. and Power Div., Bureau of Standards, Connecticut Ave. and Pierce Mill Rd., and 4629 0th St., N.W., Washington, D. C.

DICKSON, Robert B. (1919), Sales Mgr., Kewanee Boiler Co., 409 E. Prospect St., Kewanee, Ill.

DIGBY, Homer Evans (Junior 1922; Associate 1925), Salesman, C. A. Dunham Co., 1104 May Bldg., and (for mail) 323 Sweetbriar St., Pittsburgh, Pa.

DILL, H. O. (Associate 1922), Gen. Sales Mgr. (for mail) Oil City Boiler Works, 501 Fifth Ave., and 243 Mt. Hope Pl., New York., N. Y.

DILLMAN, Earnest J. (1921), Engr. (for mail) Research Dept., American Radiator Co., 1807 Elmwood Ave., Buffalo, and 202 Knowlton Ave., Kenmore, N. Y.

DILLON, Henry R. (Associate 1923), Sales Mgr., Utica Heater Co., 5620 Grand Central Terminal, New York, N. Y.

DISTEL, Frank, Jr. (1918), (for mail) Distel Heat. Equip. Co., 904 Bauch Bldg., and 1011 Genessee St., W., Lansing, Mich.

DOBBS, G. E. (Associate 1921), Boiler & Radiator Supply Co., 110 Walnut St., Philadelphia, Pa. and (for mail) 72 Berlin Ave., Haddonfield, N. J.

DOBSON, George G. (1922), Mech. Engr., Eastman Kodak Co., Kodak Park, and (for mail) 166 Harding Rd., Rochester, N. Y.

DODDS, Forrest F. (1920), Mgr. (for mail) American Radiator Co., 906 Davidson Bldg., and 3716 Broadway, Kansas City, Mo.

DOERING, Frank L. (1919), Repr., American Radiator Co., 451 Rivermont Ave., Lynchburg, Va.

DOHERTY, James (1917), Vice-Pres. (for mail) Utica Heater Co., 365 E. Illinois St., and 2600 Lakeview Ave., Chicago, Ill.

DOHERTY, John A. (1924), Heat. Expert, Richardson & Boynton Co., 260 Fifth Ave., and 539 51st St., Brooklyn, N. Y.

DOHERTY, John J. (1921), (for mail) P. C. Doherty Co., 112 Main St., and 135 Academy St., Poughkeepsie, N. Y.

DOLAN, Raymond G. (Junior 1922), Secy. and Treas., 614 W. Grand, Oklahoma City, Okla.

DOME, Walter R. (1920), Mgr. Boiler Sales, Abram Cox Stove Co., American and Dauphin Sts., and (for mail) 156 W. Hansbury St., Philadelphia, Pa.

DONAHUE, Edmund S. (Associate 1924), (for mail) American Radiator Co., 400 Barlum Bldg., and 53 E. Euclid Ave., Detroit, Mich.

DONNELLY, James A.* (1904), (Treasurer 1912-1914), Donnelly Systems Co., 9 Murray St., New York, N. Y.

DONNELLY, John R. (1915), 905 Congress Ave., Austin, Tex.

DONNELLY, Russell (1923), Sales Engr., Nash Eng. Co., 350 Madison Ave., New York, N. Y.

DONNELLY, Webster C. (Junior 1922), Heat. Engr. 208 Whalley Ave., New Haven, Conn.

DONOGHUE, James J. (Associate 1924), National Radiator Co., 47 West 42nd St., New York, N. Y.

DONOVAN, James E. (Junior 1923), Heat. Engr., 16 Putnam Ave., Port Chester, N. Y.

DOODY, Catherine A. (1924), Mgr., (for mail) Doody Vapor Heat. Co., 46 Cornhill, Boston, and 84 High St., Canton, Mass.

DORNHEIM, G. A. (Junior 1906; 1912), (for mail) Thompson-Starrett Co., 245 Hunters Point Ave., Long Island City, and 32 Kraft Ave., Bronxville, N. Y.

DORSEY, Francis C. (1920), Heat., Plbg. and Elect. Contr., Francis C. Dorsey, 110 Prospect Ave., Roland Park, Baltimore, Md.

DOUD, Malcolm P. (Associate 1921), (for mail) 419 Widener Bldg., Philadelphia, and 226 Rutledge Ave., Rutledge, Pa.

DOUGHTY, Charles J. (1920), Supt. of Maintenance, Bd. of Education, 155 College St., and (for mail) 44 Erindale Ave., Toronto, Ont.

DOUGLASS, Thomas C. (1922), Thos. J. Douglass & Co., 352 Whiting St., Chicago, Ill.

DOWNE, Henry S. (1895), Vice-Pres. and European Director (for mail) American Radiator Co., 149 Boulevard Haussmann, and 5 Rue Verdi, Paris, France.

DOWNES, H. H. (1923), Salesman, American Blower Co., 2135 Oliver Bldg., Pittsburgh, Pa.

DOWNES, Nate W. (1917), Engr. (for mail) School Dist. of Kansas City, 601 Finance Bldg., and 2119 East 68th St., Kansas City, Mo.

DOWNEY, Frank E. (1921), Pres. and Mgr. (for mail) Downey Supply Co., 613 Clybourn St., and 1188 Prospect Ave., Milwaukee, Wis.

DOYLE, Christopher J. (Associate 1922), Heat., Contr. (for mail) S.E. 21st and Pine Sts., Philadelphia, Pa.

DOYLE, William J. (1920), Designing Engr., Williamson Heater Co., 4558 Marburg Ave., Oakley, and (for mail) 3766 Hyde Park Ave., Hyde Park, Cincinnati, O.

DRAKE, George H. (1919), (for mail) 218 Lexington Ave., and 353 Norwood Ave., Buffalo, N. Y.

DRIGGS, Leland L. (1918), Heat. Engr., Edward P. Bates Co., Inc., 228 W. Water St., and (for mail) 167 W. Lafayette Ave., Syracuse, N. Y.

DRINKER, Philip (1922), Instr., Ventilation and Illumination (for mail) Harvard School of Public Health, 55 Van Dyke St., Boston, 17, and 128 Garden Rd., Brookline, Mass.

DRISCOLL, William H.* (1904), (Council 1918-1922, Treas. 1923, 2nd Vice-Pres. 1924), Vice-Pres. (for mail) Thompson-Starrett Co., 245 Hunters Point Ave., Long Island City, N. Y., and 23 Boyd Ave., Jersey City, N. J.

DRUCE, John J. (1922), Vice-Pres. and Mgr., McKelvey & Birch, Ltd., 69 Brock St., and (for mail) 26 Alice St., Kingston, Ont., Can.

DUBRY, Ernest E. (1924), Asst. Supt. of Central Heat. (for mail) The Detroit Edison Co., 2000 Second Ave., and 9116 Dexter Blvd., Detroit, Mich.

DUDFIELD, Alvin (1920), Pres., Dudfield Mfg. Co., 116 W. Kansas St., Liberty, Mo.

DUDLEY, W. Lyle (1922), Vice-Pres. (for mail) Western Blower Co., 1800 Ninth Ave., S., and 2525 Second Ave., W., Seattle, Wash.

DUFF, Kennedy (1915), Mgr., Eastern Territory (for mail) Johnson Service Co., 118 East 28th St., New York, N. Y., and 9 Park Ave., Maplewood, N. J.

DUGAN, Thomas M. (1920), Master Plumber (for mail) National Tube Co., Fourth Ave. and Locust St., McKeesport, and 311 Washington Ave., Dravosburg, Pa.

DUNCAN, George W., Jr. (1923), Consulting Mech. Engr. (for mail) Coddington & Duncan, 547 Phelan Bldg., San Francisco, and 2132 Derby St., Berkeley, Calif.

DUNCAN, J. Ray (1923), Carrier Eng. Corp., 750 Frelinghuysen Ave., Newark, N. J.

DUNCAN, John M. (1924), 32 Church St., Toronto, Ont.

DUNHAM, Clayton A. (1911), Pres. (for mail) C. A. Dunham Co., 230 E. Ohio St., Chicago, and 150 Maple Hill Rd., Glencoe, Ill.

DUNLAP, Ralph L. (1917), Ch. Engr. and Gen. Supt. (for mail) J. H. Kitchen & Co., Pioneer Trust Bldg., 1016 Baltimore Ave., and 5533 Holmes St., Kansas City, Mo.

DUNLAP, Walter G. (Associate 1924), H. B. Smith Co., 17th and Arch Sts., Philadelphia, Pa.

DUQUET, Asa M. (1923), Engr. (for mail) Maurice E. Chase, 263 Summer St., and 19 Blake St., Wallaston, Mass.

DURAND, William L.* (1921), Engr. (for mail) Clark, McMullen & Riley, 101 Park Ave., New York, and 242 Lafayette Ave., Brooklyn, N. Y.

DUSOSSOIT, Edmond A. (1920), Treas. (for mail) Lynch & Woodward, Inc., 202 Harrison Ave., Boston, and 16 Hancock Ave., Newton Centre, Mass.

DWYER, Frank A. (1902), Consulting Engr., 447 Guy Park Ave., Amsterdam, N. Y.

DWYER, John V. (Associate 1922), Asst. Factory Mgr. (for mail) Peninsular Stove Co., Fort St., W., Detroit, and 372 Lakeland Ave., Grosse Pointe Village, Mich.

DWYER, Thos. F. (1923), Heat. and Vent. Engr. (for mail) Board of Education, Flatbush Ave., and Concord St., Brooklyn, and 282 Cypress Ave., Bronx, N. Y.

DYER, Orville K. (1919), Sales Engr., Buffalo Forge Co., 490 Broadway, Buffalo, N. Y.

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EADIE, John G. (1909), Consulting Engr., Eadie, Freund & Campbell, 7 West 45th St., New York, N. Y.

EAGAN, George A. (1917), Pres. (for mail) Eagan & Beahm, Inc., 304-306 Stephen Girard Bldg., Philadelphia, Pa., and 17 Newton Ave., Woodbury, N. J.

EAGAR, R. Frank (1922), Consulting Engr. (for mail) 138 Lower Water St., P. O. Box 904, Halifax, and Bedford, Halifax County, Nova Scotia.

EASTER, Terrill J. (Associate 1919), Pres. and Treas. (for mail) Automatic Gas-Steam Radiator Co., Fulton Bldg., and 312 S. St. Clair St., Pittsburgh, Pa.

EASTERBROOKS, Clifton C. (1922), Sales Engr. (for mail) Koithan & Pryor, 39 Cortlandt St., and 2735 Sedgewick Ave., New York, N. Y.

EASTWOOD, Everett Owen (1921), Prof. (for mail) Univ. of Washington, and 4702 12th Ave., N.E., Seattle, Wash.

EATON, Byron K. (Associate 1919; 1920), Gen. Sales Mgr., Winslow Boiler & Engr. Co., 208 South La Salle St., Chicago, and (for mail) 522 N. Fifth Ave., La Grange, Ill.

EBERT, William A. (1920), Engr. and Estimator (for mail) P. O. Box 1280, and 1004 Drexel Ave., San Antonio, Tex.

EBIN, Louis* (Junior 1924; 1924), Heat. and Vent. Engr. (for mail) Phillips Getschow Co., 130 W. Kinzie St., and 3801 Ainslie St., Chicago, Ill.

ECKARDT, Chas. A. T. (Associate 1924), Sales Engr., The Whitlock Coil Pipe Co., 726 Commercial Trust Bldg., and 5822 Girard Ave., Philadelphia, Pa.

ECKART, Claude H. (1915), Secy.-Treas. (for mail) Eckart Bros., Inc., 320 Westlake N., and R. F. D. No. 4 Box 263, Seattle, Wash.

EDDY, Ernest J. (Associate 1919), Br. Mgr. (for mail) Keasbey & Mattison Co., 17 Terrace, and 175 Dorchester Rd., Buffalo, N. Y.

EDELSTON, Samuel H. (Junior 1922), Heat. Engr. (for mail) W. L. Fleisher & Co., Inc., 31 Union Sq., W., New York, N. Y., and 330 South 12th St., Newark, N. J.

EDGAR, A. C. (Charter Member), (Council 1920), (for mail) Edgar Heat. Co., 1705 Alter St., Philadelphia, and Newton Square, Delaware Co., Pa.

EDWARDS, C. H. (Associate 1924), R. M. Edwards & Son, 29 Water St., Cannonsburg, Pa.

EDWARDS, Daniel F. (1920), (for mail) D. F. Edwards Heat. Co., 2340-42 Pine St., St. Louis, Mo., and Millstadt, Ill.

EDWARDS, Paul A. (1919), Engr. and Estimator (for mail) The G. F. Higgins Co., 606 Wabash Bldg., and 1260 Mississippi Ave., S. Hills P. O., Pittsburgh, Pa.

EGGLESTON, Lewis W. (1921), Mgr. (for mail) American Radiator Co., 1807 Elmwood Ave., Buffalo, and Harris Hill Rd., Williamsville, N. Y.

EGGLY, Harry J., Jr. (1925), Consulting Engr., and (for mail) 1505 Race St., and 5903 North 6th St., Philadelphia, Pa.

EHRENZELLER, Adolphe (1924), Mgr. of Heat. Dept., and (for mail) Walker & Pratt Mfg. Co., 31 Union St., Boston, and 23 Parlevale Rd., West Roxbury, Mass.

EHRLICH, M. William* (1916), Br. Mgr., Trane Co., Rm. 2332 Park Row Bldg., 15 Park Row, New York, N. Y., and (for mail) 56 Ridge Rd., Lyndhurst, N. J.

EICHER, Hubert C. (1922), Director, Bureau of School Bldgs., Dept. of Public Instruction, State Capitol, and (for mail) 103 South St., Harrisburg, Pa.

EICHLER, Alvin (1919), Pres. (for mail) Eichler Heat. Co., 2010 R'y. Ex. Bldg., and 5449 Enright Ave., St. Louis, Mo.

EISERT, Hermann* (1920), Consulting Engr., 404 St. Paul Pl., and (for mail) 4007 Bateman Ave., Baltimore, Md.

ELDERMAN, B. E. (Associate 1925), (for mail) Ben Elderman Eng. Co., 610 21st St., and 525 25th St., Denver, Colo.
ELLIOTT, A. Douglass (1918), Elec. Heat. Engr. (for mail) Elliott Equip. Co., 927 Met. Life Bldg., and 3015 43rd Ave., S., Minneapolis, Minn.
ELLIS, Ernest E. (1922). Mgr., and (for mail) Fred A. Ellis & Co., Inc., 840 Center St., Winnetka, Ill.
ELLIS, Frederic R. (1913), Mgr. Heat. & Vent, Depts., B. F. Sturtevant Co., 131 Beacon St., Hyde Park, Boston, Mass.
ELLIS, Harry W. (Associate 1909; 1923), Pres. and Gen. Mgr., Johnson Service Co., 149 Michigan St., Milwaukee, Wis.
ELLIS, John Edwin (Associate 1921), (for mail) U. S. Radiator Corp., 1412 West 12th St., and 3030 Oak St., Kansas City, Mo.
ELLIS, Walter C. (Associate 1923), Mech. Engr. (for mail) 64 W. Randolph St., Chicago, and 324 Ninth Ave., La Grange, Ill.
ELLISON, J. Huyler (1919), Pres. Ellison & Co., Inc., 211 West 126th St., New York, and (for mail) 41 Wallace St., Freeport, N. Y.
EMERICK, Stanley H. (Junior 1923), Mech. Engr., Louis Kamper, Archt., 3729 Cass Ave., and (for mail) 5471 15th St., Detroit, Mich.
EMERSON, Ralph R. (1922), Sales Engr. (for mail) Hoffman Specialty Co., 512 Fifth Ave., New York, and 660 59th St., Brooklyn, N. Y.
EMERY, Wm. D. (1923), Pres. (for mail) Blest & Emery Co., 784 Coney Island Ave., and 496 Argyle Rd., Brooklyn, N. Y.
EMMERT, Luther D. *(1919), Repr. (for mail)* Buffalo Forge Co., 562 W. Washington Blvd., Chicago, and 1704 Hinman Ave., Evanston, Ill.
EMPKEY, George J. (1919), Secy. (for mail) The Schneider Plbg. Co., 4420 Euclid Ave., and 9812 North Blvd., Cleveland, O.
EMSWILER, John E.* (1917), Prof. of Mech. Eng., Univ. of Mich., 231 Eng. Bldg., Ann Arbor, Mich.
ENGLE, Alfred (Associate 1922; 1923), Salesman, Jenkins Bros., 80 White St., and 60 West 190th St., New York, N. Y.
ENGLE, Harris J. (Associate 1922; 1923), Heat. Engr., 248 East 34th St., New York, N. Y.
ERICKSON, Harry A. *(1917), Engr. (for mail)* Corbit Bros., Plbg. & Heat. Co., Third and Oley Sts., and 719 Mcknight St., Reading, Pa.
ERTMAN, Bernard R. (1920), Heat. Engr. and Mgr., A. F. Ertman, 309 N. Main St., Herkimer, N. Y.
ERWIN, J. P. (Junior 1923; Associate 1925), Colo. Hospital and Sanitarium, and (for mail) 402 Maxwell Ave., Boulder, Colo.
EVANS, C. A. (1919), 218 Lexington Ave., Buffalo, N. Y.
EVANS, Edwin C. (1919), Dist. Mgr., Reed Air Filter Co., 841 Oliver Bldg., and (for mail) 2793 Bergman St., and Corliss Station, Pittsburgh, Pa.
EVANS, John (1919), Archt. (for mail) 30 Water St., and 15 Ball Ave., Galt, Ont.
EVANS, Raymond S. (Junior 1920; Associate 1925), Experimental Engr. (for mail) 4333 Drummond Pl., Chicago, Ill.
EVANS, William A. (1918), Dealer in Hot Water Equipt., 149 Broadway, New York, N. Y., and 24 Woodland Rd., Maplewood, N. J.
EVELETH, Charles F.* (1911), Ch. Engr. Heat. & Vent. (for mail) Warren Webster & Co., 17th and Federal Sts., Camden, and Woodbury, N. J.

F

FALVEY, John D. (1922), Sales Engr. (for mail) Hester-Bradley Co., 4200 Forest Park Blvd., and 5762a McPherson Ave., St. Louis, Mo.
FARLEY, J. W. (Associate 1921), Mgr., Farley Sleeve & Hanger Co., 3748 East 71st St., Cleveland, O.
FARNHAM, Roswell (1920), Dist. Mgr. Engr. Sales (for mail) Buffalo Forge Co., 490 Broadway, and 711 W. Delavan Ave., Buffalo, N. Y.
FARRAR, Cecil W. (Associate 1918; 1920), Vice-Pres. (for mail) Excelso Specialty Works, Inc., 119 Clinton St., and 429 Norwood Ave., Buffalo, N. Y.
FAY, Francis C. (1925), Engr. (for mail) Raisler Heat. Co., 129 Amsterdam Ave., New York, N. Y., and 12 21st St., Elmhurst, L. I., N. Y.
FEBREY, Ernest J. (1903), (for mail) E. J. Febrey & Co., 616 New York Ave., N. W., and 1610 Riggs Pl., N. W., Washington, D. C.
FEEHAN, J. B. (1923), Pres. and Treas. (for mail) John B. Feeham, Inc., 471 Union St., and 24 Tudor St., Lynn, Mass.
FEHLIG, John B. (1918), Pres. and Treas. (for mail) Excelsior Heat. Supply Co., 528 Delaware St., and 2927 Brooklyn Ave., Kansas City, Mo.
FEIGE, Henry W. (1922), Sales Mgr. (for mail) Powers Regulator Co., 1206 Colonial Trust Bldg., Philadelphia, Pa., and Oaklyn, N. J.
FELDMAN, Abram M.* (1903), Consulting Engr., 145 West 45th St., New York, N. Y.
FELS, Arthur B. (1919), Pres. (for mail) The Fels Co., 60 Union St., Portland, and Box 33, Yarmouth, Me.
FELTWELL, Robert Hall (1922), Heat. Engr., Dist. Mgr., D. & T. Mfg. Co., St. Louis, Mo., and (for mail) 1040 S. Frazier St., Philadelphia, Pa.
FENSTERMAKER, Sidney E. (1909), Pres. (for mail) S. E. Fenstermaker & Co., 821 Hume-Mansur Bldg., and 3102 Washington Blvd., Indianapolis, Ind.
FEST, Leon T. (1919), Mgr., Pierce Butler & Pierce Mfg. Corp., 31st and Oxford Sts., and (for *mail) 6646 North 18th St., Philadelphia,* Pa.
FESTORAZZI, Angelo O. (Junior 1925), (for mail) C. A. Dunham Co., 1631-1633 Second Ave., N., and 2215 14th Ave., S., Birmingham, Ala.
FIEDLER, Harry W. (1923), Ch. Engr. (for mail) Burnham Boiler Corp., 30 East 42nd St., New York, N. Y., and 19 Archer Ave., White Plains, N. Y.
FIELDING, Howard H. (1904), (Council 1918-1919) Heat. and Vent. Engr. (for mail) Warren Webster & Co., 1226-1228 California St., and 1515 E. Ninth Ave., Denver, Colo.
FILSON, Foster E. (1924), 116 S. Second St., Harrisburg, Pa.
FINAN, James J., Sr. *(1923), Supervising Engr.,* Board of Education, and (for mail) 7149 Euclid Ave., Chicago, Ill.
FINK, Raymond (Associate 1925), (for mail) Pierce, Butler & Pierce Mfg. Corp., Rm. 1010, 41 East 42nd St., and 240 West End Ave., New York, N. Y.
FIRESTONE, James F. (Junior 1914; Associate 1925), Ch. Engr., The Beckwith Co., Dowagic, Mich.
FIRSCHING, Frank J. (1921), Heat. Engr. (for mail) Warren Webster & Co., 1005 Empire Bldg., and 9951 Frankstown Ave., Pittsburgh, Pa.
FISKE, T. Dunmars (1922), (for mail) Montgomery, Ward & Co., St. John and Belmont Sts., and 2917 East 67th St., Kansas City, Mo.
FITTS, Charles D. (1920), Salesman (for mail) American Radiator Co., 915 Metropolitan Life Bldg., and 2807 Dean Blvd., Minneapolis, Minn.
FITZ, Geo. L. (Associate 1924), Alberger Heat. Co. and Howard Iron Works, 200 Fifth Ave., New York, N. Y.
FITZ, Jean C. (1925), Heat. Engr. and Estimator., Louis J. Sommer & Son, 2436 Brown St., and (for mail) 4213 Darien St., Philadelphia, Pa.
FLEISHER, Walter L.* (1914), Pres. (for mail) W. L. Fleisher & Co., Inc., 31 Union Sq., W., and 126 Waverly Pl., New York, N. Y.
FLEMING, James P. (1923), Engr.-Custodian (for mail) Bd. of Education, 1410 N. Rockwell St., and 4035 N. Keystone Ave., Chicago, Ill.
FLEMING, Thomas C. (1919), Asst. Mgr., Crane Co., 245 Master St., and 5239 North 15th St., Philadelphia, Pa.
FLETCHER, Saxton W. (1923), Sales Engr. (for mail) J. O. Ross Eng. Co., 30 East 42nd St., New York, and 67 S. Broadway, White Plains, N. Y.

FLETT, Henry R. (Associate 1915; 1915), Mgr., Taylor-Forbes Co., Ltd., 1088 King St., W., Toronto, Ont.
FLINK, Carl H. (1923), Ch. Engr., Dept. of Research (for mail) American Radiator Co., 1807 Elmwood Ave., and 192 Baynes St., Buffalo, N. Y.
FLINT, Coll T. (1919), Boston Mgr. (for mail) H. B. Smith Co., 640 Main St., Cambridge, and 56 Brantwood Rd., Arlington, Mass.
FLORENCE, Wm. E., Jr. (Junior 1924; Associate 1925) Engr., Acme Heat. & Vent. Co., 13 Hawkins St., Boston, and (for mail) 79 Salem St., Reading, Mass.
FOGG, Oscar H. (1914), Vice-Pres., Consolidated Gas Co. of New York, 130 East 15th St., New York, N. Y.
FOISY, George A. (1923), Designing Engr., U. S. Cartridge Co., Lawrence St., Lowell, Mass.
FOLEY, Wm. J. (Associate 1923), Mgr. and Engr., Wm. J. Foley Heat. Service Co., 230 15th St., Denver, Colo.
FORFAR, Donald M. (1917), Mech. Engr. (for mail) Croft & Boerner, Inc., 1004 Marquette Ave., and 3345 Harriet Ave., Minneapolis, Minn.
FORGAN, Donald M. (Associate 1923), Mgr. (for mail) American Radiator Co., 4201 Duncan Ave. and N. Denny Rd., St. Louis, Mo.
FORGEE, Frederick A. (1919), Consulting Engr. (for mail) 141 East 29th St., New York, N. Y., and Ridgewood, N. J.
FORSBERG, William (1919), Secy. (for mail) Hopson & Chapin Mfg. Co., 231 State St., New London, and Quaker Hill, Conn.
FOSTER, Charles (1923), Consulting Engr. (for mail) *512 Sellwood Bldg., and 1731 E. Superior* St., Duluth, Minn.
FOSTER, James M. (Associate 1920), Dist. Mgr. (for mail) Ilg Electric Ventilating Co., 1421 Syndicate Trust Bldg., and 7021 Lindell Blvd., St. Louis, Mo.
FOSTER, William M. (Associate 1914), Vice-Pres. and Engr. (for mail) The Leggett-Doll-Foster Co., 16508-10 Woodward Ave., and 86 Pilgrim Ave., Highland Park, Mich.
FOUILHOUX, J. Andre (1915), R. M. Hood & J. A. Fouilhoux, 40 West 40th St., New York, N. Y., and (for mail) West Rd., Short Hills, N. J.
FOULDS, Powys A. L. (1916), Mech. Engr. (for mail) *Hollis French & A. Hubbard,* 210 South St., Boston, and 854 N. Shore Rd., Revere, Mass.
FRANCIS, Isaac H. (1907), Consulting Engr. (for mail) 1520 Locust St., Bonbright Bldg., Philadelphia, and Devon, Pa.
FRANCIS, William C. (1919), Heat. Engr., Jas. P. Wood Heat. Co., 320 New St., and 1623 W. Westmoreland St., Philadelphia, Pa.
FRANK, George W. (1919), Pres. and Treas. (for mail) Frank & Miller, Inc., 79 Best St., and 136 High St., Buffalo, N. Y.
FRANK, John M. (Associate 1912; 1918), Vice-Pres., Ilg Electric Vent. Co., 2850 N. Crawford Ave., Chicago and (for mail) 1152 Chatfield Rd., *Hubbard Woods,* Ill.
FRANK, Olive E. (1919), Pres., O. E. Frank Heater & Engr. Co., Inc., 20 Milburn St., and 296 Norwalk Ave., Buffalo, N. Y.
FRANKLIN, Ralph S. (1919), Pres. and Treas. (for mail) Albert B. Franklin, Inc., 25 Haverhill St., Boston, and 320 Grove St., Melrose, Mass.
FRANZHEIM, Geo. W. (1924), Pres. and Gen. Mgr., Universal Smokeless Boiler Co., Ravenna, O.
FRASER, William G. (1916), Vice-Pres. (for mail) Power Efficiency Corp., 137 Arthur St., and 1515 Amherst St., Buffalo, N. Y.
FRENCH, Bascom P. (Junior 1915; Associate 1925), Olney Plbg. & Heat. Co., 106 W. Main St., Olney, Ill.
FRIDAY, Leslie M. (Associate 1923), Salesman (for mail) Utica Heater Co., 628 Union Bldg., and 735 East 91st St., Cleveland, O.
FRIEDMAN, Abraham (1922), Heat. Contr. (for mail) A. Friedman, 217 East 47th St., New York, and 2529 Erickson St., East Elmhurst, L. I., N. Y.
FRIEDMAN, Ferdinand J. (1921), Mech. Engr. (for mail) McDougall, Pease & Friedman, 85 Osborne St., Montreal, Que.
FROST, Robinson V.* (1921), Consulting Engr., 828 W. Marshall St., Norristown, Pa.
FRUTCHY, Asel E. (Junior 1920; 1924), Vice-Pres. (for mail) Frutchy Barnes Co., 104 W. Second St., and 864 Euclid Ave., Elmira, N. Y.
FRY, J. D. (Junior 1924), Asst. Engr. (for mail) McDougall, Pease & Friedman, 85 Osborne St., and 66 McTavish St., Montreal, Que.
FRYER, Frederick C. (1918), Director, Rowntree & Co., Ltd., York, England.
FULLER, Charles A.* (1913), (Council 1917) Consulting Engr. (for mail) 347 Fifth Ave., New York, and 501 E. Fifth St., Mt. Vernon, N. Y.
FULLER, J. Lansing (Associate 1916), Dist. Sales Mgr. (for mail) Hart & Crouse Co., 315 E. Adams Ave., and 1745 Chicago Blvd., Detroit, Mich.
FULLER, Robert K. *(1923), Archt. and Engr.* (for mail) 503 Insurance Bldg., Denver, Colo.
FULTON, Walter J. (1924), Sales Mgr. (for mail) Central Steam Heat Div., 54 King St., and Fawuct Ave., Winnipeg, Man.
FURMAN, J. R. (1919), Mech. Engr., 1417 Railway Exchange, and (for mail) 5488 University Ave., Chicago, Ill.

G

GALE, Thomas J. C. (Associate 1920; 1921), Heat. and Piping Contr., 324 Oddfellow Bldg., and (for mail) 4023 Shaw Ave., St. Louis, Mo.
GALLAHER, James E. (Junior 1923), Engr. (for mail) Air Conditioning & Eng. Co., 2914 S. Jefferson Ave., St. Louis, and 2307 Bellevue Ave., Webster Groves, Mo.
GALLIGAN, Andrew B. (1921), Mgr. (for mail) Galligan Bros., 716-18 South 51st St., and 5231 Race St., Philadelphia, Pa.
GALLIGAN, John H. (1923), Engr., Marine Galligan Co., 1822 Ludlow St., Philadelphia, and (for mail) 1930 South 56th St., W. Philadelphia, Pa.
GANNON, James E. (1918), Pres., Gannon & Carey Co., 903 Parade St., and 508 West 11th St., Erie, Pa.
GANT, H. P. (1915; Pres. Member 1923), (Council 1918; 2nd Vice-Pres., 1921; 1st Vice-Pres., 1922; Council 1924), (for mail) Lewis, Robinson & Gant, Land Title Bldg., Philadelphia, Pa.
GARDNER, Benj. F. (1924), Heat. and Plbg. Contr. (for mail) 322 Myrtle Ave., and 277 Carlton Ave., Brooklyn, N. Y.
GARDNER, S. Franklin (1911), (for mail) Standard Eng. Co., 2129 Eye St., N.W., and 3805 Kanawha St., Washington, D. C.
GARDNER, W., Jr. (Associate 1921), Sales Mgr. (for mail) Garden City Fan Co., 1842 McCormick Bldg., and 7836 Loomis St., Chicago, Ill.
GAUSMAN, C. E. (1923), Magney & Tusler, 126 South 9th St., Minneapolis, and (for mail) 748 Margaret St., St. Paul, Minn.
GAWTHROP, Fred. H. (1919), Pres.-Treas. (for mail) Gawthrop & Bro. Co., 705 Orange St., and 1110 Shallcross Ave., Wilmington, Del.
GAYLOR, William S. (1919), Heat. and Vent. Engr., Starrett & Van Vleck, 8 West 40th St., New York, and (for mail) 42 Mayhew Ave., Larchmont, N. Y.
GAYLORD, Frank H. (1921), Br. Mgr., Hoffman Specialty Co. (for mail) 130 N. Wells St., and 5234 Kimbark Ave., Chicago, Ill.
GEDNEY, Kenneth H. (1923), Archt. and Engr. (for mail) K. H. Gedney Co., Osborn Bldg., and 3 Park Court, Hastings, Neb.
GEIGER, Irvin H. (1923), Rm. 311, Commonwealth Bldg., 212-14 North 3rd St., Harrisburg, Pa.
GEMENY, William J. (1919), Pres. (for mail) W. J. Gemeny Co., 2528 W. Madison St., and 7601 Normal St. Chicago, Ill.
GERRISH, Harry E. (1910), (Council 1919) Pres. (for mail) Morgan-Gerrish Co., 800-6 LaSalle Ave., and 4534 S. Freemont Ave., Minneapolis, Minn.

GETSCHOW, Geo. M. (1906), Phillips-Getschow Co., 130 W. Kinzie St., Chicago, Ill.
GETSCHOW, Roy M. (1919), Secy. and Heat. and Vent. Engr., Phillips-Getschow Co., 130 W. Kinzie St., and 4517 Beacon St., Chicago, Ill.
GIBBONS, M. J., Jr. (1914), Secy. (for mail) M. J. Gibbons Supply Co., 601 E. Monument Ave., and 22 Oxford Ave., Dayton, O.
GIBBS, Edward W. (1919), (for mail) The Smith Gibbs Co., S. Main St., and 61 President Ave., Providence, R. I.
GIBBS, Frank C. (1921), Secy. (for mail) Colby-Merrill Co., 1121 Nicholas Bldg., and 1937 Parkdale Ave., Toledo, O.
GIBBS, Harold E. (1920), *Specialty Sales Co.*, 1550 Main St., and (for mail) 443 Richmond Ave., Buffalo, N. Y.
GIBSON, John H. (1921), Dist. Mgr. (for mail) Whitlock Coil Pipe Co., 726 Commercial Trust Bldg., Philadelphia, and Merion, Pa.
GIESECKE, F. E.* (1913), (for mail) Prof. of Archt. Engr., University of Texas, University Sta., and 901 East 24th St., Austin, Tex.
GIFFORD, Robert L. (1908), Pres., Illinois Engineering Co., Chicago, Ill., and (for mail) 1231 S. El Molino Ave., Pasadena, Calif.
GIGUERE, Geo. H. (1920), Mech. Engr., c/o State Archt., and (for mail) 623 Fountain St., Ann Arbor, Mich.
GILBERT, Maxwell F. (Associate 1915), Mgr. (for mail) Richardson & Boynton Co., 1308 Arch St., Philadelphia, and 138 Fernbrook Ave., Wyncote, Pa.
GILBOY, John P. (1924), Heat. and Vent. Engr. (for mail) 407 Miller Bldg., and 718 Prescott Ave., Scranton, Pa.
GILES, Edward H. (1919), Dist. Mgr., Pierce, Butler & Pierce Mfg. Corp. (for mail) 31st and Oxford Sts., and Stonleigh Court Apts., 46th and Chestnut Sts., Philadelphia, Pa.
GILLESPIE, Raymond B. (1924), Sales Repr. (for mail) American Radiator Co., 24th and Blake Sts., and Denver Athletic Club, Denver, Colo.
GILLETT, Merriman C. (1916), Sales Engr., Standard Heater Co., Walnut St., Willamsport, and (for mail) 6600 Rising Sun Ave., Philadelphia, Pa.
GILLHAM, Walter E.* (1917), (Council 1924) Consulting Engr. (for mail) 409 Interstate Bldg., and 3427 Bellfontain, Kansas City, Mo.
GILLING, William F., Jr. (Associate 1919), *Asst. Mgr., American Radiator Co.*, 129 Federal St., Boston, and (for mail) 29 Abbott Rd., Wellesley Hills, Mass.
GILMORE, Frank P. (1923), Sales Engr., Peerless Unit Ventilation Co., 100 Boylston, Boston, Mass.
GILMORE, R. E. (1923), Mech. Engr. (for mail) c/o Schmidt, Garden & Martin, 104 S. Michigan Ave., and 3917 Rokeby St., Chicago, Ill.
GIVIN, Albert Wm. (Associate 1925), Mgr. (for mail) Taylor Forbes Co., Ltd., 1070 Homer St., and 2609 Hemloch St., Vancouver, B. C.
GLASSEY, J. Wilbur (1922), *Partner (for mail)* Vapor Engr. Co., 10 South 18th St., Philadelphia, and Wyndmoor, Chestnut Hill, Pa.
GLEASON, Gilbert H. (1923), 25 Huntington Ave., Boston, and 43 Clyde St., Newtonville, Mass.
GLORE, Evins F.* (Associate 1916), Treas. and Sales Mgr., Abram Cox Stove Co., American and Dauphin Sts., Philadelphia, Pa., and (for mail) 715 Riverside Dr., New York, N. Y.
GODFREY, Foskett H. (1921), Mgr. (for mail) General Boilers Co., 2021 L. C. Smith Bldg., and College Club, Seattle, Wash.
GOLDBERG, Harry M. (Junior 1923), John J. Nesbitt, Inc., 48 East 41st St., New York, N. Y.
GOLDSTEIN, A. M. (1923), (for mail) Federal Heat. Co., 310 13th St., N.W., and 1501 Varnum St., Washington, D. C.
GOLDSCHMIDT, Otto E. (1915), Consulting Engr., 116 West 39th St., New York, N. Y.
GOMBERS, Henry B. (Associate 1901), Secy. (for mail) Heat. and Piping Contrs., National Assn. 50 Union Sq., New York, N. Y., and 160 Halsted St., East Orange, N. J.
GOMERSALL, William H. (Associate 1921), Sales Engr., Sherman Eng. Co., 254 South 15th St., and 7500 Limekiln Pike, Mt. Airy, Philadelphia, Pa.
GOOD, Macy S. (1921), Mgr., Chicago Territory C. A. Dunham Co., Rm. 606, 230 E. Ohio St., and 6360 Greenwood Ave., Chicago, Ill.
GOODNOW, Wallace F. (1912), Spec. Repr. (for mail) Pierce, Butler & Pierce Mfg. Corp., 41 East 42nd St., and 261 West 11th St., New York, N. Y.
GOODRICH, Charles F. (1919), Andrews & Goodrich, Inc., 88 Broad St., Boston, Mass.
GOODWIN, Samuel L. (1924), Consulting Engr., Heat. and Vent., T. W. Lamb, 644 Eighth Ave., New York, N. Y., and (for mail) 247 Madison Ave., Hasbrouck Heights, N. J.
GORDON, Edward B., Jr. (1908), Chas. L. Pillsbury Co., Capital National Bank Bldg., St. Paul, and (for mail) 3215 Girard Ave., S., Minneapolis, Minn.
GORDON, Edward G. (1923), Robert Gordon, Inc., 1355 W. Washington Blvd., and (for mail) 1621 Lunt Ave., Chicago, Ill.
GORMLY, John* (Charter Member; Honorary Member; Pres. 1906), Council 1889; Board of Governors 1900-1903; 1st Vice-Pres., 1904), 410 E. Marshall St., Norristown, Pa.
GORMLY, P. (1919), R. D. No. 5, Norristown, Pa.
GORNSTON, Michael H. (Associate 1923), P. S. 109, Dumont Ave., and Powell St., and (for mail) 251 Crescent St., Brooklyn, N. Y.
GORTON, G. H. (Associate 1924), W. B. Young Supply Co., 208 Delaware St., Kansas City, Mo.
GORTNER, John W. (1919), Heat., Vent. and Sanitary Plumber (for mail) A. W. Gortner and Son, 318 Sunbury St., and 42 N. Sixth St., Shamokin, Pa.
GOSS, Mathew H. (1921), Estimator and Engr., The Brown Co., 1053 Baltimore Ave., W., and (for mail) 3632 Helen Ave., Detroit, Mich.
GOSSETT, Earl J. (1923), Pres., Bell & Gossett Co., 117 N. Dearborn St., and 6719 Newgard Ave., Chicago, Ill.
GOTTWALD, C. (Associate 1916), Pres. (for mail) Ric-Wil Co., Union Trust Bldg., Cleveland, O.
GRAEFF, Richard J. (1920), Pres. (for mail) R. J. Graeff, Inc., 1048 Beaubien St., and 1926 Euclid Ave., W., Apt. 6-A, Detroit, Mich.
GRAHAM, Edwin H. (Associate 1924), (for mail) Mgr., Crane Co., 1328 West 12th St., and 5410 State Line Rd., Kansas City, Mo.
GRAHAM, Wm. D. (Junior 1923), Dist Mgr., and (for mail) York Heat. & Vent. Corp., 307 Plymouth Bldg., Cleveland., and 1549 Cordova Ave., Lakewood, O.
GRASSLER, Edmund (Associate 1919), (for mail) Grassler & Gezelschap, 214 Third St., and 750 Summit Ave., Milwaukee, Wis.
GRAVES, Ralph E. (Assocaite 1923), Factory Repr. (for mail) The Fulton Co., 1014 Holland Bldg., St. Louis, and 8516 Florence Ave., Webster Groves, Mo.
GRAVES, Willard B. (1906), Pres. (for mail) W. B. Graves Heating Co., 162 N. Desplaines St., Chicago and 254 Edgewood Pl., River Forest, Ill.
GRAY, George A. (1924), (for mail) C. A. Dunham Co., Ltd., 205 Roy Bldg., and 17 Walnut St., Halifax, N. S.
GRAY, William E. (1922), Sales Engr. (for mail) Moore Dry Kiln Co., State St., and 903 Farragut Pl., S. Jacksonville, Fla.
GREASON, David R. (Associate 1924), 72 West 101st St., and (for mail) 4 Grassy Sprain Rd., Yonkers, N. Y.
GREBE, Henry W. (1919), Pres. (for mail) Central Asbestos & Magnesia Co., 214 W. Grand Ave., and 2650 Wilson Ave., Chicago, Ill.
GREEN, Charles E. (1924), Vice-Pres. and Gen. Sales Mgr. (for mail) Midwest Air Filters, Inc., 100 East 45th St., New York, N. Y.

GREEN, William C. (1906), Warren Webster Co., 310 Provident Bank Bldg., Cincinnati, O.
GREENE, Walter C. (1921), Mgr. (for mail) W. C. Greene Co., 1629 Union Trust Bldg., Cleveland, and 2400 Demington Dr., Cleveland, O.
GRETZINGER, Franklin (1919), Mech. Engr., Land Title Bldg., and (for mail) 2124 North 17th St., Philadelphia, Pa.
GRIER, William (1908), P. O. Box 75, Cincinnati, O.
GRIFFIN, Frank A., Jr. (1917), (for mail) Kellogg-Mackay Co., 2030 Walnut St., and 3930 S. Benton St., Kansas City, Mo.
GRIFFIN, John J. (1921), Pres. (for mail) International Eng. & Supply Co., Suite 609-11 Tower Bldg., Sixth and Olive Sts., and 3662 Humphrey St., St. Louis, Mo.
GRIFFIN, Porter C. (1923), Hutton Bros. Co., 9 Union St., and (for mail) 151 Oak St., Winsted, Conn.
GRIFFITH, Morgan R. (Associate 1922), Canadian Blower & Forge Co., 186 King St., Toronto, Ont.
GRILL, Guido E. (Junior 1922), Designer (for mail) Clark, McMullen & Riley, 101 Park Ave., New York, and 90 Alter Ave., Dongan Hills, Staten Island, N. Y.
GROOM, Stanley L. (1920), Managing Director, Buffalo Forge Co., Ltd., 24 Buckingham Gate, and (for mail) Homestead Thrale Rd., Streatham, London, England.
GROSCUP, William F. (1923), (for mail) c/o The Groscup Co., Inc., 2549 St. Paul and 26th St., and 3409 Springdale Ave., Baltimore, Md.
GROSS, Raymond A. (1923), Vice-Pres., and Treas., Ben Rigby, Inc., 604 W. Lake St., Chicago, and (for mail) 527 N. Washington St., Park Ridge, Ill.
GROSSMAN, Howard M. (1922), Dist. Mgr., Burnham Boiler Corp., and (for mail) 634 Race Ave., Lancaster, Pa.
GROSVOLD, Fred E. (1917), Plbg. and Heat. (for mail) 411 Grand Ave., E., and 603 Main St., Eau Claire, Wis.
GROTZ, Arthur B. (1921), Treas., Patterson Kelly Co., 101 Park Ave., New York, and (for mail) 17 Cambridge Pl., Brooklyn, N. Y.
GRUMBEIN, Irwin F.* (1915), Pres. (for mail) National Heat. & Vent. Co., 736 Drexel Bldg., Philadelphia, and Lebanon, Pa.
GUEST, Peyton L. (1921), Pres., Smith & Guest, 19 Houston St., and (for mail) 247 McLinden St., Atlanta, Ga.
GUNN, Joseph F. (1924), Pres., Heckel-Gunn Heat., 3685 Olive St., and 4325 North 21st St., St. Louis, Mo.
GUNTON, William (1923), (for mail) 1400 44th St., and Success Heater Mfg. Co., Des Moines, Ia.
GUSTAFSON, T. E. (Junior 1923), U. S. Radiator Corp., 500 N. Dearborn St., Chicago, Ill.

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HAAS, Samuel L. (1923), Pres. and Treas. (for mail) Advance Heat. Co., 117-119 N. Desplaines St., and 1513 Fargo Ave., Chicago, Ill.
HAAS, William (1915), Pres. and Treas. (for mail) The William Haas Co., 429 E. Third St., and 1632 S. Wayne Ave., Dayton, O.
HACKETT, Charles P. (Associate 1921), Br. Mgr. (for mail) U. S. Radiator Corp., Cunard Bldg., 220 South 16th St., Philadelphia, and 61 W. Eagle Rd., Upper Darby, Br., Pa.
HACKETT, H. Berkeley (1921), Mech. and Consulting Engr. (for mail) 505 Chestnut St., Philadelphia, Pa.
HACKNEY, Henry (Associate 1919), Contr. and Engr., 34 W. Fifth St., and 1541 E. Seventh St., Charlotte, N. C.
HADEN, George N. (Junior 1922), G. N. Haden & Sons, Ltd., Trowbridge, and Owens Cottage, Hilperton near Trowbridge, England.
HADEN, William N. (1902), G. N. Haden & Sons, Ltd., Silver St., Trowbridge, England.
HADESTY, Alfred L., Jr. (1921), 130 E. Broad St., Tamaqua, Pa.
HAGEDON, Charles H. (1919), Ch. Engr., Weinshank & Fenstermaker, 821 Hume-Mansur Bldg., and (for mail) 4156 Broadway Indianapolis, Ind.
HAILEY, Syd Houston (1925), Asst. Engr., 924 Broadway and (for mail) 3737 Harding Rd., Nashville, Tenn.
HAINES, John J. (1915), Vice-Pres. and Secy., The Haines Co., 1933 W. Lake St., Chicago, Ill.
HALE, Frank M. (Associate 1923), Chandler Pump & Supply Co., 931 W. Eighth St., Kansas City, Mo.
HALE, John F.* (1902; Pres. 1913), (Board of Governors *1908; 1910; 1st Vice-Pres. 1912*; Council 1914), Pres., Atmospheric Conditioning Corp., 920 Lafayette Bldg., Phialdelphia, Pa.
HALEY, Harry S.* (1914), Consulting Engr. (for mail) Leland & Haley, 58 Sutter St., and 735 21st Ave., San Francisco, Calif.
HALLER, Arthur L. (1920), Engr. (for mail) Hunt Heat. Co., 1515 Oliver St., St. Louis, and 530 Yeatman Ave., Webster Groves, Mo.
HALLETT, Edwin S.* (1918), (Council 1921-1923), Ch. Engr. (for mail) Board of Education, Bd. of Education Bldg., and 5156 Cabanne Ave., St. Louis, Mo.
HALLEY, Wilson H. (Junior 1923; 1925), Designer and Engr. (for mail) Langenberg Mfg. Co., 4519 N. Euclid Ave., and 6134 West Park Ave., St. Louis, Mo.
HAMJY, Paul W. (1924), Heat. and Vent. Contr. (for mail) 611 Mohawk St., and 606 Kossuth Ave., Utica, N. Y.
HAMLET, Francis A. (1922), Draftsman and Estimator, W. J. Evans, Heat. Contr., 4 Park Ave., Montreal, and (for mail) Provincial Hotel, Gananoque, Ont., Can.
HAMLET, Thomas F. (1920), Sales Engr., Darling Bros., Ltd., 120 Prince St., and (for mail) 34 Burton Ave., Westmount, Montreal, Que.
HAMLIN, Harry A. (Associate 1916), Mgr. (for mail) Johnson Service Co., 427 Brainard St., Detroit, and 1210 Winona Ave., Highland Park, Mich.
HAMMER, H. M. (1920), Economy Steam Specialty Co., 608 Fullerton Bldg., and 4411 Clarence Ave., St. Louis, Mo.
HANES, J. W. E. (Junior 1922), Designer (for mail) Dell S. Reynolds, Engrs., "Dome" Hillstreet Bldg., Los Angeles, and 337 Carroll Park, W., *Long Beach, Calif.*
HANKIN, Richard (1898), Vice-Pres., John Hankin & Bro., 228 Cherry St., New York, N. Y., and (for mail) 279 Main St., Passaic, N. J.
HANLEY, John H., Jr. (1923), Vice-Pres. and Ch. Engr., Reed Engr. Co., 50 Church St., New York, and (for mail) 816 Rugbey Rd., Brooklyn, N. Y.
HANSEN, John (1921), Heat. Engr., Nilson Bros., 3222 N. Halsted St., and (for mail) 2611 Kimball Ave., Chicago, Ill.
HANSON, E. W. (1922), Engr. and Estimator, W. N. Sauer Co., 806 Chestnut St., and (for mail) 919 Eldora Pl., Pittsburgh, Pa.
HANSON, Henry A. (Associate 1923), Pres. (for mail) Hexo Mfg. Co., Inc., 5620 Grand Central Terminal, New York, and 330 Johnson Ave., Teaneck, N. J.
HANSON, Leon C. (Associate 1918), Bjorkman Bros., 712 South 10th St., Minneapolis, Minn.
HARBISON, Earl J. (Associate 1924), J. E. Harbinson, 211½ Union St., and (for mail) 15 Brickwood Blvd., Schenectady, N. Y.
HARBULA, Michael G.* (1921), Air Conditioning Engr., Drying Systems, Inc., 11 S. Desplaines St., and (for mail) 2040 East 68th St., Chicago, Ill.
HARDING, Louis A.* (1911), (Council 1922; 1924), Pres. (for mail) L. A. Harding Constr. Corp., 1335 Main St., and 85 Cleveland Ave., Buffalo, N. Y.
HARE, Edgar S. (1920), Pres. and Mgr. (for mail) William Hare's Sons Co., 46 14th St., Wheeling, W. Va., and West Alexander, Pa.

HARMS, William T.* (1917), Heat. Contr., 1173 Clark Ave., Detroit, Mich.
HARRIGAN, Edward M. (1915), Pres. (for mail) Harrigan & Reid Co., 1705 First St., and 7450 La Salle Blvd., Detroit, Mich.
HARRINGTON, Chas. (1923), P. O. Box 891, Halifax, N. S.
HARRIS, Emery E. (1916), Vice-Pres. (for mail) Pittelkow Heat. and Eng. Co., 312 W. Larned St., and 1492 Bewick Ave., Detroit, Mich.
HARRIS, Henry W. (Associate 1924), J. R. Brockenan Mfg. Co., 617 N. Second St., and 4296 Washington Blvd., St. Louis, Mo.
HARRIS, Jesse B. (1918), (for mail) Rose & Harris, Engr., 417 Northwestern National Life Ins. Bldg., 15th and Oak Grove Sts., and 3620 Colfax Ave., S., Minneapolis, Minn.
HARRISON, Burt S. (1908), Ch. Engr., Drying Systems, Inc., 11 S. Desplaines St., and (for mail) 2914 Washington Blvd., Chicago, Ill.
HARRISON, James M. (1919), Vice-Pres. (for mail) McCann-Harrison Co., 5005 Euclid Ave., and 2041 East 96th St., Cleveland, O.
HART, Harry M.* (1912; Pres. 1916), (Council 1914; 1st Vice-Pres. 1915; Council 1917), Pres., L. H. Prentice Co., 330 S. Sherman St., and 5409 Winthrop Ave., Chicago, Ill.
HARTMAN, Frank E.* (1924), Ch. Chemist, U. S. Ozone Co., and (for mail) George and High Sts., Scottdale, Pa.
HARTPENCE, Charles C. (1923), Box 337, Columbus, Ga.
HARTWELL, Joseph C. (1922), Dept. Mgr. (for mail) Grinnell Co., Inc., 260 W. Exchange St., and 16 Freeman Parkway, Providence, R. I.
HARVEY, Alex. D. (Junior 1925), Asst. to Sales Mgr. (for mail) Nash Engr. Co., S. Norwalk, and Suburban Club, Stamford, Conn.
HASEY, Charles E. (1919), C. E. Hasey Co., 513 Second Ave., S., and 2613 Third Ave., S., Minneapolis, Minn.
HASKELL, Benj. E. (1925), Engr., Arthur B. Fels, 42 Union St., Portland, and (for mail) 539 Brighton Ave., Woodfords, Me.
HAUSER, Martin (1917), Pres. Engr., General Heat. Supply Co., R. 1, Reliance Bldg., and 1316 East 42nd St., Kansas City, Mo.
HAUSS, Charles F. (1922), Special Repr. for Far East (for mail) American Radiator Co., 4 Yuen Ming Yuen Rd., Shanghai, China.
HAUTZ, Edward H. (Associate 1923), Riester & Thesmacher Co., 1526 West 25th St., Cleveland, O.
HAWLEY, E. F. (Junior 1923; Associate 1925), Lloyd Miller, Inc., 539 Main St., Poughkeepsie, N. Y.
HAYES, James J. (1920), Sales Engr. (for mail) Stannard Power Equipment Co., 926 Monadnock Block, and 1423 East 66th Pl., Chicago, Ill.
HAYES, Partick M. (Associate 1923), K. C. Asst. Mgr. (for mail) Dempster Mill Mfg. Co., 1307 West 11th St., and 4011 Kenwood, Kansas City, Mo.
HAYES, Joseph G. (1908), Mgr. and Engr. (for mail) Hayes Bros., Inc., 236 W. Vermont St., and 2849 N. Capitol Ave., Indianapolis, Ind.
HAYNES, Charles V. (1917), Vice-Pres. and Gen. Sales Mgr., Hoffman Specialty Co., 25 West 45th St., New York, N. Y., and (for mail) 115 Llanfair Rd., Ardmore, Philadelphia, Pa.
HAYWARD, Ralph B. (1909), Pres. (for mail) R. B. Hayward Co., 1714 Sheffield Ave., Chicago, and 201 S. Stone Ave., La Grange, Ill.
HEAGERTY, Wm. H. (Associate 1923), Gen. Mgr., Oil City Boiler Works, P. O. Box 137, Oil City, Pa.
HEAGLER, John M. (1922), Engr. (for mail) American Foundry & Furnace Co., 508 Guardian Life Bldg., and 1646 Iglehart Ave., St. Paul, Minn.
HEAP, Walter E. (1920), Mgr. (for mail) Charles R. Heap & Son, 26 Roe St., and 412 Delafield Ave., W. New Brighton, Staten Island, N. Y.
HEATH, Frederick R. (1913), Sales Engr., E. B. Badger & Sons Co., 75 Pitts St., Boston, and (for mail) 89 Trowbridge St., Cambridge, Mass.
HEATHERTON, James M. (Associate 1904) Pres. and Editor (for mail) Plumbers Trade Journal Publishing Co., 239-241 West 30th St., New York, and 395 Clinton Ave., Brooklyn, N. Y.
HECK, George L., Jr. (Associate 1921), Sales Engr. (for mail) Garden City Fan Co., 1842 McCormick Bldg., and 7522 Cornell Ave., Chicago, Ill.
HECKEL, Edmund P. (1918), Vice-Pres. (for mail) Carrier Eng. Corp., 1032 Burnham Bldg., Chicago, and 314 Cuttriss Pl., Park Ridge, Ill.
HEDGES, H. Berkley (1919), Mgr. (for mail) York Heat. & Vent. Corp., 149 Broadway, New York, N. Y., and 1021 Park Lane, Plainfield, N. J.
HEDLEY, Park S. (1923), W. A. Chase & Son Mfg. Co., 31 Main St., Buffalo, N. Y.
HEEBNER, Walter M. (1922), Heat. and Vent. Engr. Warren Webster & Co., 15 West 34th St., New York, N. Y., and (for mail) 362 Highwood St., Bogota, N. J.
HEIBEL, Walter E. (1921), (for mail) Thomas Haverty Co., Eighth and Maple Sts., and 956 S. Dacotah St., Los Angeles, Calif.
HEILES, Frederick C. (Junior 1914; 1920), Consulting Engr., 13 Central Ave., Newark, and (for mail) 34 Boyden Parkway, Hilton, N. J.
HEILMAN, Russell H. (1923), Senior Industrial Fellow (for mail) Mellon Inst. of Industrial Research, and 7108 Willard St., Pittsburgh, Pa.
HEINLE, Earl L. (1920), Secy.-Treas., The Kain-Petersen-Heinle Co., 1364 East 34th St., Cleveland, and (for mail) 2206 Bellfield Ave., Cleveland Heights, O.
HELLERMAN, Harry H. (1902), Pres. and Gen. Mgr., The Penn Eng. Co., 312 Cherry St., Philadelphia, Pa.
HELPHINGSTEIN, Otto (1919), Engr. and Supt., Gen. Del., Galveston, Tex.
HENION, Hudson D. (Associate 1923), Mgr. (for mail) Young Pump Co., 96 Mary St., and 114 Rossiyn Ave., S., Hamilton, Ont.
HENRICH, George A. (1914), Pres. and Treas. (for mail) Geo. A. Henrich Co., 702 N. Wells St., and 548 Fullerton Parkway, Chicago, Ill.
HENRICI, Herman C. (1925), Pres., Henrici-Lowry Eng. Co., 404 Security Bldg., and (for mail) 430 West 58th St., Kansas City, Mo.
HERENDEEN, Frederick W. (1920), Secy. (for mail) The National Boiler & Radiator Mfgs. Assn., 29 Seneca St., and 815 S. Main St., Geneva, N. Y.
HERING, John B. (Junior 1922), Philip Hering & Son, 409 Belgrade St., Philadelphia, Pa.
HERLIHY, George F. (1922), Vice-Pres. (for mail) J. J. Herlihy, Inc., 810 W. Congress St., and 212 East 109th St., Chicago, Ill.
HERLIHY, Jermiah J. (1914), Pres. (for mail) J. J. Herlihy, Inc., 810 W. Congress St., and 3634 N. Keeler Ave., Chicago, Ill.
HERRICK, Daniel A. (1923), Factory Mgr. (for mail) Julian D'Este Co., 26 Canal St., Boston, and 27 Agassiz St., Cambridge, Mass.
HERRING, Edgar (1919), Managing Director (for mail) J. Jeffreys & Co., Ltd., Barron's Pl., Waterloo Rd., London, S.E., and "Kenia," Keowick Rd., Putney, London, S.W., 15, England.
HERSH, Edgar E. (1916), Ch. Engr. and Asst. Gen. Mgr., Hersh Bros. Co., 645 Mill St., and (for mail) 120 South 16th St., Allentown, Pa.
HERSH, G. Willis (1917), Gen. Mgr., Hersh Bros. Co., 645 Mill St., Allentown, Pa.
HERTZ, H. Porter (1924), (for mail) Routledge & Hertz, Archts., 304 State Exchange Bk. Bldg., and 314 12th Ave., E., Hutchinson, Kans.
HESS, Horace L. (1924), H. B. Smith Co., 17th and Arch Sts., Philadelphia, Pa.
HESTER, Thomas J. (1919), (for mail) Hester-Bradley Co., 4200 Forest Park Blvd., and 3704 Sylvan Pl., Kenwood Springs, St. Louis, Mo.
HETHERINGTON, Edward T. (1919), Sales Engr. (for mail) 1718 Sansom St., and 3311 North 16th St., Philadelphia, Pa.
HEYDON, Charles G. (Associate 1923), (for mail) Wright-Austin Co., 315 W. Woodbridge St., and 2649 Nebraska St., Detroit, Mich.

HIBBS, Frank C. (1917), Salesman, H. B. Smith Co., S.E., cor. 17th and Arch Sts., and (for mail) 3203 Columbia Ave., Philadelphia, Pa.
HIGGINS, John M. (1922), Salesman, H. B. Smith Co., 640 Main St., Cambridge 39, and (for mail) 84 Harlow St., Arlington, Mass.
HIGGINS, Thomas J. (Junior 1923), Mgr. (for mail) Ross Eng. Co. of Canada, Ltd., New Birks Bldg., Montreal, Que.
HILDEBRANDT, Henry A. (1918), Supt. of Bldgs. and Grounds (for mail) University of Minnesota, and 323 Church St., S.E., Minneapolis, Minn.
HILL, Charles H. (1917), Ch. Engr., State Normal School, Emporia, Kan.
HILL, E. G. T. (1922), Heat. and Mech. Engr., E. G. Hill & Co., 20 Vermont Crescent., Newland, Hull, E. Yorks, England.
HILL, Dr. E. Vernon* (Associate 1912; 1914; Pres. 1920), (Council 1915; 1917, 1921; 2nd Vice-Pres. 1918; 1st Vice-Pres. 1919), (for mail) E. Vernon Hill Co., 64 W. Randolph St., and 4357 Kenmore Ave., Chicago, Ill.
HILL, Newell J. (1916), Consulting Engr. (for mail) 708 Architect's Bldg., and 1737 Atkinson Ave., Detroit, Mich.
HILLMAN, R. Ward (1919), Gen. Mgr. Sales. (for mail) U. S. Radiator Corp., 133 E. Grand River Ave., Detroit, and 80 Oakdale Blvd., Pleasant Ridge, Detroit, Mich.
HILLS, Arthur H. (1924), Engr. C. A. Dunham Co., Ltd., 904 New Birks Bldg., and (for mail) 13 Royal Ave., Montreal, Que.
HINCHMAN, E. G. (1923), (for mail) E. G. Hinchman Co., 1263 Atlantic Ave., and 547 Eastern Parkway, Brooklyn, N. Y.
HINKLE, Edwin C. (1911), Eastern Mgr., Buckeye Blower Co., 1400 Broadway, New York, and (for mail) 170 Franklin St., Hempstead, N. Y.
HITCHCOCK, Frederick P. (1917), Pres. (for mail) H. & P. Sales Co., 1107 Continental Bldg., and 4938 Forest Ave., Kansas City, Mo.
HOBBS, J. Clarence (1920), Supt. of Power, Diamond Alkali Co., and (for mail) 126 Wood St., Painesville, O.
HOBEN, Robert J. (1919), Plbg. and Heat. Contr. (for mail) 258-60 S. Van Pelt St., and 5102 Spruce St., Philadelphia, Pa.
HOCHULI, Henry W. (1925), Sales Engr., National Radiator Co., 47 West 42nd St., New York, N. Y., and (for mail) 206 Park Ave., Orange, N. J.
HODGDON, Harry A. (1919), Heat. and Vent. Engr., Stone-Underhill Heat. & Vent. Co., 171 Harrison Ave., Boston, and (for mail) 153 Norfolk St., Wollaston, Mass.
HOERSTING, Frank J. (1921), Hoersting & Holtmann, 1133 W. Third St., Dayton, O.
HOESINGTON, Ned. P. (Associate 1923), (for mail) 102 Summit Ave., Bywood Heights, Upper Darby, P. O., Pa.
HOFFMAN, Chas. F. (Junior 1925), (for mail) International Heater Co., 101 Park Ave., and 123 Grove Pl., Utica, N. Y.
HOFFMAN, Chas. S. (1924), (for mail) Baker, Smith & Co., Inc., 576 Greenwich St., New York, N. Y., and 19 Belvidere Pl., Montclair, N. J.
HOFFMAN, George D.* (1906), Hoffman Specialty Co., 512 Fifth Ave., New York, N. Y.
HOFFMAN, James D.* (1903; Pres. 1910), (1st Vice-Pres. 1908; Board of Governors 1911; 1912), Prof. of Practical Mechanics, Head of Dept., Director of Practical Mechanics Laboratory (for mail) Purdue University, and 323 University St., W., Lafayette, Ind.
HOFT, Paul J. (Associate 1924; 1925), 245 S. Eighth St., Philadelphia, Pa.
HOGAN, Edward L. (1911), Mgr., Air Conditioning Dept. (for mail) American Blower Co., 6004 Russell St., Detroit, Mich.
HOGUE, Carl T. (1922), Heat. and Vent. Engr., San Angelo, Tex.
HOIER, William V. (1917), Mgr. (for mail) Wm. V. Hoier Co., 701 N. Wells St., and 5960 Kenmore Ave., Chicago, Ill.
HOLBROOK, Frank M. (1923), Armstrong Cork Co., Linoleum Division, Lancaster, Pa.
HOLLOWAY, Robert B. (Junior 1923), Engr., and Salesman, Gurney Heater & Mfg. Co., 108 North 17th St., Philadelphia, and (for mail) 26 W. Rockland St., Germantown, Pa.
HOLMBERG, John A. (1924), 122 E. Lincoln, Lindsborg, Kan.
HOLMES, Joseph (1921), Heat. Engr., 1902 Freeman St., Toledo, O.
HOMANN, Frederick A. (1918), Sales Repr. (for mail) The Herman Nelson Corp., 1233 Marlyn Rd., Philadelphia, Pa.
HONIBALL, Charles R.* (1911), Pres., Charles R. Honiball Co., 156 Boundary St., Liverpool, England.
HOOK, C. Howard (1915), Pres., Peerless Heater Co., 5602 Baum Blvd., Pittsburgh, Pa.
HOOK, Maurice G. (1919), Mgr., C. A. Dunham Co., 101 Park Ave., New York, and Gifford Park, Tuckahoe, N. Y.
HOOVER, H. Earl (Associate 1922), Vice-Pres. (for mail) The Hoover Co., 1407 Railway Exchange, Chicago, and 1801 Green Bay Rd., Glencoe, Ill.
HOPKIN, William E. (1919), Pres. and Treas. (for mail) Chas. E. Hopkin Co., 107 Bethlehem Pike and Wyndmoor Ave., Chestnut Hill, Philadelphia, Pa.
HOPSON, William T. (1915), Hopson & Chapin Mfg. Co., New London, Conn.
HOPWOOD, Arthur M. (1920), Sales Engr., Abram Cox Stove Co., American and Dauphin Sts., and (for mail) 1842 Wellington St., Philadelphia, Pa.
HORNUNG, John C. (1914), Engr. (for mail) 343 S. Dearborn St., Chicago, and Glencoe, Ill.
HOSTERMAN, Chas. C. (1924), McMurrer Co., 303 Congress St., Boston, Mass.
HOUGHTEN, F. C.* (1921), Heat. and Vent. Engr. and Secy., A. S. H. & V. E., 29 West 39th St., New York, N. Y.
HOUPT, George A. (1916), Engr., S. Faith Co., Inc., Evans Ave. and Old York Rd., Willow Grove, Pa.
HOWATT, John* (1915), Ch. Engr. (for mail) Chicago Board of Education, 650 S. Clark St., and 7227 Oglesby Ave., Chicago, Ill.
HOWELL, Frank B.* (1920), Director, Inst. of Thermal Research (for mail) American Radiator Co., 1807 Elmwood Ave., and Westbrook Apts., North at Delaware Ave., Buffalo, N. Y.
HOWELL, Lloyd (1915), Ch. Engr. (for mail) American Foundry & Furnace Co., 915 E. Washington St., and 1203 E. Jefferson St., Bloomington, Ill.
HOYT, William B. (1919), Sales Mgr. and Secy. (for mail) National Bending Co., River and Lloyd Sts., New Haven and 39 Clifford St., Whitneyville, Conn.
HUBBARD, Allen (1919), Consulting Engr. (for mail) Hollis French and Allen Hubbard, 210 South St., Boston, and 51 Montvale Rd., Newton Center, Mass.
HUBBARD, Allen M. (1922), Heat. and Vent. Contr., 1900 West 1st St., and 232 N. Vendome St., Los Angeles, Calif.
HUBBARD, George W. (1911), Mech. Engr. (for mail) Graham, Anderson, Probst & White, 1417 Railway Exchange, Chicago, and 331 Bonnie Brae, River Forest, Ill.
HUBBARD, Nelson B. (1919), Consulting Engr., 1504 Broadway, Rm. 614, and 2985 Blaine Ave., Detroit, Mich.
HUBERT, Jack W. (1924), Vice-Pres., Barron-Hubert Co., Inc., 126 West 64th St., New York, N. Y.
HUCH, Aloysius J. (1919), Gen. Mgr. of Sales. (for mail) Central Supply Co., 312 S. Third St., and 4037 Harriet Ave., Minneapolis, Minn.
HUCKEL, Frank, Jr. (1920), Mgr., Heat. Dept., Keystone Supply & Mfg. Co., 907 N. Ninth St., Philadelphia, and (for mail) 5335 Wingohocking Terrace, Germantown, Pa.

HUCKER, Joseph H. (1921), Sales Engr., Haynes Selling Co., Inc., 1711 Sansom St., Philadelphia, and 715 Stanbridge St., Norristown, Pa.
HUETHER, Chas. G. L. (1924), Heat. Vent. Air-Conditioning, Power and Mech. Equip. (for mail) Atlantic Eng. Co., 206-9 Title Annex Bldg., and 3814 Kate Ave., Forest Park, Baltimore, Md.
HUGHES, Willard C. (1921), (for mail) Wicks-Hughes & Co., 224 Genesee St., and 16 Cottage Pl., Utica, N. Y.
HULL, Bret R. (1910), Engr. and Contr., 406 Poyntz Ave., Manhattan, Kan.
HUMPHREY, D. E. (1921), Heat. and Vent. Engr. (for mail) Goodyear Tire and Rubber Co., Akron, and 128 S. Fourth St. Cuyahoga Falls, O.
HUMPHREYS, Aurelius E. (1911), Mgr., O'Mara Heat. Co., 504 Victoria Bldg., St. Louis, Mo.
HUNT, Phil M. (1922), Steam and Heat. Engr. Dept., Crane Co., 221 West 1st St., and (for mail) 32 West 14th St., Oklahoma City, Okla.
HUNT, Richard B. (1912), Mgr., 414 S. Fourth Ave., Mt. Vernon, N. Y.
HUNTER, Wallace S. (Associate 1924), (for mail), United Plumbers Supply Co., Inc., 146th and Exterior Sts., and 254 East 202nd St., New York, N. Y.
HURLEY, Joseph C. (1915), Pres. (for mail) Petroleum Fuel Eng. Co., 4028-32 Filbert St., and 21 South 61st St., Philadelphia, Pa.
HUSBAND, Edward Woods (1922), Heat. Engr., Geo. Frederick Hall, Archt., 807 Union Trust Co. Bldg., and (for mail) 114 Corinth St., Providence, R. I.
HUTCHISON, J. E. (1921), Engr. (for mail) Isaac Hathaway Francis, 1520 Locust St., and 5129 Newhall St., Philadelphia, Pa.
HUTTON, William (1919), Pres. and Treas. (for mail) Hutton Bros. Co., 9 Union St., and 28 Spring St., Winsted, Conn.
HUTZEL, A. F. (1916), (for mail) Hutzel & Co., 119 E. Washington St., and 722 W. Washington St., Ann Arbor, Mich.
HUTZEL, Hugo F. (1918), Engr. (for mail) American Radiator Co., 1807 Elmwood Ave., and 85 Crestwood Ave., Buffalo, N. Y.
HUTZEL, Max H. (1923), (for mail) Hutzel & Co., Hutzel Bldg., and 731 N. Elm St., Muncie, Ind.
HUTZEL, Victor C. (1923), (for mail) Hutzel & Co., Hutzel Bldg., and 401 E. Main St., Muncie, Ind.
HUZZARD, Edward C. (Associate 1924), Fleck-Marshall Plbg. & Heat. Co., Hazel and Water Sts., and R. D. No. 7, Lancaster, Pa.
HYMAN, Wallace M. (1920) Vice-Pres. (for mail) Reis & O'Donovan, Inc., 253 West 28th St., and 210 West 70th St., New York, N. Y.
HYNES, Lee P.* (1919), Pres., Hynes & Cox Electric Corp., 406 N. Pearl St., and 50 S. Manning Blvd., Albany, N. Y.

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ICKERINGILL, John (1923), Sales Engr., c/o Standard Heater Co., Otis Bldg., Philadelphia, and 235 Rector St., Roxborough, Pa.
IDDLES, Alfred (1921), Ch. Power Engr. (for mail) Day & Zimmerman, Inc., 1600 Walnut St., Philadelphia, and 304 Conestoga Rd., Wayne, Pa.
IMPEY, Paul F. (Junior 1921; Associate 1925), Heat. Engr., John C. Moninger Co., 900 Blackhawk St., and (for mail) 3842 N. Mozart St., Chicago, Ill.
INGALLS, F. D. B. (1906), Sales Engr. Br. Mgr. (for mail) C. A. Dunham Co., 136 Federal St., Boston, and 1 Hopkins St., Reading, Mass.
INGLES, Margaret M.* (Junior 1918; 1923), Research Engr. (for mail) U. S. Bureau of Mines, and 238 N. Dithridge St., Pittsburgh, Pa.
INNIS, Helen R.* (Junior 1918; 1921), (for mail) Donnelly Systems Co., 9 Murray St., New York, and 34 McDonough St., Brooklyn, N. Y.
IRWIN, Clarence W. (1924), c/o V. G. Ralston, 1004-7 L. & J. Bank, and (for mail) 729 Campbell Ave., Waterloo, Iowa.
ISSERTELL, Henry G.* (Associate 1912; 1913), Sales Engr. (for mail) Bldg. Equip. Section, General Electric Co., 120 Broadway, New York, N. Y.

J

JACKSON, Charles H. (1923), Bayley Mfg. Co., 732 Greenbush St., Milwaukee, Wis.
JACKSON, Charles J. (Associate 1912), Local Mgr. (for mail) Jenkins Bros., 646 W. Washington Blvd., Chicago, and 323 Hazel Ave., Glencoe, Ill.
JACKSON, Marshall S. (1919), (for mail) Heat & Power Plant Equip., 232 Delaware Ave., and 108 Larchmont Rd., Buffalo, N. Y.
JACOBUS, Dr. David S. (1916), Advisory Engr., Babcock & Wilcox Co., 85 Liberty St., New York, N. Y.
JALIEN, John J. (1922), Staff Engr. (for mail) Schwab Import Co., 552 Seventh Ave., and 365 West 118th St., New York, N. Y.
JANES, Arthur (1919), Pres., Arthu Janes Co., Scarsdale, N. Y.
JANET, Harry L. (1920), Engr. (for mail) Carrier Eng. Corp., 750 Frelinghuysen Ave., Newark, N. J., and 588 Decatur St., Brooklyn, N. Y.
JARVIS, Geo. E. (1923), Secy., Estimator, Heat. and Vent. Engr. (for mail) A. E. Holmes & Bros. Co., 911-15 Banks Ave., and 1626 Baxter Ave., Superior, Wis.
JAYNES, Eubertis L. (1918), Pres. and Gen. Mgr. (for mail) Northwestern Furnace & Supply Co., 619 Washington Ave., S., and 4849 Girard Ave., S., Minneapolis, Minn.
JELLETT, Stewart A.* (Charter Member; Pres. 1895), Board of Managers 1896-1897; Secy. 1898; Board of Managers 1899), Consulting and Constr. Engr., Pres. (for mail) Stewart A. Jellett Co., 1200 Locust St., and 6701 Lincoln Dr., Mount Airy, Philadelphia, Pa.
JENKINS, Harry E. (Associate 1923), Sales Mgr. Radiator Div. (for mail) U. S. Cartridge Co., and 343 High St., Lowell, Mass.
JENNINGS, Frederick W. (Associate 1905), Ashwell & Nesbit, Ltd., 12 Great James St., Bedford Row, London, W. C., England.
JENNINGS, Irving C. (1924), Pres. and Gen. Mgr. (for mail) The Nash Engr. Co., and 148 Flax Hill Rd., South Norwalk, Conn.
JENNINGS, Stanley A. (Junior 1924; Associate 1925), Salesman (for mail) Darling Bros., 77 York St., and 15 Brookmount Rd., Toronto, Ont.
JENNINS, Henry H. (1901), Edwin Oldroyd & Co., Ltd., Crown Works, and (for mail) 15 Grange View, Chapeltown Rd., Leeds, England.
JENSON, Jean S. (1912), 431 S. Dearborn St., Chicago, Ill.
JOHN, Benjamin F. (1920), Pres. (for mail) Benj. F. John Co., 1003 Race St., and 881 North 24th St., Philadelphia, Pa.
JOHNSON, Carl W. (1912), Pres. (for mail) C. W. Johnson, Inc., 211 N. Desplaines St., and 1809 Morse Ave., Chicago, Ill.
JOHNSON, Edward B. (1919), Sales Engr., Staten Island Supply Co., 1390 Richmond Terrace, and (for mail) 154 Wardwell Ave., West New Brighton, N. Y.
JOHNSON, Fred W. (1916), Vice-Pres. (for mail) Johnson, Larsen & Co., 693-703 Monroe Ave., Detroit, and R. F. D. 4, Birmingham, Mich.
JOHNSON, Paul H. (Associate 1924), Engr., E. H. Sheldon Co., and (for mail) 205 Washington Ave. Muskegon, Mich.
JOHNSON, Ralph B. (1922), Sales Engr. (for mail) Johnson Service Co., 411 East 10th St., and 2117 East 68th St., Terrace, Kansas City, Mo.
JOHNSON, Tracy R. (1924), Trane Co. (for mail) 315 Y. M. C. A., La Crosse, Wis.
JOHNSTON, James A. (1912), Member of Firm, Archt. and Engr. (for mail) Carneal & Johnston, 806 Va. Ry. & Power Bldg., and 1411 Grove Ave., Richmond, Va.

JOHNSTON, William B. (Associate 1916; 1921), Vice-Pres. (for mail) Ideal Furnace Co., 530 Jefferson Ave., W., and 1667 Atkinson Ave., Detroit, Mich.
JOHNSTON, Wm. H. (1924), Pres. (for mail) Johnston Heat. Co., 131 East 26th St., New York, and 19 Magnolia Ave., Larchmont, N. Y.
JOLLIFFE, Arthur H. (Associate 1918), Br. Mgr. (for mail) U. S. Radiator Corp., 712-16 Boyce Bldg., 500 N. Dearborn St., Chicago, Ill.
JONES, A. Marshall (1922), Mgr. (for mail) Machinery Mfgs. Sec., Westinghouse Elec. & Mfg. Co., E. Pittsburgh, and 209 Biddle Ave., Wilkinsburg, Pa.
JONES, D. C. (Associate 1924), (for mail) Hoffman Specialty Co., 200 Builders Exchange, and 4508 29th Ave., S., Minneapolis, Minn.
JONES, David J. (1919), Mech. Asst. (for mail) Illinois Central Railroad Co., Rm. 700, Dowie Bldg., and 425 East 89th Pl., Chicago, Ill.
JONES, Edwin (Junior 1924), Watt Plbg. Heat. & Supply Co., Box 582, Tulsa, Okla.
JONES, Edwin A. (1919), Constr. Engr. (for mail) Williams Raditor Co., 1860 W. Washington, Los Angeles, and 343 12th, Santa Monica, Calif.
JONES, Edwin F. (1923), Consulting Engr., 301 Zenith Bldg., and (for mail) 1358 Ashland Ave., St. Paul, Minn.
JONES, Ernest F. (1923), Mgr. Heat. Dept. (for mail) Kellogg-Mackay Co., 1351 West 37th Pl., and 3350 Gladys Ave., Chicago, Ill.
JONES, Harold L. (1920), Asst. Supt. (for mail) W. W. Farrier Co., 44 Montgomery St., Jersey City, and 11 Cambridge Rd., Glen Ridge, N. J.
JONES, Ivor R. (Junior 1923), (for mail) Isaac H. Francis, 1520 Locust St., Philadelphia, and 344 Taylor Terrace, Chester, Pa.
JONES, Louis T. (1921), Salesman, 3700 Highland Ave., Drexel Hill, Del. Co., Pa.
JONES, Raymond E. (1919), Vice-Pres. (for mail) Haynes Selling Co., Inc., 1711 Sansom St., Philadelphia, Pa., and 39 West End Ave., Haddonfield, N. J.
JONES, William R. (1922), Engr. of Plant, University of Pennsylvania, 3446 Walnut St., and (for mail) 550 South 48th St., Philadelphia, Pa.
JONES, William T. (1915), 11 Rossmere St., Newtonville, Mass.
JOYCE, Walter P. (Associate 1924), Heat. Engr. (for mail) 2039 Hardesty Ave., Kansas City, Mo.
JUNG, John S. (Associate 1923), 554 Layton Blvd., Milwaukee, Wis.
JUNKERS, Prof. Hugo (1925), Pres., Junkers Corp. of America, 342 Madison Ave., New York, N. Y., and 21 Kaiser Platz, Dessau, Germany.
JUTTNER, Otto J. (1915), Pres. (for mail) Juttner Heating Co., 432 Jefferson St., and 496 Newton Ave., Milwaukee, Wis.

K

KAHN, Henry P. (1919), Salesman, Hoffman Specialty Co., 512 Fifth Ave., and (for mail) 456 West 148th St., New York, N. Y.
KAISER, Harry S. (Junior 1924), Heat. and Vent., Hanley & Co., 6 N. Clark St., and (for mail) 3608 Wilson Ave., Chicago, Ill.
KAMMAN, Arnold R. (Junior 1921), 156 York St., Buffalo, N. Y.
KAMMERER, William Chas. (1923), Mech. Engr., Hadlow, Hick & Co., 412 Finance Bldg., Cleveland, and (for mail) 14915 Clifton Blvd., Lakewood, O.
KAPPEL, George W. A. (1921), Pres. and Treas. (for mail) Camden Heat. Co., 8 Market St., Camden, N. J., and 5844 Springfield Ave., Philadelphia, Pa.
KARLSON, Alfred F. (1918), Ch. Engr. (for mail) Parks-Cramer Co., 970 Main St., Fitchburg, and 8 Fairview St., N., Leominster, Mass.
KARR, Theo., Jr. (1921), Pres. (for mail) Karr Supply Co., 325 S. High St., Belleville, Ill.
KASTELLO, August (1923), Mgr. (for mail) C. A. Dunham Co., Ltd., 904 New Birks Bldg., and 112 Rutland Ave., Town of Mt. Royal, Montreal, Que.
KAUFFMAN, Rufus (1921), (for mail) 4308 N. Broad St., and 326 W. Seymour St., Germantown, Philadelphia, Pa.
KAUFFMANN, Frederick F. (1922), Consulting Engr. (for mail) 13 North 13th St., Philadelphia, Pa., and 909 Pine St., Camden, N. J.
KEASBEY, Aertsen P. (1922), Vice-Pres., Robt. A. Keasbey Co., 445 West St. New York, N. Y., and 6 Cobb Rd., Mountain Lakes, N. J.
KEENAN, P. Frank (Associate 1921), (for mail) Leo Flush Valve Co., 331 Madison Ave., New York, and 156 Ackroyd Ave., Jamaica, N. Y.
KEENEY, Frank P. (Associate 1915), Pres. (for mail) Domestic Engineering, 1900 Prairie Ave., and 70th St., and the Lake, Chicago, Ill.
KEHM, August (1901), (Board of Governors 1908; 1911; 1st Vice-Pres. 1909), Pres., Kehm Bros. Co., 51 E. Grand Ave., Chicago, Ill.
KEISER, Walter (Associate 1920), Vice-Pres. (for mail) Air Conditioning & Eng. Co., 2914 S. Jefferson Ave., and 2822 Jefferson Ave., St. Louis, Mo.
KELLEY, James J. (Associate 1924), Vice-Pres. (for mail) Ballard Oil Burning Equipment Co., 289 Congress St., Boston, and 142 Governors Ave., Medford, Mass.
KELLOGG, Alfred* (1916), (Council 1920-1921, 1923-1924), (for mail) 89 Franklin St., Boston, and 6 Hawthorne St., Waverly, Mass.
KELLOGG, Clarence V. (Associate 1900), Pres. (for mail) Kellogg-Mackay Co., 419 West 18th St., and 1338 Fargo Ave., Chicago, Ill.
KELLOGG, Hosford D. (Associate 1916), Mgr., H. B. Smith Co., 17th and Arch Sts., Philadelphia, and Haverford, Pa.
KELLOGG, Thos. M. (Associate 1923), The Bishop & Babcock Co., 444 Lafayette St., New York, N. Y.
KELLY, John G. (Associate 1919), Plbg. and Heat. Spec., 210 East 45th St., New York, and (for mail) 55 Cornell Ave., Yonkers, N. Y.
KENNEALLY, Victor J. (1919), Engr. (for mail) V. J. Kenneally Co., 256 Dover St., Boston, Mass.
KENT, Lawrence F. (Junior 1924), Vice-Pres. and Engr. (for mail) Moncrief Furnace Co., P. O. Box 1673, 62 Hemphill Ave., Atlanta, and Smyrna, Ga., R. F. D. No. 2.
KERSHAW, Melville G. (Junior 1921), (for mail) c/o Dupont Engr. Co., Wilmington, Del., and 3957 N. Percy St., Philadelphia, Pa.
KERSJES, William (1922), Pres., Wheeler, Blaney Co., 223 N. Burdick St., and (for mail) 728 Clinton St., Kalamazoo, Mich.
KEYES, Robert E. (1913), Construction Engr. (for mail) W. L. Fleisher & Co., Inc., 31 Union Sq., W., and 2497 Grand Ave., New York, N. Y.
KIEB, August A. (1924), c/o F. P. Merkel, 131 South 12th St., and (for mail) 112 South 10th St., Newark, N. J.
KIEFER, Carl J. (1922), Consulting Engr., 901 Schmidt Bldg., Cincinnati, O.
KIEWITZ, Arthur A. (1912), Heat. Engr. (for mail) 23-80 Chauncey St., Astoria, Long Island City, N. Y.
KIEWITZ, Conway (1907), Engr., N. Y. Bd. o Education, Flatbush Ave., and Concord St., Brooklyn, and Floral Park, L. I., N. Y.
KILLIAN, Maurice A. (1922), Glanz & Killian Co., 1761 Forest Ave., W., Detroit, Mich.
KILPATRICK, Wm. S. (1923), Engr. (for mail) H. S. McClelland, 823 East 15th St., Los Angeles, Calif.
KIMBALL, Charles W. (1915), Richard D. Kimball Co., 6 Beacon St., Boston, Mass.
KIMBALL, Dwight D.* (1908; Pres. 1915), (Board of Governors 1912; 1913; 2nd Vice-Pres. 1914; Council 1916) Consulting Engr. (for mail) 15 West 38th St., New York, and 230 23rd St., Jackson Heights, N. Y.
KIMBROUGH, Hal. C. (1914), Dist. Mgr. (for mail) American District Steam Co., 712 First National Bank Bldg., Chicago, and Hotel Windermere, Hyde Park, Ill.
KINEALY, John H.* (Charter Member; Pres. 1901), (1st Vice-Pres. 1898; Board of Governors 1902), Consulting Engr., 503 Granite Bldg., St. Louis, Mo.

KING, Thomson (1923), Sales Mgr., Gas Boiler Dept., Peerless Heater Co., 5602 Baum Blvd., Pittsburgh, Pa.
KINGSBURY, James W. (1924), B. B. Shine, 224 E. Walnut St., Green Bay, Wis.
KINNER, J. E. (1924), Bryant Heater & Mfg. Co., 952 East 72nd St., and 1453 East 116th St., Cleveland, O.
KINSEY, Albert J. (Junior 1923), 1088 King St., Toronto, Ont.
KIPE, J. Morgan (1919), Philadelphia Mgr., Standard Heater Co., 609 Otis Bldg., and Homestead and Beck Aves., Beechwood Park, Philadelphia, Pa.
KIRBY, W. C. (1918), Consulting Engr. (for mail) Grinnell Co., Inc., 276 Marrietta St., Atlanta, and 306 Ponce de Leon Pl., Decatur, Ga.
KIRK, Charles D. (1909), Mgr., Chas. D. Kirk Co., Cor. Sargent and Colleen Sts., and 774 McMillian Ave., Winnipeg, Man.
KIRK, George H. (1906), Engr. and Contr., 6711 Wentworth Ave., Chicago, Ill.
KIRK, Leonard G. (1923), Pres., L. G. Kirk Co., 441 West 50th St., New York, and 859 Boulevard East, Weekawken, N. J.
KIRMES, Edwin W. (1923), Secy. and Ch. Engr. (for mail) Walworth-English-Flett Co., 81 Commercial Wharf, Boston, and 29 Oakland St., Melrose, Mass.
KISSICK, J. J. (1918), Supervisor of Operation, Bd. of Education, Sixth and Rockwell Ave., and (for mail) 1768 Wayside Rd., Cleveland, O.
KITAURA, Shigeyuki (1918), Mech. Engr., Monopoly Bureau, Dept. of Finance, Tokyo, Japan.
KITCHEN, Francis A. (Junior 1923), John H. Kitchen Co. (for mail) 1012 Pioneer Trust Bldg., Kansas City, Mo.
KITCHEN, John H. (1906), Heat. and Vent. Engr. (for mail) John H. Kitchen & Co., 1016 Baltimore Ave. (Pioneer Trust Bldg.), and 5015 Westwood Terrace, Kansas City, Mo.
KITTLE, F. C. (1923), (for mail) Lord & Burnham Co., and 42 Main St., Irvington-on-Hudson, N. Y.
KLAUSS, Louis J. (Junior 1921), Asst. Heat. Engr., Socony Burner Corp., 26 Broadway, and Farmingdale, L. I., N. Y.
KLEIN, Dr. Albert R. (1920), Panoramastrasse 23, Stuttgart, Germany.
KLEIN, Edward W. (1917), S.E. Dist. Mgr. (for mail) Warren, Webster & Co., 618 Atlanta Trust Bldg., and 227 Myrtle St., Atlanta, Ga.
KLEIN, Walter A. (1919), Pres. (for mail) Klein Heat. Co., 4209 Olive St., and 4061a Shaw Ave., St. Louis, Mo.
KLIE, Walter (1915), Pres. (for mail) Smith & Oby Co., 6107 Carnegie Ave., and 18411 South Woodland Rd., Shaker Heights, Cleveland, O.
KLINE, George W., Jr. (1921), Kline & Co., 1222 Callowhill St., and (for mail) 634 North 17th St., Philadelphia, Pa.
KLINE, Walter J. (1912), Sales Engr. (for mail) American Dist. Steam Co., North Tonawanda, and 186 Pine St., Lockport, N. Y.
KLONOWER, Arthur A. (1920), Mgr., J. S. Cassedy Co., 133 Austin St., Cambridge, and "The Breakers," Shore Dr., Lynn, Mass.
KNAPP, A. F. (1923), Sales Engr. (for mail) American Radiator Co., 40 West 40th St., New York, N. Y., and 419 Post Ave., Lyndhurst, N. J.
KNIGHT, Alvin B. (Associate 1916), Warren Webster & Co., 2123 Dime Bank Bldg., and 8818 Dexter Blvd., Detroit, Mich.
KNOWLES, Arthur F. (Associate 1914), Knowles Mushroom Ventilator Co., 202 Franklin St., New York, N. Y., and 135 Haddon Pl., Upper Montclair, N. J.
KOCH, Harry O. (1916), Gen. Supt., American Heat. & Vent. Co., 804 Times Dispatch Bldg., Richmond, Va.
KOEHLER, George T. (1923), Sales Engr., Richmond Radiator Co., 1480 Broadway, New York, N. Y., and (for mail) 1111 Market St., Harrisburg, Pa.
KOHLBRY, Edward G. (1920), Pres. (for mail) Kohlbry-Howlett Co., 63 W. Ontario St., Chicago, and 1144 Chestnut Ave., Wilmette, Ill.
KOITHAN, William S. (1913), Sales Engr., Koithan & Pryor, 39 Cortlandt St., New York, N. Y.
KORN, Chas. B. (1922), Reber, Korn Co., 215-221 N. Lumber St., and (for mail) 1022 S. Eighth St., Allentown, Pa.
KRATZ, Alonzo P.* (1925), (for mail) University of Illinois, Dept. of Mech. Engr., and 1003 Douglas Ave., Urbana, Ill.
KREISSL, Hans G. (1925), Engr. (for mail) American Radiator Co., 816 S. Michigan Ave., and 630½ Cornelia Ave., Chicago, Ill.
KRESSLY, Maurice E. (1922), Heat. and Vent. Engr., Bureau of School Bldgs., Dept. of Pub. Instruction, and (for mail) 1941 Lenox St., Harrisburg, Pa.
KRIEBEL, Arthur E. (1920), Sales Engr. (for mail) c/o Kriebel & Co., 822 Green St., Philadelphia, Pa., and Berwyn, Pa.
KRIES, Henry A. (1901) Pres. (for mail) Henry A. Kries & Sons Co., 6 W. Lombard St., Baltimore, and Catonsville, Md.
KROEGER, Alvin (Associate 1923), Chicago Mgr. (for mail) Richmond Radiator Co., 568 Wrigley Bldg., and 4056 N. Harding Ave., Chicago, Ill.
KRUEGER, James I. (1921), Mech. Heat. and Vent. Engr. (for mail) Illinois Engineering Co., 417 Market St., Suite 320 and 775 Post St., San Francisco, Calif.
KRUEGER, William E. (Associate 1924) Mgr. of Heat. Dept., Passaic Plbg. Co., Passaic, and (for mail) 453 Devon St. Arlington, N. J.
KURKE, William F. (1922), Engr. (for mail) 211 Equity Bldg., and 820 12th St., Fargo, N. D.

L

LA BUNDY, Bert A. (Associate 1919), Heat. Engr., 2577 Oxford St., Memphis, Tenn.
LA FOLLETTE, Byron E. (1916), (for mail) The Tarpenning-La Follette Co., Engrs., and Sheet Metal Contrs., 1030 Canal St., and 230 East 47th St., Indianapolis, Ind.
LAGODZINSKI, Harry J. (Junior 1920), Sales Engr., Ilg Elec. Vent. Co., 324 W. Monroe St., and (for mail) 3628 N. Tripp St., Chicago, Ill.
LAIDLAW, Ernest J. (Associate 1923), Crane Co., Ltd., 306 Front St., Toronto, Ont.
LAMB, Foster W. (1906), F. W. Lamb Co., 24 E. Kinzie St., Chicago, Ill.
LAMSON, Frank S. (1924), Mgr. Heat. and Pump Dept., Central Supply Co., 312 S. Third St., and (for mail) 2319 Dupont, S., Apt. 1, Minneapolis, Minn.
LANCE, Joseph (1923), Harrigan & Reid, 1705 First St., Detroit, Mich.
LANDERS, John J. (Junior 1924), Engr., American Radiator Co., 1 Austine St., and (for mail) 823 Smith St., Buffalo, N. Y.
LANE, Alfred M. (1916), Pres. (for mail) Monarch Metal Products Co., 5020 Penrose St., and 4238 Lafayette Ave., St. Louis, Mo.
LANE, Edward K. (1916), Pres. and Mgr. (for mail) Lane-Bowen Co., 201 Seventh St., and 333 Fourth St., Lorain, O.
LANG, Lawrence, P. (Junior 1925), Heat Engr. *(for mail) Warren Webster & Co.*, 549 W. Washington St., and 1508 Larrabee St., Chicago, Ill.
LANGENBERG, Everett B. (1914), Vice-Pres. (for mail) Langenberg, Mfg. Co., 4525 N. Euclid Ave., St. Louis, and 7214 Pershing Ave., University City, Mo.
LAPERLE, Lorenzo G. (1923), Asst. Supt., George H. Drake, Inc., 218 Lexington Ave., Buffalo, N. Y.
LARIMER, George B. (1915), Pres. (for mail) Larimer-Lauer, Inc., 1824 S. Hope St., and 6666 Selma Ave., Hollywood Sta., Los Angeles, Calif.
LARIMER, Wm. McCoy (1922), Mgr. Heat. Dept., M. J. O'Fallon Supply Co., 1621 15th St., and 159 W. Second Ave., Denver, Colo.

LARSON, Gustus L. (1923), Professor of Steam and Gas Eng. (for mail) University of Wisconsin, and Route 7, Madison, Wis.
LARSON, J. M. (1924), (for mail) National Regulator Co., 2301 Knox Ave., and 3541 Wrightwood Ave., Chicago, Ill.
LARSON, Wm. C. (1925), Heat. and Vent. Engr., Narrowetz Heat. and Vent. Co., 1711 Park Ave., and (for mail) 4224 N. Winchester Ave., Chicago, Ill.
LATHAM, Geo. (1924), Engr. and Supt. of Plant (for mail) Edmonton Public School Bd., 504 Civic Block, and 11317 91st St., Edmonton, Alberta, Can.
LAUTENSCHLAGER, Fred. (1915), Mgr. Greenhouse Dept. (for mail) Brunswick-Kroeschell Co., 4221 Diversey Ave., and 3846 Alta Vista Terrace, Chicago, Ill.
LAVAN, P. J. (1921), Heat. Contr., 1319 Eighth Ave., and 4232 Bagley Ave., Seattle, Wash.
LAWRENCE, Chas. E. (1922), N. Y. Sales Mgr. (for mail) Massachusetts Blower Co., 444 Lafayette St., New York, and 52 Waldorf Court, Brooklyn, N. Y.
LeBEAU, John F. (Junior 1921; 1924), Engr. in Charge of Heat. and Vent. Depts. and (for mail) Cascade Automatic Sprinkler Corp., 5844 Grand Central Terminal, and 3505 Rochambeau Ave., New York, N. Y.
LeCOMPTE, William G. (Associate 1914), Mgr. (for mail) Jenkins Bros., 80 White St., and 112 East 81st St., New York, N. Y.
LEEK, Walter (1903), Leek & Co., 1090 Homer St., Vancouver, B. C.
LEES, Herbert K. (Junior 1912; 1924), Estimator (for mail) William Lees, 584 W. Washington Blvd., Chicago, Ill.
LEGIER, Edward W. (1924), Monarch Metal Products Co., 5020 Penrose St., St. Louis, Mo.
LEILICH, Roger L. (1922), Vice-Pres. and Mgr., Baltimore Heat. Corp., 425 St. Paul Pl., and 2810 Elsinor Ave., Baltimore, Md.
LEITCH, Arthur S. (1908), Managing Director, The Arthur S. Leitch Co., Ltd., 1123 Bay St., and 421 Russell Hill Rd., Toronto, Can.
LELAND, William E. (1915), Consulting Engr., 58 Sutter St., San Francisco, Calif.
LENONE, Jose M. (1919), 4808 Dorchester Ave., Chicago, Ill.
LEONHARD, Frederick (1921), Sales Engr. and Mgr., Jas. P. Marsh & Co., 536 East 123rd St., Cleveland, O.
LEVIN, Joseph (Associate 1923), Power Equipment Co., 1015 Chestnut St., Philadelphia, Pa.
LEWIS, Edw. B. (1924), Engr. National Heat. and Vent. Co., 619 Washington Ave., S., Minneapolis, and (for mail) 2283 Commonwealth Ave., St. Paul, Minn.
LEWIS, George C. (1919), Sales Engr. (for mail) American Heat. & Vent. Co., 1505 Race St., Philadelphia, Pa.
LEWIS, J. Clifford (1913), Lewis & Warren (for mail) 1001 Realty Bldg. and Upper River Rd., Louisville, Ky.
LEWIS, L. Logan (1918), Secy. (for mail) Carrier Eng. Corp., 750 Frelinghuysen Ave., Newark and 724 Carlton Ave., Plainfield, N. J.
LEWIS, Samuel R.* (1905; Pres. 1914), (Board of Governors 1909; 2nd Vice-Pres. 1910; Board of Governors 1912; Council 1915), Consulting Engr. (for mail) 407 S. Dearborn St., and 4737 Kimbark Ave., Chicago, Ill.
LEWIS, Thornton (1919), (Council 1923-1924), Vice-Pres. and Gen. Mgr. (for mail) York Heating and Ventilating Corp., 1502 Locust St., Philadelphia, and Merion Sta., Pa.
LIBBY, Lawrence R. (1900), Pres. and Treas., Libby & Blinn, Inc., 135 Sheldon St., and 269 New Britain Ave., Hartford, Conn.
LICHTY, A. J. (Junior 1923), Engr. and Designer, C. A. Dunham Co., 1631 Second Ave., N., and 1011 Tuscaloosa Ave., Birmingham, Ala.
LICHTY, Chas. P. (1920), Mgr. (for mail) C. A. Dunham Co., Br. No. 22, 1631 Second Ave., and 1011 Tuscaloosa Ave., Birmingham, Ala.
LIND, Clarence C. (Junior 1921), Heat. Engr. and Contr., 1653 Mt. Ephraim Ave., Camden, N. J.
LINDEMAN, Henry (Junior 1923), Engr., 157 Foxall St., Ridgewood, L. I., N. Y.
LINDEMUTH, Nelson R. (Associate 1924), Vice-Pres. and Gen. Mgr. (for mail) Lindemuth Engr. Co., Inc., 155 N. George St., and 584 W. Princess St., York, Pa.
LINER, John J. (Associate 1916), Pres. (for mail) Philadelphia Asbestos Co., Roberts Ave., W. of Wayne Ave., Wayne Jct., Philadelphia, Pa., and Hadden Ave., W. Berlin, N. J.
LINHARD, Howard V. (Associate 1921), Dist. Mgr., Utica Heater Co., 1265 Griswold St., and (for mail) 7238 Webb Ave., Detroit, Mich.
LINN, Homer R. (1914), Engr., American Radiator Co., 816 S. Michigan Ave., Chicago, and (for mail) 321 S. Ashland Ave., La Grange, Ill.
LIPPE, Ernest V. (1922), Consulting Mech. Engr., 332 S. La Salle St., Rm. 840, and (for mail) 5340 S. Kimbark Ave., Chicago, Ill.
LIPPMAN, Orville S. (Associate 1920), Sales Repr. (for mail) The Kellogg Mackay Co., 1351 West 37th Pl., and 7251 Princeton Ave., Chicago, Ill.
LISSAUER, Adolph W.* (1918), Pres. (for mail) Louisville Drying Machinery Co., Inc., 451 Baxter Ave., and 2006 Douglass Blvd., Louisville, Ky.
LITTLE, C. W. (1921), Dept. Mgr., Grinnell Co., Inc., 413 Capitol Theatre Bldg., and 489 Eastlawn Ave., Detroit, Mich.
LITTLE, Edwin R. (1916), Consulting Engr., E. R. Little Co., Inc., 1918-1920 Ford Bldg., and 1463 Lawrence Ave., Detroit, Mich.
LOCKE, Hiram W. (1920), Heat. Engr. and Sheet Metal Worker, 1942 North 20th St., Philadelphia, Pa.
LOCKER, Charles W. (1916), Mgr. (for mail) C. A. Dunham Co., Rm. 101, 2845 Grand River Ave., Detroit, and R. F. D. Farmington, Mich.
LOCKETT, John W. (1922), Mgr., Fitzgibbon Boiler Co., Oswego, N. Y.
LOCKWOOD, Edwin H.* (1915), Asst. Prof. Mech. Engr. (for mail) Sheffield Scientific School, Yale University, and 51 Sheldon Terrace, New Haven, Conn.
LOEFFLER, Frank X. (1914), Pres. (for mail) F. Loeffler Supply Co., 5 Empress Theatre Bldg., and 320 West 26th St., Oklahoma City, Okla.
LOHMAN, William J. (Associate 1922), Ozone Purifiers, Deodorizing and Sterilizing, 3849 Cleveland Ave., St. Louis, Mo.
LONDON, Irving (Junior 1924), (for mail) Raisler Heat. Co., 129 Amsterdam Ave., New York, and 1681 President St., Brooklyn, N. Y.
LONG, John A. (1919), Sales Engr., Vapor Vacuum Heat. Co., Otis Bldg., 16th and Sansom Sts., Philadelphia, and (for mail) 8283 W. Chester Pike, Kirklyn, Del. Co., Pa.
LONGENECKER, Howard J. (1917), Pres. and Gen. Mgr. (for mail) York Heating & Ventilating Corp., Bridgeport, Montgomery Co., and 1009 DeKalb St., Norristown, Pa.
LONGWELL, Henry E. (1919), Vice-Pres. (for mail) Pierce, Butler and Pierce Mfg. Corp., Eastwood, and 407 Graves St., Syracuse, N. Y.
LORD, Frank Russell (1922), Mgr. Heat. Dept., Walworth Mfg. Co., 245 Arch St., Philadelphia, Pa., and Delanco, N. J.
LOUGHERY, George B. (1919), *(for mail)* 221 N. Camac St., Philadelphia, and 112 W. Johnson St., Germantown, Pa.
LOVE, Clarence H. (1919), Mfgr. Agt. (for mail) Nash Engr. Co., 840 Ellicott Sq., and 289 Norwalk Ave., Buffalo, N. Y.
LOVELACE, James A. (1920), Vice-Pres. and Gen. Supt., R. L. Spitzley Heat. Co., 246 Larned St., W. Detroit, Mich.
LOWNSBERY, Benjamin F. (1920), Heat. Engr. (for mail) F. Shaw Co., Second and Lombard Sts., and 21 S. Sycamore St., Wilmington, Del.
LUCE, George D., Jr. (1919), Mech. Engr., D. H. Burnham Co., Burnham Bldg., and (for mail) 3633 N. Harding Ave., Chicago, Ill.

LUCK, Alexander W.* (1919), Pres. and Gen. Mgr., Reading Heater & Supply Co., Church and Woodward Sts., Reading, Pa.

LUCKE, C. E. (1924), Prof. Mech. Engr., Columbia University, and 260 Riverside Dr., New York, N. Y.

LUMSDEN, Edward R. (1923), Pres. (for mail) E. R. Lumsden Co., 728 Philadelphia St., and 737 Water St., Indiana, Pa.

LYLE, Ernest T. (1919), Engr. (for mail) Carrier Eng. Corp., 176 Federal St., and The Braemore, 466 Commonwealth Ave., Boston, Mass.

LYLE, J. Irvine* (1911; Pres. 1917), (Council 1918) Treas. and Gen. Mgr. (for mail) Carrier Eng. Corp., 750 Frelinghuysen Ave., Newark, and 1200 W. Seventh St., Plainfield, N. J.

LYMAN, Samuel E. (Associate 1924), Supt. of Erection Philadelphia Territory, Carrier Eng. Corp., 1402 Land Title Bldg., and (for mail) 132 North 50th St., Philadelphia, Pa.

LYMAN, Wm. Ira (Associate 1925), Engr. Grinnell Co., and (for mail) 225½ Scott St., Warren, O.

Mc

McCAFFREY, H. Grattan (1922), Ch. Engr., Sheldons, Ltd., W. Main St., S., Galt, Ont.

McCANN, Frank G. (1903), Council 1914; 1915), Ch. of Heat. and Vent. Div. (for mail) Dept. of Education, Rm. 614, 131 Livingston St., and 1616 East 10th St., Brooklyn, N. Y.

McCARTHY, Charles J. (1919), Contr. (for mail) Otis Bldg., 16th and Sansom St., and 533 South 55th St., Philadelphia, Pa.

McCARTHY, Thos. (1921), Heat. Contr. (for mail) McCarthy & Crandall Plbg. & Heat. Co., 529 S. Cascade Ave., and 444 W. Yampa St., Colorado Springs, Colo.

McCAULEY, James H. (1921), Contr. (for mail) James H. McCauley, Inc., 565 W. Washington Blvd., and 3831 Lexington St., Chicago, Ill.

McCLELLAN, James E. (1922), Sales Engr. (for mail) American Blower Co., 140 S. Dearborn St., and 1321 Ardmore St., Chicago, Ill.

McCLINTOCK, Alexander, Jr. (Junior 1920), Heat. Engr. (for mail) 1937 Ridge Ave., and 121 Rochelle Ave., Wissahickon, Philadelphia, Pa.

McCLINTOCK, Alexander, Sr. (1917), (for mail) A. McClintock & Sons, 1937 Ridge Ave., and 121 Rochelle Ave., Wissahickon, Philadelphia, Pa.

McCLINTOCK, John L. (1917), Heat Engr. (for mail) 1937 Ridge Ave., and 121 Rochelle Ave., Wissahickon, Philadelphia, Pa.

McCLOSKEY, John (1923), 458 48th St., Brooklyn, N. Y.

McCOLL, Jay R.* (1916; Pres. 1922), (2nd Vice-Pres. 1920; 1st Vice-Pres. 1921; Council 1923), Dean of Engr., University of Detroit, Consulting Engr. (for mail) McColl, Snyder & McLean, 2348 Penobscot Bldg., and 825 Chicago Blvd., Detroit, Mich.

McCONNER, Charles R. (Junior 1922; Associate 1925), Mgr. Industrial Dept. (for mail) Clarage Fan Co., 111 W. Washington St., and 536 Brompton Ave., Chicago, Ill.

McCORMICK, Edward T. (Associate 1923), Br. Mgr., Pierce, Butler & Pierce Mfg. Corp., 600 Second Ave., Pittsburgh, Pa.

McCOY, Thomas F. (1924), Mgr. (for mail) The Powers Regulator Co., 263 Summer St., Boston, and Glen Rd., Wellesley Farms, Mass.

McCREA, Lester W. (1920), (for mail) Jas. McCrea & Son, 19 N. Carrollton Ave., and 564 University Parkway, Baltimore, Md.

McCREERY, Hugh Joseph (1922), Dist. Mgr. (for mail) Combustion Eng. Corp., Ltd., 612 Standard Bank Bldg., Vancouver, B. C.

McCULLEY, David E. (Associate 1917), Pres. and Treas. (for mail) D. E. McCulley Co., 1820 St. Mary's Ave., and 5104 Cuming St., Omaha, Neb.

McDONALD, John C. (1920), Br. Mgr. (for mail) U. S. Radiator Corp., 1412 West 12th St., Kansas City, Mo.

McDONNELL, Everett N. (1923), (for mail) McDonnell & Miller, Wrigley Bldg., 410 N. Michigan, Blvd., and Belmont Hotel, Chicago, Ill.

McELLORY, George Sheffler (1925), Engr., R. T. Withers Sons Co., 111 N. Shenango St., and (for mail) 407 Clenmore Blvd., New Castle, Pa.

McEVOY, William J. (1917), Sales Engr. (for mail) Peerless Unit Ventilation Co., 808 Monadnock Block, and 6718 Lakewood Ave., Chicago Ill.

McFARLAND, William P. (Associate 1923), Powers Regulator Co., 2720 Greenview Ave., and (for mail) 1106 Columbia Ave., Chicago, Ill.

McGINNESS, J. E. (1903), Pres. (for mail) McGinness, Smith & McGinness Co., 527 First Ave., and 142 Bellefield Ave., Pittsburgh, Pa.

McGLENN, G. Raymond (1915), Secy., American Warming Ventilating Co., 317-19 Pennsylvania Ave., and (for mail) 259 Lormore St., Elmira, N. Y.

McGOWAN, Thomas F. (1921), Heat. and Contr. Engr., 2832 Girard Ave., Philadelphia, Pa.

McGREGOR, George H. (1920), Mgr. (for mail) Western Heat. Co., 5051 W. Chicago Ave., Chicago, and 902 S. Crescent Ave., Park Ridge, Ill.

McGUIGAN, L. A. (Associate 1919), Salesman, National Radiator Co., 215 Wood St., and (for mail) 724 Hastings St., Pittsburgh, Pa.

McHENRY, Robert W. M. (1921), Asst. Engr., M. F. Thomas, 229 College St., and (for mail) 236 Eglinton Ave., E., Toronto, Ont.

McINTIRE, James F. (Associate 1914; 1915), Vice-Pres. (for mail) U. S. Radiator Corp., 133 E. Grand River Ave., and 2061 Taylor Ave., Detroit, Mich.

McINTOSH, Fabian C. (Junior 1917; 1921), Br. Mgr. (for mail) Johnson Service Co., 10 E. North Diamond St., N.S., and 3335 Portola St., Pittsburgh, Pa.

McINTYRE, Wm. N. (1917), Supt., A. Holtman Heating Co., 700 East 18th St., and (for mail) 6027 Cherry St., Kansas City, Mo.

McKENNA, William N. (1912), Treas. (for mail) Wm. N. McKenna Co., 79 Chestnut St., and 21 W. Cedar St., Boston, Mass.

McKIEVER, Wm. H.* (Junior 1896; 1897), Consulting and Contr. Engr. (for mail) Wm. H. McKiever, Inc., 247 West 13th St., New York, and 479 Eighth Ave., Brooklyn, N. Y.

McLAIN, Roland D. (1921), Heat. Engr., 238 West St., and (for mail) 716 Vernon Ave., Williamsport, Pa.

McLEAN, Dermid (1917), (for mail) McColl, Snyder & McLean, Consulting Engrs., 2348 Penobscot Bldg., and 5140 Ridgewood Ave., Detroit, Mich.

McLEAN, Ivory D. (1924), Pres. (for mail) McLean & Cousens Co., 65 Chandler St., Boston, and 156 Coolidge St., Brookline, Mass.

McLELLAND, H. Burton (Associate 1912), Salesman, Jenkins Bros., 646 Washington Blvd., and 129 N. Menard Ave., Chicago, Ill.

McMAHON, W. W. (Associate 1923), National Regulator Co., 166 Lexington Ave., New York, N. Y.

McMICHAEL, Peter (Associate 1925), Pres. and Mgr., Kewanee Boiler Co., Ltd., 66 Richmond St., E., and (for mail) 41 Spadina Rd., Apt. 7, Toronto, Canada.

McMILLAN, Luther B.* (1918), Consulting Engr. (for mail) Johns-Manville, Inc., 292 Madison Ave., and Larchmont, N. Y.

McMORRAN, Francis J. (1917), In charge of Sales and Eng., Pecco, Inc., St. Louis, and (for mail) 230 E. Argonne Dr., Kirkwood, Mo.

McMURRAY, John (1920), Pres., Iron City Heat. Co., 843 Jackson St., N.S. Pittsburgh, Pa.

McMURRER, Louis J. (Junior 1924), Off. Mgr., The McMurrer Co., 303 Congress St., Boston, and (for mail) 37 Walnut St., Everett, Mass.

McNAIR, Edward E. (1905), (Council 1921-1922; 2nd Vice-Pres. 1923) Vice-Pres. (for mail) U. S. Radiator Corp., 133 E. Grand River Ave., Detroit, Mich.

McPHERSON, Charles J. (1903), Pres. (for mail) W. G. McPherson Co., 19th and Wilson Sts., and 1031 Quimby St., Portland, Ore.

McVEHIL, Earl W. (1923), Mgr., McVehil Plbg. Co., 40 E. Wheeling St., Washington, Pa.

M

MacDADE, Ambrose H. (1923), Salesman, Haynes Selling Co., Inc., 1711 Sansom St., Philadelphia, Pa.

MacDOUGALL, Burgess W. (1923), Mech. Supt., State of New Jersey, State Office Bldg., Trenton, c/o State Dept. of Architecture, and (for mail) 219 Netherwood Ave., Plainfield, N. J.

MACKENSEN, Wm. H. (1923), Estimator and Designer, Huffman-Wolfe Co., 669 N. High St., Columbus, O.

MacKENZIE, Burt (1924), Heat. and Vent. Engr. and Contr. (for mail) B. MacKenzie, 349 N. Elm St., and 347 N. Elm St., Greensboro, N. C.

MACKIE, James (1917), Mgr. (for mail) James Mackie Plbg. and Heat. Co., 357 Langside St., and 254 Montrose St., Winnipeg, Man.

MACON, William W.* (1908), (Secretary 1911, 1912; Board of Governors 1913; Council 1914), Editor (for mail) "Iron Age," 239 West 39th St., New York, and 711 Ave. J, Brooklyn, N. Y.

MAGINN, Peter F. (1908), P. F. Maginn & Co., 207 Fulton Bldg., Pittsburgh, Pa.

MAIER, George M. (1921), Eng.-Planning and Research Dept. (for mail) American Radiator Co., 40 West 40th St., New York, N. Y., and Apt. 54, Peldean Court, Pelham, N. Y.

MALLIS, William (1914), Archt. and Engr., 326 Lyon Bldg., and North Gate Apts., First Ave., W., Seattle, Wash.

MANDEVILLE, Edgar W. (1914), Treas., E. W. Mandeville, Inc., 623 Parkside Ave., and (for mail) 1171 East 37th St., Brooklyn, N. Y.

MANN, Carl P. (1924), Consulting Engr. (for mail) Carl P. Mann, 1217 Race St., Philadelphia, Pa., and Beverly, N. J.

MANSELL, P. C. (1921), (for mail) Purdy-Mansell, Ltd., 63 Albert St., and 26 Grassmere Rd., Toronto, Can.

MANSFIELD, F. A. (Associate 1920), Dist. Mgr. (for mail) The Louis Allis Co., 1213 Bessemer Bldg., and 600 Shady Ave., Pittsburgh, Pa.

MAPPETT, A. S. (Charter Member), Treas., Fowler & Wolfe Mfg. Co., 521 Bulletin Bldg., Philadelphia, Pa.

MARCH, Ralph C. (1919), Asst. Engr. (for mail) Public Service Co., of Northern Illinois, 114 N. Oak Park Ave., Oak Park, and Lombard, Ill.

MARKEL, Frank E. (1923), 412 Rhodes Bldg., Atlanta, Ga.

MARSHALL, H. Hall (1923), Consulting Engr. (for mail) 37 West 43rd St., New York, and 63 Pine St., Garden City, N. Y.

MARTENIS, John V. (1918), Associate Prof. of Mech. Eng., Mech. Eng. Dept., Univ. of Minnesota, and (for mail) 131 Orlin Ave., S.E., Minneapolis, Minn.

MARTIN, Albert B. (1917), Dist. Sales Mgr. (for mail) Kewanee Boiler Co., 822 W. Washington Blvd., Chicago, and 997 Vine St., Winnetka, Ill.

MARTIN, George W. (1911), Pres. (for mail) New York Service Co., 141 East 29th St., New York, N. Y., and 314 Prospect St., Ridgewood, N. J.

MASON, James J. (1918), Dist. Sales Mgr., Utica Heater Co., 707 Union Bldg., Euclid Ave., and (for mail) 936 Whitby Rd., Cleveland, O.

MASON, Orion Augustus (Associate 1922) Vice-Pres. and Sales Mgr., Homer C. Perkins Co., 30 Oliver St., Boston, and (for mail) 30 Vista Ave., Auburndale, Mass.

MATCHETT, James C. (1923), Vice-Pres. and Mgr. (for mail) Illinois Engr. Co., Racine Ave., at 21st St., and 9936 S. Winchester Ave., Chicago, Ill.

MATHEY, Nicholas J. (1915), Heat. and Vent. Engr., Mathey Plbg. Co., 31 Third Ave., N.E., Le Mars, Ia.

MATHIS, Eugene (1922), Pres. and Treas., A. Mathis & Son, Inc., 3151 Shields Ave., and 9151 S. Hoyne Ave., Chicago, Ill.

MATHIS, Henry (1921), New York Blower Co., 2248 S. Halsted St., and (for mail) 143 West 71st St., Chicago, Ill.

MATHIS, Julien W. (Associate 1921), Pres. N. Y. Blower Co., 2248 Halsted St., and (for mail) 7003 S. Peoria St., Chicago, Ill.

MATHY, Joseph, Jr. (1925), Ch. Engr. and Gen. Supt. (for mail) R. B. Hayward Co., 1714 Sheffield Ave., and 3415 West 61st Pl., Chicago, Ill.

MATTHEWS, Charles Russell (1924), Heat. Engr. (for mail) Warren Webster & Co., 220 Devonshire St., Boston, and 48 Dana St., Cambridge, Mass.

MATTHEWS, John K. (1923), Morgan Heat. & Plbg. Co., Box 843, Charleston, W. Va.

MATTHIESSEN, H. G. F. (1923), Hoffman Specialty Co., 512 Fifth Ave., New York, N. Y.

MATZEN, Harry B. (1919), Sales Engr., Carrier Eng. Corp., 1032 Burnham Bldg., La Salle and Randolph Sts., and 1629 Farwell Ave., Chicago, Ill.

MAUER, William J. (1919), Sales Engr., Dwyer Equipment Co., 4534 W. North Ave., Chicago, and (for mail) 2624 Central St., Evanston, Ill.

MAURER, Edward D. (1921), Secy. and Treas., Maurer Bros. Co., 8600 Detroit Ave., Cleveland, and (for mail) 1527 Mars Ave., Lakewood, O.

MAY, Edwin A. (1906), 171 N. Kenilworth Ave., Oak Park, Ill.

MAYER, Robert S. (1911), Br. Sales Mgr. (for mail) Heggie-Simplex Boiler Co., 2026 East 22nd St., and 9327 Amesbury Ave., Cleveland, O.

MEAD, Walter R. (1924), Sales Repr., Hoffman Specialty Co., Waterbury, Conn., and (for mail) 132 Victor Ave., Dayton, O.

MEADOWS, Frank H. (1923), The Meadows Heating Co., 94 Second St., Milwaukee, Wis.

MEDWAY, Fred J. (Associate 1919), Mgr. (for mail) Johns-Manville, Inc., Madison Ave., and 41st St., New York, N. Y., and 803 Boulevard E., Weehawken, N. J.

MEHAFFY, William Chambers (1922), Engr., Chambersburg Const. Co., Chambersburg, Pa.

MEHRING, George (Charter Member), Pres., Mehring & Hanson Co., 162-66 N. Clinton St., Chicago, Ill.

MEIER, Konrad* (1916), Consulting Engr., Rychenbergstrasse 57, Winterthur, Switzerland.

MELLON, James T. J. (1911), (Council 1915), Mellon Co., 4415-21 Ludlow St., and 431 North 63rd St., Philadelphia, Pa.

MENK, Rudolph W. (1919), Mgr., Heating Service & Supply Co., 169 N. May St., Chicago, and (for mail) 118 Buell Ave., Joliet, Ill.

MENSING, Frederick D. (1920), Consulting Engr., Mensing & Co. (for mail) 928 Presser Bldg., and 2845 Frankford Ave., Philadelphia, Pa.

MERKEL, Fred P. (1924), 131 South 12th St., Newark, and (for mail) 2 Garfield Pl., East Orange, N. J.

MERRILL, Carle J. (1919), Treas. and Mgr. (for mail) C. J. Merrill, Inc., 50-56 St. John St., Portland, and 15 Longfellow St., Woodfords, Me.

MERRITT, James H. (1906), Pres. (for mail) Jas. H. Merritt Co., 207 Water St., New York, N. Y., and Bound Brook, N. J.

MERTZ, Walter A. (1919), Secy. (for mail) Kehm Bros. Co., 51 E. Grand Ave., and 3753 N. Keeler Ave., Chicago, Ill.

MERVINE, Thos. R. (1922), Mervine Bros., 208 S. Seventh St., and (for mail) 5852 N. Fifth St., Philadelphia, Pa.

MERWIN, Gile E. (1924), Heat. Engr. (for mail) U. S. Supply Co., and 2437 Fontenelle Blvd., Omaha, Neb.

MEWSHAW, James P. (1923), Br. Sales Office Mgr. (for mail) C. A. Dunham Co., 710 14th St., N.W., and 2700 35th Pl., N.W., Washington, D. C.

MEYER, Hans J. (1919), (Council 1922), Pres., Chas. L. Pillsbury Co., 1200 Second Ave., S., and 2736 Hennepin Ave., Minneapolis, Minn.

MEYER, Henry C., Jr. (1898), (Council 1915, 1916), Consulting Engr., 101 Park Ave., New York, N. Y.
MEYER, John S. (1920), Heat. Dept. (for mail) Aird-Don Co., and 79 Van Buren, Kingston, N. Y.
MEYER, John W., Jr. (1921), Mgr. of Credit and Order Dept., American Blower Co., 6004 Russell St., and 4744 Second Blvd., Detroit, Mich.
MEYERING, Archer S. (1922), Heat. and Vent. Engr. (for mail) Br. Mgr., C. A. Dunham Co., 1721¼ Carey Ave., P. O. Box 477, and 1211 West 31st St., Cheyenne, Wyo.
MEYERS, Samuel H. (Associate 1924), Meyers Bros., 219 Hale St., and 1502 Virginia St., Charleston, W. Va.
MICHAEL, L. A. (1921), Heat. and Vent. Engr. (for mail) 414 W. Colfax Ave., Denver, Colo.
MILLER, Charles A. (Associate 1917), Salesman (for mail) H. B. Smith Co., 10 East 39th St., and 2178 University Ave., New York, N. Y.
MILLER, Charles W. (1919), (for mail) The Rado Co., 194 Reed St., Milwaukee, and R. 1, Box 62, Menomonee Falls, Wis.
MILLER, Edwin A. (Associate 1925), Sales Engr. (for mail) Titusville Iron Works Co., 152 West 42nd St., and Emerson Hotel, 75 St. and Amsterdam Ave., New York, N. Y.
MILLER, Floyd A. (1911), Inspector of Mech. and Elec. Eng., 477 Federal Bldg., Chicago, Ill.
MILLER, Harry M. (1920), Heat. and Vent. Engr., 6089-91 Plankinton Bldg., Milwaukee, and (for mail) 1290 Stowell Ave., Shorewood, Wis.
MILLER, Harvey N. (1921), Sales Engr., Illinois Engr. Co., Racine Ave., at 21st St., Chicago, and (for mail) 744 Lafayette Ave., S.E. Grand Rapids, Mich.
MILLER, James E. (1914), Vice-Pres. (for mail) C. W. Johnson, Inc., 211 N. Desplaines St., Chicago, and 2210 Colfax St., Evanston, Ill.
MILLER, John F. G. (1916), Vice-Pres. and Treas., American Blower Co., 6004 Russell St., Detroit, Mich.
MILLER, Max Paul (1911), (for mail) W. D. Cashin & Co., 35 Hartford St., Boston, and 12 Byfield Rd., Waban, Mass.
MILLER, Robert B. (1922), Pres., 9403 95th St., Woodlawn, L. I., N. Y.
MILLER, William C. (1918), Pres. (for mail) Heating Specialties Co., 10 South 18th St., Philadelphia, and Collegeville, Pa..
MILLIKEN, J. H. (1923), Chicago Dist. Mgr. (for mail) Reed Air Filter Co., 140 S. Dearborn St., Chicago, and 618 Hinman Ave., Evanston, Ill.
MILLIS, Linn W.* (1918), Secy. and Treas., Security Stove & Mfg. Co., 17th and Oakland Sts., and (for mail) 3534 Wabash Ave., Kansas City, Mo.
MILWARD, Robert K. (Associate 1920), Br. Mgr. (for mail) U. S. Radiator Corp., 4004 Duncan Ave., St. Louis, and 434 Lee Ave., Webster Groves, Mo.
MINNICH, Harry S. (1921), Mgr., Philadelphia Br., Richmond Radiator Co., 2241 N. American St., and (for mail) 4526 Walnut St., Philadelphia, Pa.
MITCHELL, Charles H. (1924), Barber Co., 26 Warrenton St., Boston, and (for mail) 179 Thatcher St., Milton, Mattapan P. O., Mass.
MODIANO, Rene (1925), Continental Salesman, (for mail) Carrier Engr. Co., Ltd., 10 Rue Gustave Doré Paris, 17 eme., France.
MOFFETT, William S. (1907), Consulting and Constructing Engr., Staunton, Va.
MOLER, W. H. (Junior 1923), Carrier Eng. Corp., Douglas Bldg., 257 Spring St., Los Angeles, Calif.
MOLO, Harold E. (1922), Mgr. (for mail) Linehan & Molo, 472 Main St., and 305 W. Locust St., Dubuque, Ia.
MONAGHAN, Thomas H. (1914), Pres., Robert Gordon, Inc. (for mail) 22 W. Austin Ave., and 623 Denning Pl., Chicago, Ill.
MONDAY, Charles E. (1920), (for mail) Chas. E. Monday Co., 1320 Olive St., Philadelphia, Pa., and 15 N. Chelsea Ave., Atlantic City, N. J.
MONIN, E. H. (1923), E. H. Monin, Inc., 70 Delaware Ave., Buffalo, N. Y.
MONROE, Lewis O. (Junior 1917), Clarage Fan Co., Kalamazoo, Mich.
MONTAGNA, C. J. (1924), (for mail) 2913 Colonial Ave., and 1215 De Bree Ave., Norfolk, Va.
MONTGOMERY, Walter R. (Associate 1923) Montgomery Bros., 1020 S. Wabash Ave., Chicago, Ill.
MOODY, Lawrence E. (1919), Engr. (for mail) Isaac H. Francis, 1520 Locust St., Bonbright Bldg., Philadelphia, Pa., and 237 Jefferson Ave., Haddonfield, N. J.
MOON, L. Walter (1915), 3834 Olive St., St. Louis, Mo.
MOORE, D. S. (1923), Mgr. (for mail) Flexlume Sales Co., of Md., 901 American Bldg., and Oakley Ave., near Green Spring, Baltimore, Md.
MOORE, H. Lee (1919), Mgr., Buffalo Forge Co., 927 Union Trust Bldg., Pittsburgh, and 7065 Flaccus Rd., Ben Avon, Pa.
MOORE, Herbert S. (Associate 1923), Sales Mgr., The Atlas Engr. and Machine Co., Ltd., 23 River St., and 107 Clendeman Ave., Toronto, Can.
MOORE, Josiah C. (1921), Consulting Equip. Engr. (for mail) Aero Alarm Co., 508 Thompson Bldg., and 2409 E. Prospect St., Seattle, Wash.
MORAN, Frank E. (1922), Pres. (for mail) Ben Rigby, Inc., 604 W. Lake St., Chicago, and 3034 Maple Ave., Berwyn, Ill.
MORAN, F. N. (1916), 128 W. Main St., Staunton, Va.
MORGAN, C. Stanley (Associate 1919), (for mail) 445 W. Larned St., and 14595 Harbord Rd., Detroit, Mich.
MORGAN, Francis H. (1912), Pres. and Treas. (for mail) John F. Morgan & Son, Inc., 67 Blake St., and 194 Maple St., Lynn, Mass.
MORGAN, Glenn C. (1911), Vice-Pres. and Secy. (for mail) Morgan-Gerrish Co., 800-6 La Salle Ave., and 1219 West 24th St., Minneapolis, Minn.
MORGAN, J. Scott (Associate 1922), Mgr. (for mail) Morgan Bros., 7227 Tioga St., and 7031 Hamilton Ave., Pittsburgh, Pa.
MORGAN, Robert C. (1915), Ch. Engr. (for mail) Stewart A. Jellett Co., 1200 Locust St., and 314 W. Seymour St., Philadelphia, Pa.
MORITZ, Carl J. (1921), Engr., Sodemann Heat. & Power Co., 2306 Morgan St., and (for mail) 6923a Garner Ave., St. Louis, Mo.
MORRIS, C. Raymond (1921), (for mail) 55 Lexington Ave., Passaic, and 381 20th Ave., Paterson, N. J.
MORROW, Charles F. (Associate 1919), Mgr. (for mail) National Radiator Co., 1509 Arrott Bldg., Wood and Fourth Ave., Pittsburgh, and Wampum, Pa.
MORSE, C. T. (1921), Sales Mgr., American Blower Co., 6004 Russell St., Detroit, Mich.
MOSHER, Clarence H. (Associate 1919), Dist. Sales Agent, American Schaeffer & Budenberg Corp., 338 Berry St., Brooklyn, and (for mail) 423 Ashland Ave., Buffalo, N. Y.
MOSS, Edward (1920), Supervisor Plbg. and Heat. (for mail) New York Rapid Transit Corp., 1130 Atlantic Ave., Brooklyn, and 9053 204th St., Hollis, L. I., N. Y.
MOTEJL, J. A. (1917), Secy. (for mail) Bd. of Education, 705 First Ave., and 220 16th Ave., Cedar Rapids, Ia.
MOTT, Abram C., Jr. (1921), Pres. (for mail) Abram Cox Stove Co., American and Dauphin Sts., Philadelphia, and "The Woods," Lansdale, Pa.
MOUAT, Thomas G. (1914), Pres. (for mail) Mouat Vapor Heat. Co., 1246 W. Fourth St., and 360 East 105th St., Cleveland, O.
MOULDER, Albert Wm. (1917), Ch. Engr. (for mail) Grinnell Co., Inc., Dana and Paige Ave., and 74 Roosevelt Ave., Warren, O.
MOWER, Wm. P. (1924), Heat. Engr. (for mail) Warren Webster & Co., 220 Devonshire St., Boston, and 48 Middlesex Ave., Swampscott, Mass.

MUELLER, Ben. H. (Junior 1923; Associate 1925), (for mail) 1887 Railway Exchange Bldg., and 4117 Magnolia Ave., St. Louis, Mo.
MUELLER, Paul E. (1919), Pres. (for mail) Paul E. Mueller Co., 320 Park St., and 924 Summit Ave., Milwaukee, Wis.
MUIR, George A. (1917), Engr., Muir & Brooke, 136 W. Lake St., Chicago, and (for mail) 234 S. Scoville Ave., Oak Park, Ill.
MULLEN, Frank J. (1921), Heating Supplies, F. J. Mullen, 1316 Adams St., and 755 Dearborn St., Toledo, O.
MUNDER, J. F., Jr. (Junior 1924), Sales Engr. American Blower Co., 50 Church St., and 1738 University Ave., New York, N. Y.
MUNIER, Leon L. (Junior 1915; 1919), Secy. and Treas. (for mail) Wolff & Munier, Inc., Engr. and Contr., 405 Lexington Ave., New York, and 610 Lafayette Ave., Mt. Vernon, N. Y.
MUNRO, Edward A. (1920), Heat. and Vent. Engr. (for mail) Hutchinson Regulator Co., 506-507 Metropolitan Bank Bldg., and 1717 K. St., N.W., Washington, D. C.
MUNROE, Edward K. (1904), Engr. Salesman, Republic Boiler & Radiator Co., Union Ave., and (for mail) 5924 Bellona Ave., Baltimore, Md.
MUNSON, M. G. (1925), Baxter Bldg., 1005 W. Franklin Ave., Minneapolis, Minn.
MURCH, Greenwood E. (1923), Richardson & Boynton Co., 3639 S. Ashland Ave., and (for mail) Chicago Ath. Assoc., Box 120, Chicago, Ill.
MURPHY, Edward T.* (1915), Vice-Pres., and Gen. Sales Mgr. (for mail) Carrier Engr. Corp., 2021 Land Title Bldg., and 4621 Osage Ave., Philadelphia, Pa.
MURPHY, H. C. (1923), Vice-Pres., Reed Air Filter Co., 215 Central Ave., Louisville, Ky.
MURPHY, Joseph R. (Associate 1925), Sales Repr., Thermal Appliance Co., Inc., 342 Madison Ave., New York, N. Y., and (for mail) 1981 Burlingame Ave., Detroit, Mich.
MURPHY, William R. (1911), Pres. American Heat. & Vent. Co., 804 Times-Dispatch Bldg., Richmond, Va., and (for mail) Rm. 602, 1505 Race St., Philadelphia, Pa.
MURRAY, James M. (1922), Vice-Pres. T. F. Higgins Co., 606 Wabash Bldg., Pittsburgh, Pa.
MURRAY, Thos. F. (1923), Engr., State Archt., and (for mail) 300 Washington Ave., Albany, N. Y.
MUSAUS, John, Jr. (1923), (for mail) J. Musaus Sons, 5912 New Utrecht Ave., and 1242 73rd St., Brooklyn, N. Y.
MUSSELMAN, Joseph F. (1917), Consulting Engr., 101 Park Ave., New York, N. Y.
MUTH, Herbert (1912), Pres. and Treas. (for mail) Muth Heat. & Eng. Co., 4338 N. Western Ave., and 4117 Greenview Ave., Chicago, Ill.
MYERS, David R. (1923), Mgr., W. G. Cornell Co., 19 Patterson St., N.E., and 5629 32nd St., N.W., Washington, D. C.
MYERS, G. W. F. (Junior 1923), Designing and Sales Engr., (for mail) York Heating & Ventilating Corp., 1502 Locust St., and 2233 South 15th St., Philadelphia, Pa.
MYRICK, James W. H. (1909), (for mail) New England Air Conditioning Co., 53 Devonshire St., Boston, and 398 Columbia Rd., Dorchester, Mass.

N

NACEY, Harry M. (1908), Pres. and Gen. Mgr. (for mail) P. Nacey Co., 927 S. State St., and 229 Lake Shore Dr., Chicago, Ill.
NADEN, Lester J. (Junior 1925), Sales Engr., 22 Beverly Ave., Albany, N. Y.
NADER, John H. (1919), (for mail) Crane Co., 30 South 16th St., and 6043 Pershing Ave., St. Louis, Mo.
NAROWETZ, Louis L., Jr. (Associate 1912), Secy. (for mail) Narowetz Heat. & Vent. Co., 1711-17 Park Ave., Chicago, and 118 Park Ave., Park Ridge, Ill.
NATKIN, Benjamin (Junior 1907; 1909), Mgr. (for mail) Natkin Eng. Co., 208 Mutual Bldg., and 3725 Tracy Ave., Kansas City, Mo.
NAYLOR, Ben C. (Associate 1922), Vice-Pres. and Sales Mgr. (for mail) Standard Asbestos Mfg. and Insulation Co., and 3204 Windsor Ave., Kansas City, Mo.
NEILER, Samuel G. (1898), Consulting Engr., Neiler, Rich & Co., 431 S. Dearborn St., Chicago, and 737 N. Oak Park Ave., Oak Park, Ill.
NEITZEL, Carl Wm. (1921), Manager, C. W. Neitzel Co., 525 Erie Bldg., and Belvoir Blvd., S. Euclid Ave., Cleveland, O.
NELSON, Frank, Jr. (1923), Supt., Frank Nelson & Son, 1822 Cherry St., Philadelphia, Pa.
NELSON, Geo. O. (1923), Carstens Bros., Ackley, Ia.
NELSON, Herman W. (1909), Pres. (for mail) Herman Nelson Corp., 1824 Third Ave., and 2500 11th St., Moline, Ill.
NELSON, Ralph L. (1917), Engr. and Sales Repr., Ralph L. Nelson, 506 Empire State Bldg., and 218 W. Buckeye, Spokane, Wash.
NESBIT, David M.* (1895), (Board of Governors 1900), Ashwell & Nesbit, Ltd., Ashwell Lodge, Burkby Lane, Leicester, England.
NESBITT, A. J. (1921), Secy-Treas. (for mail) John J. Nesbitt, Inc., 213 N. Vermont Ave., and 212 Victoria Ave., Atlantic City, N. J.
NESBITT, John J. (1923), Pres., John J. Nesbitt, Inc., 213 N. Vermont Ave., Atlantic City, N. J., and (for mail) Rockfield Farm, Ambler, Pa.
NESDAHL, Ellert (1915), Ch. Engr., Atmospheric Conditioning Corp., 921 Lafayette Bldg., Philadelphia, Pa., and (for mail) 415 Thomas Ave., Riverton, N. J.
NEVINS, J. R. (1921), Archt. and Engr., 1708 Hoge Bldg., Seattle, Wash.
NEWCOMB, Raymond (Junior 1924), New England Mgr., Kewanee Boiler Co., 555 Little Bldg., Boston, and (for mail) 14 Grove St., Belmont, Mass.
NEWPORT, Charles F.* (1906), Sales Engr., Weil, McLain Co., Michigan City, Ind., and (for mail) 10001 Longwood Dr., Chicago, Ill.
NICHOLLS, Percy* (1920), Fuel Section, U. S. Bureau of Mines, Pittsburgh, Pa.
NICHOLS, George B. (1915), (Council 1919-1920), Consulting Engr. (for mail) 296 Madison Ave., and 860 West 181st St., New York, N. Y.
NICOL, N. C. (1923), National Tube Co., 71 Broadway, New York, N. Y.
NIESTRATH, W. H. (Associate 1921), Jos. P. Marsh & Co., 3324 S. Jefferson Ave., St. Louis, Mo.
NILSON, Andrew (1917), Pres., Eureka Smokeless Furnace Co., 3222 N. Halsted St., and (for mail) 5407 Wayne Ave., Chicago, Ill.
NOBBS, Walter W. (1919), 50 Fairhazel Gardens, London, N.W., 6, England.
NOBIS, Harry M. (1914), Heat. Engr. 2010 East 102nd St., and (for mail) 1827 Stanwood Rd., E., Cleveland, O.
NOBLE, Milner (Junior 1924), (for mail) Aerofin Corp., 750 Frelinghuysen Ave., and 80 Broad St., Newark, N. J.
NOLAND, Lloyd U. (1915), Pres. (for mail) Virginia Eng. Co., Inc., 322-330 28th St., and 319 54th St., Newport News, Va.
NOLAND, Ralph W. (1914), Consulting and M. E. Engr. (for mail) 823 24 Lafayette Life Bldg., and 1001 Robert St., Lafayette, Ind.
NORDINE, Louis F. (1914), Sales Engr., Herman Nelson Corp., and (for mail) 1170 25th St., Moline, Ill.
NORRIS, Edward (1909), Utica Heater Co., Utica, N. Y.
NORRIS, James K. (1920), Vice-Pres. (for mail) Utica Heater Co., and 1 Jewett Pl., Utica, N. Y.
NORTON, Arthur E.* (1919), Associate Prof. of Mech. Engr., Rm. 309, Pierce Hall (for mail) Harvard University, Cambridge, and 39 Center Ave., Belmont, Mass.
NORTON, Frederick W. (Junior 1922), Engr., Gillis & Geoghegan, Inc., 537 W. Broadway, New York, and (for mail) 47 Rokeby Pl., Livingston, S. I., N. Y.
NOTTBERG, Henry J. (1919), Secy.-Treas., U. S. Eng. Co., 914 Campbell St., and 213 S. Bales, Kansas City, Mo.

NULSEN, Carl A. (1919), (for mail) Hanley & Co., 6 N. Clark St., and 931 Ainslie St., Chicago, Ill.
NUNAN, John F. (Junior 1921; Associate 1925), (for mail) Jas. Spear Stove & Heat. Co., 1823 Market St., and 238 W. Highland Ave., Chestnut Hill, Philadelphia, Pa.
NUSBAUM, Lee* (1915), Engr. (for mail) Pennsylvania Eng. Co., 1119-21 N. Howard St., and 315 Carpenter Lane, Philadelphia, Pa.

O

OAKS, Orion O. (1917), Ch. Engr., N. Y. Br., (for mail) American Radiator Co., 40 West 40th St., New York, N. Y., and 13 Russell Pl., Summit, N. J.
OBERT, Casin W. (1916), (Secy. 1916-1923) Secy., A. S. M. E. Boiler Code Committee, 29 West 39th St., New York, and (for mail) 122 N. Columbus Ave., Mt. Vernon, N. Y.
O'BRIEN, J. H. (1923), Distr. Mgr. (for mail) American Blower Co., 140 S. Dearborn St., and 6525 Glenwood Ave., Chicago, Ill.
O'CONNELL, Presly M. (1916), Sanitary Engr. (for mail) John Graham, 1501 Dexter Horton Bldg., and 5749 31st Ave., N.E., Seattle, Wash.
O'CONNOR, Jos. M. (1923), 421 Sedgwick Bldg., Wichita, Kan.
O'DONNELL, Thomas J. (1920), Secy. and Treas. (for mail) William H. McKiever, Inc., 247 West 13th St., and 31 Park Terrace, W., New York, N. Y.
OFFICER, H. S. (Associate 1923), Crane Co., 245 Master St., and (for mail) 3841 North 16th St., Philadelphia, Pa.
OFFNER, Alfred J. (1922), Consulting Engr., 1182 Broadway, New York, N. Y.
OGELSBY, William P. (1923), Sales Mgr., Oil City Boiler Works, 1043 Real Estate Trust Bldg., Philadelphia, Pa.
OHMES, Arthur K.* (1913), (Council 1915; 2nd Vice-Pres. 1916; 1st Vice-Pres. 1917), Consulting Engr., 101 Park Ave., New York, N. Y.
OLSEN, A. J. (Junior 1924), C. J. Olsen, 109-111 Center St., and 452 Center St., Winona, Minn.
OLSEN, Carlton F. (Junior 1920; Associate 1925), Sales Engr., Kewanee Boiler Co., 822 W. Washington Blvd., and (for mail) 6238 Evans Ave., Chicago, Ill.
OLSON, Robert G. (1923), Mgr., Milwaukee Office (for mail) American Blower Co., 911 Majestic Bldg., and 802 Farwell Ave., Milwaukee, Wis.
OLVANY, William J. (1912), Engr., and Contr., 100 Charles St., New York, N. Y.
O'NEILL, James Walter (Junior 1925), Repr., The Trane Co., 23 River St., and 207 McRober Ave., Toronto, Ont.
O'NEILL, Peter (1920), Treas. and Mgr., Bartley-O'Neill Co., 224 Third Ave., Pittsburgh, Pa.
ORR, Fred B. (1924), Asst. to Vice-Pres. (for mail) Illinois Maintenance Co., 72 W. Adams St., and 457 Fullerton Pkwy, Chicago, Ill.
ORR, Merrill J. (1917), Pres. and Mgr. (for mail) Orr Co., 513 Jackson St., and 1815 Jackson St., Sioux City, Ia.
ORTH, John W. (1919), Pres. (for mail) Orth Plbg. Co., 509 Columbia St., Lafayette, Ind.
OSBORNE, G. H. (1922), Gen. Mgr. (for mail) The Vent. & Blow Pipe Co., Ltd., 144 Inspector St., Montreal, Que., Can.
OSBORNE, Maurice M. (1925), Osborne & Co., 755 Boylston St., and (for mail) 367 Beacon St., Boston, Mass.
OSMON, Thomas R. (1916), Heat. and Vent. Engr., Spohn Heat. & Vent. Co., 1775 East 45th St., and (for mail) 851 Paxton Rd., Cleveland, O.
OSTRANDER, Lewis F. (1923), Vice-Pres. and Heat. Engr., O-E. Specialty Mfg. Co., 8-14 Keefe Ave., and (for mail) 411 Newberry Blvd., Milwaukee, Wis.
OSWALD, Walter L. (1919), Sales Engr., Crane Co., 23 West 44th St., New York, and (for mail) 652 Hutchinson Blvd., Mt. Vernon, N. Y.
OTIS, Gerald Earle (1922), Ch. Engr., Herman Nelson Corp., Moline, Ill.
OTT, Oran W. (1925), Consulting Mech. Engr. (for mail) 1304 Washington Bldg., and 123 S. Virgil Ave., Los Angeles, Calif.
OTTO, Robert W. (1912), Ch. Engr., Andrews Heat. Co., 2529 University Ave., S.E., Minneapolis, and (for mail) 2147 Carroll Ave., St. Paul, Minn.
OWENS, Charles Beland (1921), Secy. and Mgr. (for mail) Canadian Powers Regulator Co., Ltd., 106 Lombard St., and 25 High Park Blvd., Toronto, Ont.

P

PADGINTON, George (1919), Supervisor of Heat. Plbg., Board of Education, 906 Genesee Bldg., and (for mail) 73 Huntington Ave., N. Y.
PAETZ, Herbert E. (1922), Sales Engr. (for mail) American Blower Co., 1450 David Whitney Bldg., and 5849 Cass Ave., Detroit, Mich.
PAGE, Harry W. (1923), Vice-Pres. and General Mgr., Bayley Mfg. Co., 732 Greenbush St., Milwaukee, and 244 E. Milwaukee Ave., Wauwatosa, Wis.
PAGE, Sidney H. (1923), Mech. and Elect. Engr., 512 Sellwood Bldg., and (for mail) 5407 London Rd., Duluth, Minn.
PAINE, Leonard G. (1920), Mgr. (for mail) C. A. Dunham Co., Otis Bldg., 112 South 16th St., and 5915 Carpenter St., Philadelphia, Pa.
PAINTER, D. Howard (Associate 1924), Salesman, Hoffman Specialty Co., and (for mail) 3039 Harrison St., Kansas City, Mo.
PALMER, Geo. J. (1923), (for mail) 14-16 W. Market St., and 419 S. Walnut St., West Chester, Pa.
PARKER, Philip (1915), Engr. Dept., Braman Dow & Co., 239 Causeway St., Boston, and (for mail) 8 Middle St., Woburn, Mass.
PARKHILL, David (1915), Supt. (for mail) The Graff Furnace Co., 116 Wooster St., New York, and 197 Rutland Rd., Brooklyn, N. Y.
PARKS, Vernon H. (1918), Treas. and Mgr., Meyer Furnace & Supply Co., 1051 St. Louis Ave., and (for mail) 4321 Charlotte St., Kansas City, Mo.
PARROTT, Lyle G. (1922), Const. Engr., McColl, Snyder & McLean, 2348 Penobscot Bldg., and (for mail) 3788 Gladstone Ave., Detroit, Mich.
PARTER, Samuel C. (Junior 1907; 1909), Engr., James H. Merritt & Co., 244 Water St., and (for mail) 642 West 172nd St., New York, N. Y.
PARTLAN, James W. (1916), (for mail) 1255 Park Pl., and 478 Algonquin Ave., Detroit, Mich.
PASK, Raymond J. (Junior 1924), Engr., Wolff Coal Saver Co., 1330 Congress St., and (for mail) 18 S. Homan Ave., Chicago, Ill.
PATERSON, James S. (1922), Heat. Engr. (for mail) Bd. of Education, 155 College St., and 23 Norton Ave., Toronto, Ont.
PATERSON, William B. (Junior 1920; 1921), Asst., H. H. Angus, Consulting Engr., 2 Bloor St., W., and (for mail) 198 St. Germain Ave., Toronto, ont.
PATORNO, S. A. S. (1923), Heat. and Vent. Engr. (for mail) Meyer, Strong & Jones, Inc., 101 Park Ave., and 150 East 50th St., New York, N. Y.
PATTERSON, D. Finley (Junior 1923), (for mail) V. N. Welamb Co., 2313 Walnut St., and 6428 N. Woodstock St., Philadelphia, Pa.
PEABODY, Ernest H. (1920), (for mail) Peabody Eng. Corp., 110 East 42nd St., New York, and 557 Pelham Manor Rd., Pelham Manor, N. Y.
PEACOCK, Jas. K. (1921), Mgr. New York Br. (for mail) Hoffman Specialty Co., 512 Fifth Ave., New York, and 440 Fowler Ave., Pelham Manor, N. Y.
PEARCE, C. E. (1911), Ch. Engr., Guilbert & Betelle, Archts., Chamber of Commerce Bldg., Branford Pl., Newark, and (for mail) 1255 Clinton Pl., Elizabeth, N. J.
PEARSON, Harry D. (1917), Pres. and Treas., Michigan Warm. & Vent. Co., 317 Kelsey Bldg., Grand Rapids, Mich.

PEASE, Harrison H. (Associate 1922), Commercial Trust Bldg., and (for mail) 8409 Shawnee St., Chestnut Hill, Philadelphia, Pa.
PEASE, John G. (1917), John G. Pease Co., 308 Broadway, and 1718 East 59th St., Kansas City, Mo.
PECKHAM, Randolph R. (1919), Supt. (for mail) 650 W. Baltimore Ave., and 3018 Hogarth Ave., Detroit, Mich.
PEEBLES, John K. (Junior 1924; Associate 1925), Peebles & Ferguson, 733 Law Bldg., Norfolk, Va.
PENSINGER, Luther C. (Associate 1925), Burdick Pensinger Co., 3409 East 18th St., and 19 West 62nd St., Kansas City, Mo.
PERHAM, Stanly H. (1920), Associate Engr. (for mail) Charles R. Ammerman, 925 Continental Bank Bldg., and 4507 Carrollton Ave., Indianapolis, Ind.
PERKINS, Fred C. (Associate 1923), Perkins-LeNoir Co., Pres. (for mail) Perkins-LeNoir Co., 1068 Drexel Bldg., Philadelphia and Lansdowne, Pa.
PETERKIN, Stuart MacC. (1922), Engr., C. A. Dunham Co., 229 College St., and (for mail) 71 Deloraine Ave., Toronto, Ont.
PETERMAN, Robert M. (1917), Engr., School Dist. of Philadelphia, 19th St., above Chestnut, Philadelphia, and (for mail) 205 Lauriston St., Wissahickon, Pa.
PETERS, Harry G. (Associate 1924), (for mail) Peters Heating Co., P. O. Box 763, and 638 N. Congress St., Jackson, Miss.
PETERSEN, Gustave (Associate 1916), Treas. and Gen. Mgr. (for mail) Heat. and Vent. Magazine, 1123 Broadway, New York, N. Y., and 216 11th St., Hoboken, N. J.
PETERSON, Evan A. (1923), Sales Engr., Crane Ltd., 386 Beaver Hall Sq., and 122 Kenaston Rd., Town of Mount Royal, Montreal, Que.
PETERSON, H. K. (1920), Heat. Engr., Nelson Co., 2604 Fourth Ave., and (for mail) 14572 Coyle Ave., Detroit, Mich.
PETHERICK, David H. (Associate 1916), Salesman, U. S. Radiator Corp., 517 Dime Bank Bldg., Detroit, and 9 Kenberton Dr., Pleasant Ridge, Mich.
PETICOLAS, Lloyd D. (1925), Heat. and Vent. Engr., Thomas Haverty Co., Eighth St., and Maple Ave., and 1589 West 49th St., Los Angeles, Calif.
PFEIFFER, Jos. F. (1921), (for mail) Jos. F. Pfeiffer Steam & Hot Water Heat. Co., 1140 California St., and 717 Vine St., Denver, Colo.
PFUHLER, John L. (Junior 1923; Associate 1925), 600 Manor Rd., W. New Brighton, S. I., N. Y.
PHEGLEY, Frank G. (1913), (Council 1918-1919) Research Engr., Hart-Crouse Co., 301 Turner St., Utica, N. Y.
PHILLIPS, Frank T. (1919), Sales Engr. (for mail) American Radiator Co., 25th and Reed Sts., Philadelphia, Pa., and 827 Belmont Ave., Collingswood, N. J.
PHILLIPS, Frederic W., Jr. (1921), Engr. (for mail) E. W. Mandeville, Inc., 623 Parkside Ave., and 825 East 38th St., Brooklyn, N. Y.
PHILLIPS, Lee (1920), Heat. Engr., 308 Ferguson Bldg., 319 Third Ave., Pittsburgh, and Terrace Ave., Carnegie, Pa.
PICKETT, Clinton A. (Associate 1923), Sales Engr. (for mail) The Herman Nelson Corp., 510 Rialto Bldg., and 8003 Canton Ave., Vinita Park St., Louis, Mo.
PIERCE, Frank J. (1921), Mgr. Heat. Dept., The W. M. Pattison Supply Co., 777 Rockwell Ave., Cleveland, and (for mail) 1543 Belle Ave., Lakewood, O.
PIERCE, E. F. (Junior 1925), Hoffman Specialty Co., 72 Lynn Fells Parkway, Melrose, Mass.
PIERON, Anton (1921), Heat. and Vent. Engr., Warren & Wetmore, 16 East 47th St., New York, and (for mail) Sterling Pl., St., Albans, N. Y.
PINDER, Percy H. (1919), Treas. (for mail) Standard Steam Specialty Co., 366 Third Ave., New York, N. Y., and 12 Forest Rd., Ridgewood, N. J.
PINES, Sidney (1920), Asst. Mgr. (for mail) Natkin Eng. Co., 208 Mutual Bldg., and 5012 Forest Ave., Kansas City, Mo.
PIPER, Albert (1920), Plbg. and Heat. Contr. Piper Bros., 340-346 N. Broad St., Trenton, N. J.
PIPER, Edmund R. W. (Associate 1920), Plbg. and Heat. Contr., Piper Bros., 340-346 N. Broad St., Trenton, N. J.
PITCHER, Lester J. (Junior 1924), Chief Draftsman, Illinois Engr. Co., 21st and Racine Ave., and (for mail) 7214 East End Ave., Chicago, Ill.
PITTELKOW, Arthur G. (1907), Pres. (for mail) Pittelkow Heat. & Eng. Co., 2340 W. Lafayette Blvd., and 355 Chalmers Ave., Detroit, Mich.
PLACE, Clyde R. (1924), Consulting Engr. (for mail) Clyde R. Place, Grand Central Terminal, and 35 Fifth Ave., New York, N. Y.
PLACE, Herman R. (1924), Vice-Pres., Sprague Bates Place Co., 28 Union St., Boston, and (for mail) 835 Watertown St., West Newton, Mass.
PLAYFAIR, G. A. (Associate 1924), Mgr., Johnson Temperature Reg. Co., of Canada, Ltd., 147 Church St., and 64 Cairns Ave., Toronto, Ont.
PLEWES, Stanley E. (1917), Br. Mgr. (for mail) Johnson Service Co., 258 S. Van Pelt St., Philadelphia, and Evergreen Rd., Jenkintown, Pa.
PLUNKETT, John H. (1925), Chief of Bldg. and Boiler Inspection, Dept. of Public Safety, Rm. 24, State House, Boston, and (for mail) 81 Woodrow Ave., Dorchester, Mass.
POOL, Sterling H. (1913), Pres., Howard F. Pool Co., 5 Market St., Lynn, Mass.
POOLE, Ernest F. (1921), Engr. (for mail) F. P. Sheldon & Son, 1009 Hospital Trust Bldg., and 230 Lockwood St., Providence, R. I.
POPE, S. Austin (1917), Contr. Engr. (for mail) 26 N. Jefferson St., Chicago, and 410 N. Ashland Ave., River Forest, Ill.
POPE, William A. (1906), Contr., Engr., 26 N. Jefferson St., Chicago, Ill.
PORTER, Brayton A. (1922), Sales Engr., Kewanee Boiler Co., 510 Real Estate Trust Bldg., and (for mail) 4624 Hutchinson St., Philadelphia, Pa.
PORTER, Ray L. (1919), Supt., Belden, Porter, Gray Co., 65 North 17th St., Minneapolis, Minn.
POSEY, James (1919), Consulting Engr. (for mail) James Posey, 1309 Lexington Bldg., and 4005 Liberty Heights Ave., Baltimore, Md.
POTTINGER, C. T. (1917), Dist. Mgr., American Blower Co., 614-615 Bona Allen Bldg., Atlanta, Ga.
POWERS, Fred I. (1920), Salesman, Box 324, Bozeman, Mont.
POWERS, Fred W. (1911), (Council 1918-1919), Treas., Powers Regulator Co., 2720 Greenview Ave., Chicago, Ill.
PRATT, Edwin D. (1922), Asst. to Gen. Mgr., Childs Restaurants, 200 Fifth Ave., New York, and (for mail) 283 Glen Ave., Port Chester, N. Y.
PREBLE, J. Jarvis (1919), Asst. to the Pres. (for mail) Spray Eng. Co., 60 High St., Boston, and 38 Bowdoin St., Newton Highlands, Mass.
PRICE, Frank E. (Associate 1922), Mgr. Heat. Dept., Denver Br. Standard Sanitary Mfg. Co., 1730 Blake St., and (for mail) 1544 Jasmine St., Denver, Colo.
PROBST, Alfred H. (1919), Sales Engr. (for mail) Morgan-Gerrish Co., 800-6 LaSalle Ave., and 2902 James Ave., S., Minneapolis, Minn.
PROX, Robert F. (Junior 1922; 1923), Vice-Pres. (for mail) Frank Prox Co., and 1608 S. Fourth St., Terre Haute, Ind.
PRYOR, Frederick L. (1913), Advisory (for mail) National Silk Dyeing Co., 5 Colt St., Paterson, and Towaco, Morris Co., N. J.
PRYOR, Robert W., Jr.* (1913), (Council 1919-1920) Mech. Engr. (for mail) Kolthan & Pryor, 39 Cortlandt St., New York, N. Y., and 199 Roseville Ave., Newark, N. J.
PURCELL, Arthur J. (1914), Heat., Plbg. and Steam Spec. Repr., 631 New Britian Ave., Hartford, Conn.
PURCELL, Robert E. (1916), Heat. Vent. and Plbg. Contr., 1735 Willis Ave., W., and (for mail) 128 Avery Ave., Detroit, Mich.

PURDY, Alexander K. (1922), Pres. (for mail) Purdy, Mansell, Ltd., 63 Albert St., and 30 Glenrose Ave., Toronto, Ont.
PURINTON, Dexter J. (Associate 1923), Head of Mech. Dept. (for mail) McKenzie, Voorhees & Gmelin, 342 Madison Ave., New York, N. Y., and 23 Sachem Rd., Greenwich, Conn.
PURSELL, H. E. (1919), Br. Mgr., Kewanee Boiler Co., 1226-1228 California St., Denver, Colo.
PYLE, John W. (1919), Supt. (for mail) Peru Heat. Co., 30 W. Canal St., and 371 W. Third St., Peru, Ind.

Q

QUAY, D. M.* (Charter Member; Pres. 1909), (2nd Vice-Pres. 1895; 1st Vice-Pres. 1896), (for mail) D. M. Quay Co., Bulkley Bldg., and 1352 East 84th St., Cleveland, O.
QUENTIN, Edward H. (Associate 1919), Mgr. (for mail) Johnson Heat Regulating Co., 14 North 12th St., and 3259 Geyer Ave., St., Louis, Mo.
QUIGLEY, William J. (1920), Salesman, Gurney Heater Mfg. Co. (for mail) P. O. Box 184, Buffalo, and 27 Knowlton Ave., Kenmore, N. Y.
QUIRK, Clinton H. (1916), Vent. and Mech. Engr. (for mail) Howard & Morse, Inc., 45 Fulton St., New York, and Kilburn Rd. S., Garden City, L. I., N. Y.

R

RAE, Thos. W. (1924), Salesman (for mail) American Radiator Co. (for mail) P. O. Box 882, and 617 West 14th St., Oklahoma City, Okla.
RAINE, John J. (1912), G. S. Blodgett Co., Burlington, Vt.
RAINGER, Wallace F. (Junior 1924), Ch. Draftsman, Jaros & Baum, 116 West 39th St., New York, and (for mail) 155 Livingston Ave., Yonkers, N. Y.
RAISLER, Samuel (1921), Pres., Raisler Heat. & Sprinkler Co., 129 Amsterdam Ave., and (for mail) 202 Riverside Dr., New York, N. Y.
RASMUSSEN, Einar (Junior 1925), Draftsman, Westinghouse Elec. & Mfg. Co., E. Pittsburgh, and (for mail) 518 Todd St., Wilkinsburg, Pa.
RATHER, Max, F. (1919), Mgr. Cleveland Office, Johnson Service Co., 2028 East 22nd St., Cleveland, and 3098 Huntington Rd., Shaker Heights, O.
REARDON, J. Albert (1921), Pres., Reardon Bros. Co., Mfgs. National Bank, 341 Union St., Lynn, Mass.
RECK, Anders B.* (1899), Pres. (for mail) Reck Heat. Co., Ltd., 15 Esromgade, Copenhagen, and Christianavei 16, Hellerup, Denmark.
REDERER, Benedict S. (1922), (for mail) B. S. Rederer & Co., 513 Arrott Bldg., and 1515 Rockland Ave., Pittsburgh, Pa.
REED, J. F. (Associate 1923), Vice-Pres. (for mail) Reed Air Filter Co., 50 Church St., New York, N. Y., and 63 Watchung Ave., Montclair, N. J.
REEDER, Charles L. (1911), Consulting Engr. (for mail) 916 N. Charles St., Baltimore, and 222 Longwood Rd., Roland Park, Md.
REEDER, Frank C. (Associate 1919), Spec. Factory Repr., The Fulton Co., and (for mail) 204 E. Oklahoma Ave., Knoxville, Tenn.
REESE, Henry L. (1923), Gen. Mgr., Keystone Plbg. & Heat. Co., 1115 Union St., and (for mail) 835 Pear St., Reading, Pa.
REEVES, Charles G. (1916), 257 W. Clapier St., Germantown, Pa.
REICHWALD, Charles W. (1923), Heat. Engr., C. W. Reichwald, Inc., 3637 Blvd., Jersey City, and (for mail) Adeline Pl., North Bergen, N. J.
REINHARD, E. L. (1919), Br. Mgr. (for mail) American Radiator Co., 220 Delaware Ave., and 99 Lincoln Blvd., Buffalo, N. Y.
REPP, Harry Leroy (1922), Br. Mgr., U. S. Radiator Corp., 908 N. Senate Ave., and 824 East 42nd St., Indianapolis, Ind.
REUSS, Edward H., Jr. (1921), Heat. Contr. (for mail) E. H. Reuss, Jr., 30th and Race Sts., and Bryn Mawr and Woodbine Aves., Philadelphia, Pa.
REUTER, Albert G. (1922), Sales Engr., Daly Co., 1425 16th St., and (for mail) 702 S. Corona St., Denver, Colo.
REYNOLDS, Henry M. (1915), Vice-Pres., General Boilers Co., Waukegan, Ill.
REYNOLDS, Thurlow W. (1922), Mech. Engr., D. D. Kimball Co., 15 West 38th St., and (for mail) 242 East 23rd St., New York, N. Y.
RHODES, Solomon V. (1921), Supt. of Heat. (for mail) Farrell Heat. & Plbg. Co., 25 Houston St., and 45 E. Cain St., Atlanta, Ga.
RIBLET, William H. (Associate 1921), East. Div. Mgr. (for mail) C. A. Dunham Co., 101 Park Ave., and 32 West 40th St., New York, N. Y.
RICE, Clarence J. (Associate 1923), Pres. (for mail) Sterling Engr. Co., 1640 Halton St., Milwaukee, and 2425 Thompson Ave., Whitefish Bay, Wis.
RICE, Edmund T. (1920), Heat. and Vent. Engr. (for mail) Jas. Spear Stove & Heat. Co., 1823 Market St., and 838 South 56th St., Philadelphia, Pa.
RICE, William W. (1915), Engr., Mellon Co., 4419 Ludlow St., Philadelphia, and (for mail) Morgan Ave., above State Rd., Drexel Hill, Del. Co., Pa.
RICHARDS, Frank A. (1920), Sales Engr. (for mail) Richards & Wolfe, The Herman Nelson Corp., 832 Atlas Bldg., and 2612 Glen Echo Dr., Columbus, O.
RICHARDS, S. Frank (1915), East. Sales Repr., H. A. Thrush & Co., Peru, Ind., and (for mail) 335 W. Riverview Ave., Bellevue Br., Pittsburgh, Pa.
RICHARDSON, A. Howard (Associate 1922), 2nd Vice-Pres. (for mail) Richardson & Boynton Co., 3639 S. Ashland Ave., and 1302 Ritchie Ct., Chicago, Ill.
RICHARDSON, David R.* (1915), Pres., Richardson & Boynton Co., 260 Fifth Ave., New York, N. Y.
RIDLER, Harry C. (1919), Plbg., Heat. and Vent. Engr. and Mfgr. (for mail) 310 West 33rd St., and 3248 Pleasant Ave., Minneapolis, Minn.
RIETZ, Elmer W. (1923), Sales Engr. (for mail) 2720 Greenview Ave., and 5246 Glenwood Ave., Chicago, Ill.
RILEY, Albert H. (1919), Supt. Heat. and Vent. (for mail) Bd. of Education, Ninth and Locust Sts., and 6235 Dowler Ave., St. Louis, Mo.
RILEY, Champlain L.* (1906; Pres. 1921), (Council 1918-1919; 1st Vice-Pres. 1920), and (for mail) Clark, MacMullen & Riley, 101 Park Ave., New York, N. Y., and Plainfield, N. J.
RILEY, DeWitt H. (1921), Engr., Research Dept., American Radiator Co., 1807 Elmwood Ave., and (for mail) 815 Tonawanda St., Buffalo, N. Y.
RINKENBERGER, G. (1924), Vice-Pres. and Mgr. (for mail) Paul Plbg. & Heat. Co., 811 Railroad St., and 831 Franklin St., Johnstown, Pa.
RITCHIE, Edmund John (1923), (for mail) Sales Mgr., Sarco Co., Inc., Woolworth Bldg., New York, and 140 East 19th St., Brooklyn, N. Y.
RITCHIE William (1909), Vice-Pres., Boynton Furnace Co., 58 West 40th St., New York, N. Y., and 17 Van Reipen Ave., Jersey City, N. J.
RITTER, Arthur (1911), N. Y. Mgr. (for mail) American Blower Co., 50 Church St., New York, and 699 Ocean Ave., Brooklyn, N. Y.
ROBB, John M.* (1913), Heat. Engr., 1513 Columbia Terrace, Peoria, Ill.
ROBBINS, Loring G. (1907), Robbins, Gamwell & Co., 68 West St., Pittsfield, Mass.
ROBERTS, Henry L. (1916), Engr. and Contr., 228 North 16th St., Philadelphia, Pa.
ROBERTS, Wm. L. (1923), 183 Harrison Ave., Boston, and (for mail) 85 Baker St., West Roxbury, Mass.
ROBERTSON, George A. (1902), Acting Supv. Heat. and Vent. Inspector, Bd. of Education, Bureau of Plant Operation (for mail) 131 Livingston St., and 1081 East 39th St., Brooklyn, N. Y.

ROBINSON, Albert G. (1924), (for mail) 4 Thomson Block, and 18 Harrison Ave., Glen Falls, N. Y.
ROBINSON, S. Whitmore (Associate 1902; 1910), Consulting Engr., 10 Kilburn Priory, London, N.W., England.
ROCKART, Edward R. (1921), Mech. Engr., Minneapolis Bd. of Education, 245 Ninth Ave., N., Minneapolis, and (for mail) 1173 Arkwright St., St. Paul, Minn.
RODMAN, Robert W. (1922), Supt. of Plant Operation, Bd. of Education, 500 Park Ave., and 2102 Broadway, New York, N. Y.
ROEBUCK William, Jr. (1917), Associate Engr., The R. T. Coe Companies, Cutler Bldg., and Richford Hotel, Rochester, N. Y.
ROGERS, A. Carle (1921), Consulting Engr., Power Plants Heat. and Vent., 752 Euclid Ave., Toledo, O.
ROGERS, C. W. (1921), Secy. (for mail) N. Y. Blower Co., 2248 S. Halsted St., and 420 Aldine St., Chicago, Ill.
ROGERS, George H. (1920), Salesman and Heat. Engr., International Heater Co., and (for mail) Linthicum Heights, Md.
ROLLINS, Fred D. (1919), 4107 Washington Blvd., Chicago, Ill.
ROLLINS, Lewis M. (1916), Morris & Co., Union Stock Yards, and (for mail) 218 N. Milton St., St. Paul, Minn.
RONEY, Thomas G. (1916), T. G. Roney Heat. Co., 3461 Fort St., W., and 748 25th St., Detroit, Mich.
ROONEY, Martin A. (1918), Sales Engr. (for mail) American Radiator Co., 1807 Elmwood Ave., Buffalo, and Eggertsville, N. Y.
ROSEBROUGH, Robert M. (1920), Br. Mgr. (for mail) L. J. Mueller Furnace Co., 1409 Olive St., and 5502 Maple Ave., St. Louis, Mo.
ROSENBACH, Rudolph G. (1920), Sales Engr. (for mail) Warren Webster & Co., 549 Washington St., and 343 York St., Elmhurst, Ill.
ROSS, John O. (1920), Pres. and Gen. Mgr. (for mail) J. O. Ross Engr. Corp., 30 East 42nd St., New York, and 875 West End Ave., New York, N. Y.
ROSSMAN, Vincent D. (1919), Secy. (for mail) Modern Heat. Co., 3935 Olive St., and 2365 Klemm St., St. Louis, Mo.
ROTHROCK, John T. (1920), Supt. Mech. Engr., Thompson-Starrett Co., Packard Bldg., Philadelphia, Pa.
ROTZ, John M. (1918), Consulting Engr., Snider & Rotz, 703 Merchants Bank Bldg., and 3930 Broadway, Indianapolis, Ind.
ROW, Oliver M. (1912), Director, Royles, Ltd., Heat Specialists, Irlam, near Manchester, England.
ROWE, William A. (1921), Ch. Engr., American Blower Co., 6004 Russell St., and 7477 Churchill Ave., Detroit, Mich.
ROWLEY, Frank B.* (1918), Prof. of Mech. Eng., and Director of Experimental Eng. Laboratories, University of Minnesota, and (for mail) 63 Barton Ave., S.E., Minneapolis, Minn.
RUCKEL, John B. (Associate 1919), Pres. (for mail) J. H. Ruckel & Son, 81-83 Main St., and 183 Cleveland Ave., Buffalo, N. Y.
RUDDELL, Wm. H. (1921), Mgr., West Coast Heat. Co., Inc., 1627 Fourth Ave., and 308 Newton St., Seattle, Wash.
RUDIO, H. M. (1921), (for mail) Carrier Eng. Corp., 39 Cortlandt St., New York, and 142 Winspear Ave., Buffalo, N. Y.
RUFF, Dewitt C., 2nd (1922), (for mail) Healy-Ruff Co., 765 Hampden Ave., and 211 St. Clair St., St. Paul, Minn.
RUGART, Karl F. (Associate 1924), Sales Engr., Warren Webster & Co., 17th and Federal Sts., Camden, N. J., and (for mail) 5830 Willows Ave., Philadelphia, Pa.
RUPPERT, E. H. (Associate 1923), Salesman, Excelso Specialty Works, Inc., 210 East 45th St., New York, and (for mail) 85 Eastern Parkway, Brooklyn, N. Y.
RUSSEL, Donald Peters (1924), Heat. and Vent. Engr. (for mail) Thomas Haverty Co., 316 E. Eighth St., Los Angeles, and 451 Edwards Ave., Wilmar, Calif.
RUSSELL, Hugh G. (1911), Inspector Mech. and Elec. Engr., Supv. Archt. Office (for mail) U. S. Treasury Dept., Post Office Bldg., and 909 East 10th St., Chattanooga, Tenn.
RUSSELL, Joseph N. (1899), Mgr., Rosser & Russell, Ltd., 37 Duke St., Osford St., London, W. 1, England.
RUSSELL, William A. (1921), Asst. Gen. Mgr. Sales, U. S. Radiator Corp., 133 E. Grand River Ave., and (for mail) 2484 Pingree, Detroit, Mich.
RUSSELL, William Arthur (Charter Member), Pres. (for mail) W. A. Russell & Co., Grand Central Terminal Bldg., 70 East 45th St., New York, and 563 Palisade Ave., Yonkers, N. Y.
RUSSELL, W. L. A. (Associate 1925), Sales Mgr. (for mail) Skinner Bros. Mfg. Co., Inc., 1474 S. Vandeventer St., and 5605 Etzel Ave., St. Louis, Mo.
RUSSELL, Willard E. (1921), Mgr., C. A. Dunham Co., 219 E. Hanover St., Hunt Bldg., Trenton, N. J.
RYAN, Harry J. (1922), Sales Engr., 91 Elm St., Albany, N. Y.
RYAN, Henry B. (1920), Vice-Pres., Barry, Byrne & Ryan Co., 104 S. Michigan Ave., Chicago, and 170 Fuller Lane, Winnetka, Ill.

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SABIN, Edward R. (1919), Pres. (for mail) Edward R. Sabin & Co., 4710 Market St., Philadelphia, and S.E. Cor. Plumstead and Owen Aves., Lansdowne, Pa.
SACHLEBEN, Edward H. (Associate 1921), E. H. Sachleben & Co., 1517 Olive St., St. Louis, Mo.
SAKOUTA, Mathieu L. (1923), Consulting Engr. and Expert (for mail) Gavan, Simanskaia 4, Lenigrad, Russia.
SANBERN, Edward N. (1923), Engr., Mensing & Co. (for mail) 928 Presser Bldg., Philadelphia, Pa., and 119 Haviland Ave., Audobon, N. J.
SANBORN, Stephen H. (Associate 1924), (for mail) S. H. Sanborn Engr. Co., 123 E. Main St., P. O. 289, Middletown, N. Y.
SANFORD, Arthur L. (1915), Mech. Engr. (for mail) Bd. of Education, 245 Ninth Ave., N., and 310 East 48th St., Minneapolis, Minn.
SANTMYER, W. J. (1921), Supt., Steam Heat. Div., Puget Sound Power and Light Co., Electric Bldg., Seventh and Olive Sts., Seattle, Wash.
SANVILLE, Chas. P. (1922), Sales Engr. (for mail) Schade Valve Mfg. Co., 2527 N. Bodine St., and 1456 Sparks St., Philadelphia, Pa.
SARGENT, Leonard F. (1919), Mgr., National Heat. & Vent. Co., Box 103, Wausau, Wis.
SAULSON, Saul (1916), Mech. Engr., Albert Kahn, Inc., 1000 Marquette Bldg., and 2491 W. Euclid, Detroit, Mich.
SAVILLE, Thos. H. (1924), (for mail) International Correspondence, Vent. Schools, and 1121 Lafayette St., Scranton, Pa.
SAWADE, Carl A. (Associate 1920), Mgr. Boiler Sales (for mail) Continental Heater Corp., Dunkirk, and 35 Curtis Pl., Fredonia, N. Y.
SAWDON, Will M. (1920), Prof. Exp. Eng. (for mail) Cornell University, and 1018 E. State St., Ithaca, N. Y.
SCANLON, John J. (Associate 1924), Ames Iron Works, 1035 Commercial Trust Bldg., 30 South 54th St., Philadelphia, Pa.
SCHEER, Fred'k W. (1922), Heat. Contr., 12 Brayton St., and 412 Vermont St., Buffalo, N. Y.
SCHEIBEL, Albert H. (1919), Asst. Mech. Engr., Stone & Webster, 147 Milk St., Boston, and (for mail) 92 Milton Ave., Hyde Park, Mass.
SCHEIDECKER, Daniel B. (Associate 1919), Salesman (for mail) Bayley Mfg. Co., Rm. 1156, 38 S. Dearborn St., and 4626 N. Kilbourn Ave., Chicago, Ill.
SCHELLHAMMER, Alfred L. (1919), Schellhammer & Co., Warren, Pa.

SCHILDMILLER, George H. (1922), (for mail) Asst. Mgr., Detroit Br., American Radiator Co. 400 Barlum Bldg., Detroit, and 912 Yorkshire Rd., Birmingham, Mich.
SCHLEMMER, Oliver H. (1906), 8442 Curzon Ave., Hartwell, Cincinnati, O.
SCHLEY, Arthur A. (1920), Mgr. Heat Dept., Schley & Nash Co., 709 Columbia Bank Bldg., Pittsburgh, Pa.
SCHLUTER, H. (Associate 1921), Ames Iron Works, Rm. 1010, 41 East 42nd St., New York, and (for mail) 588 P. O. B., Harrison, N. Y.
SCHMIDT, George G. (Junior 1912; 1914), (for mail) Gen. Eastern Repr., McCann-Harrison Corp., 39 Courtlandt St., New York, and 67 Burn St., Forest Hills, L. I., N. Y.
SCHNEIDER, Charles (1923), C. Schneider Co., 492 East 163rd St., New York, N. Y.
SCHNEIDER, Paul W. (1919), 16 Pearl St., Utica, N. Y.
SCHOENIJAHN, Robert P. (1919), Consulting Engr. (for mail) Industrial Trust Bldg., 10th and Shipley Sts., and 7 Crawford Circle, Wilmington, Del.
SCHOEPFLIN, Paul H. (1920), Pres. (for mail) Niagara Blower Co., 673 Ontario (Ontario at N. Y. C. Tracks), and 155 Fordham Dr., Buffalo, N. Y.
SCHOPP, Walter J. (1922), General Eng. & Contr. Co., 419 Perry Bldg., Philadelphia, Pa.
SCHRADER, Charles C.* (Junior 1923; Associate 1925), Research Engr. (for mail) Armstrong Cork & Insulation Co., Argo Laboratory, Gloucester, N. J., and 4842 N. Fifth St., Philadelphia, Pa.
SCHROTH, August H. (1911), Sales Mgr., Richmond Radiator Co., 1480 Broadway, New York, N. Y., and (for mail) 90 S. Parkway, East Orange, N. J.
SCHULZ, Howard I. (Associate 1915), Local Mgr. (for mail) Crane Co., 1217 W. Broad St., Richmond, Va.
SCHULZE, Ben. H. (1921), Sales Engr., Hester-Bradley Co. (for mail) 4200 Forest Park Blvd., and 1914 Forest Ave., St. Louis, Mo.
SCHWAB, H. E. (1923), Vice-Pres. and Secy. (for mail) c/o R. J. Schwab & Sons, Co., 283 Clinton St., and 266 Juneau Ave., Apt. 210, Milwaukee, Wis.
SCIPIO, Lynn A.* (1921), Dean School of Eng., Robert College, Constantinople, Turkey.
SCOLLAY, Ulysses G. (Charter Member), (Council 1894; Board of Managers 1895; Treas. 1904-1911) Pres., J. A. Scollay, Inc., 76 Myrtle Ave., Brooklyn, N. Y.
SCOTT, A. P. (1924), (for mail) Dennison Mfg. Co., 300 Howard St., Framingham, Mass.
SCOTT, Charles E. (1907), Pres. and Treas. (for mail) Vapor Engr. Co., 489 Fifth Ave., New York, N. Y., and 46 West Ave., Darien, Conn.
SCOTT, Edwin A. (1912), Editor (for mail) E. A. Scott Publishing Co., 45 West 45th St., and 3224 Grand Concourse, New York, N. Y.
SCOTT, George M. (1915), Child & Scott Co., 108 Wooster St., New York, N. Y.
SEABRIGHT, Louis C. (1920), Mech. Engr. (for mail) c/o C. W. Bates, 77 12th St., and 155 Elm St., Edgwood, Wheeling, W. Va.
SEKIDO, Kunisuke (1903), Nakano, Tokio Suburb, Japan.
SELLARS, Fred J. (1917), Pres. (for mail) Sell-Orr Heat. Co., 311 N. Penn Ave., and 619 North 9th St., Independence, Kan.
SELLMAN, Nils T. (1922), Engr. of Utilization (for mail) Consolidated Gas Co. of N. Y., 130 East 15th St., and 2463 Grand Ave., New York, N. Y.
SELTZER, A. P. (1921), Show Room Mgr. (for mail) American Radiator Co., 820 S. Michigan Ave., Chicago, and Evanshire Hotel, Evanston, Ill.
SETZER, Walter C. (Junior 1922), Sales Eng., H. B. Smith Co., 17th and Arch Sts., and (for mail) N.W. Cor. Gilham St., and Hasbrook Ave. Lawndale, Philadelphia, Pa.
SEWARD, Percival H.* (Charter Member), Vice-Pres., Richmond Radiator Co., 1480 Broadway, New York, and (for mail) 369 Washington Ave., Brooklyn, N. Y.
SEWELL, John M. (1919), Consulting Engr. (for mail) 1822 Ludlow St., Philadelphia, and Warren Ave., Berwyn, Pa.
SHANKLIN, John R. (1899), Pres. and Gen. Mgr. (for mail) West Virginia Heat. & Plbg. Co., 233 Hale St., and 1507 Quarrier St., Charleston, W. Va.
SHAW, Clinton E. (1921), Instructor (for mail) Northeast High School, Eighth and Lehigh Ave., and 6412 North 11th St., Philadelphia, Pa.
SHAW, Edgar (1923), Pres. (for mail) Lynch & Woodward, Inc., 202 Harrison Ave., Boston, and 51 Royal St., Wallaston, Mass.
SHAW, Norman James Henderson (Junior 1925), Sales Engr. (for mail) Barnes & Jones, 5 Melrose St., Boston, and 428 Adams St., Dorchester, Mass.
SHAW, Raymond E. (1921), Sales Mgr. (for mail) B. F. Sturtevant Co., Hyde Park, and Boston Athletic Assn., Boston, Mass.
SHAY, Russell A. (1924), Heat. Engr., 108 Linwood St., Brooklyn, N. Y.
SHEA, M. B. (1921), Mgr. (for mail) American Radiator Co., 417 South 10th St., and 3616 Lincoln Blvd., Omaha, Nebr.
SHEARS, Matthew W. (1922), Heat. Engr., C. A. Dunham Co., Ltd., 1523 Davenport Rd., and (for mail) 53 Sylvan Ave., Toronto, Ont.
SHEFFIELD, Edward B. (1921), Asst. Eng. (for mail) Melvern F. Thomas, 229 College St., Toronto, and 25 Government Rd., Lambton Mills, Ont.
SHEFFLER, Morris (1921), Sheffler-Gross Co., 205-11 Drexel Bldg., and 5451 Lebanon Ave., Philadelphia, Pa.
SHEPPARD, Frank A. (1918), Johnson Service Co., 411 East 10th St., Kansas City, Mo.
SHEPPARD, William G. (1922), Heat. and Vent. Engr. (for mail) Sheppard & Abbott, 119 Harbour St., and 479 Dovercourt Rd., Toronto, Ont., Can.
SHERIFFS, Walter A. (1918), Mehring & Hanson Co., 162 N. Clinton St., Chicago, Ill.
SHINOHARA, Shiro (1924), Takata & Co., Marunouchi, and (for mail) 51 Iga Machi, Yotsuyaku, Tokyo, Japan.
SHIPP, C. C. (1923), (for mail) C. C. Shipp & Co., 230 E. Ohio St., and 3405 Guilford Ave., Indianapolis, Ind.
SHODRON, John G. (1921), Research Engr., James Mfg. Co., and (for mail) 411 E. Milwaukee Ave., Ft. Atkinson, Wis.
SHORB, Will A. (1909), Treas., Field & Shorb Co., 133 W. William St., and (for mail) 3 Lincoln Pl., Decatur, Ill.
SHOZO, Saito (1923), (for mail) Maru No Uchi Bldg., Opposite Tokyo Station, and Imperial Hotel, Tokyo, Japan.
SHREINER, Dewey C. (Junior 1923), (for mail) Harry E. Shreiner & Son, 116 W. High St., and 608 W. Blvd., Elkhart, Ind.
SHROCK, John H. (1924), Vice-Pres. (for mail) New York Blower Co., and Bellevue Apts., La Porte, Ind.
SHUELL, Frank W. (Associate 1921), Pres. and Gen. Mgr. (for mail) Everhot Heater Co., 524 Wesson Ave., and 360 E. Boston Blvd., Detroit, Mich.
SHULTZ, Earle (Associate 1919), Vice-Pres. (for mail) Illinois Maintenance Co., Rm. 1136, Edison Bldg., and 1310 Birchwood Ave., Chicago, Ill.
SIEGEL, John F. (Associate 1915), Mgr., Fuel Oil Burner Engr. Co., 101 Park Ave., New York, and 220 Sheridan Ave., Mt. Vernon, N. Y.
SIEGEL, Leo (Junior 1924; Associate 1925), Mech. Engr., Bd. of Education, Heat. and Vent. Div., Flatbush and Concord Sts., and (for mail) 1507 Ave. U., Brooklyn, N. Y.
SIMONSEN, Lawrence A. (1920), Estimator and Engr., E. J. Claffey Co., 10 W. Illinois St., and (for mail) 6419 Vernon Ave., Chicago, Ill.

SIMPSON, William K. (1919), Secy. (for mail) Hoffman Specialty Co., and 61 Fiske St., Waterbury, Conn.
SKAGERBERG, R. (Junior 1921; 1924), Sales Engr. (for mail) Drying Systems, Inc., 11 S. Desplaines St., Chicago, Ill., and 1610 Burlingame, Detroit, Mich.
SKELLY, John F. (1921), Heat. and Vent. Engr., M. J. Daly & Sons, 543 Bank St., and (for mail) 393 Ford St., Ogdensburg, N. Y.
SKINNER, Henry W. (1920), Mech. Engr., Rapp & Rapp, 190 N. State St., Chicago, and (for mail) 418 Lawn Court, Waukegan, Ill.
SMALL, John D. (1910), Consulting Engr. (for mail) 127 N. Dearborn St., Chicago, and 411 Maple Ave., Wilmette, Ill.
SMALLMAN, Edwin W. (1920), Pres. Isaac Coffin Co., 52 Sudbury St., Boston and 73 Rowe St., Melrose, Mass.
SMALLMAN, William T. (1911), Treas, Isaac Coffin Co., 52 Sudbury St., Boston, Mass.
SMITH, Layton F. (1923), Dist. Mgr. (for mail) Midwest Air Filters, Inc., 1411 Walnut St., and 311 S. Hicks St., Philadelphia, Pa.
SMITH, Leslie L. (1919), Mech. Engr. (for mail) Smith, Hinchman & Grylls, 800 Marquette Bldg., and 1931 Delaware Ave., Detroit, Mich.
SMITH, Milton S. (1919), Production Mgr., Carrier Engr. Corp., 750 Frelinghuysen Ave., Newark, and (for mail) 13 North Terrace, Maplewood, N. J.
SMITH, Patrick J. (1923), W. J. McGuire, Ltd., 91 Jarvis St., and (for mail) 98 Woodfrey St., Toronto, Ont.
SMITH, Virgil A. (Junior 1923), Sales Engr. (for mail) C. A. Dunham Co., 1434 Franklin St., Tampa, Fla.
SNELL, Ernest (1920), Heat. and Vent. Engr., 3914 LeMay Ave., Detroit, Mich.
SNYDER, Charles B. J. (1895), (Board of Governors 1900-1904; 2nd Vice-Pres. 1905; 1st Vice-Pres. 1906; Pres. 1907; Board of Governors 1908), Consulting Archt., Dept. of Education, and (for mail) 430 Lewis Ave., Brooklyn, N. Y.
SNYDER, Jay W. (1917), (for mail) McColl, Snyder & McLean, 2348 Penobscot Bldg., and 8987 Martindale Ave., Detroit, Mich.
SNYDER, Joseph Samuel (Associate 1925), Sales Engr. (for mail) American Radiator Co., Rm. 414, 220 Delaware Ave., and 51 Granger Pl., Buffalo, N. Y.
SODEMANN, Paul (Junior 1920; Associate 1925), Sales Engr., Fischer Heat. Co., 367-69 Adams St., and (for mail) 206 Garland Pl., Memphis, Tenn.
SODEMANN, William C. (1919), Vice-Pres., Sodemann Heat. & Power Co., 2306 Morgan St., and (for mail) 3510 University St., St. Louis.
SODERBERG, Charles H. (1919), Consulting Engr., 1011 Charlevoix Bldg., Detroit, and 220 Puritan Rd., Birmingham, Mich.
SOMMER, Louis J., Jr. (1922), Plbg. and Heat. Contr. (for mail) Sommer & Son, 2436 Brown St., Philadelphia, Pa.
SOPER, Horace A. (1916), Vice-Pres., American Foundry & Furnace Co., 1122 E. Monroe St., Bloomington, Ill.
SOPER, Ira N. (1919), Sales Engr. (for mail) Warren Webster & Co., 549 W. Washington Blvd., and 7214 Prairie Ave., Chicago, Ill.
SOULE, Lawrence C. (1908), Secy. (for mail) Aerofin Corp., 750 Frelinghuysen Ave., Newark, and 26 Wootton Rd., Essex Falls, N. J.
SOWERS, Paul Edgar (1922), Engr., and Br. Mgr., Vapor Heat Co., 201 N. George St., and (for mail) P. O. Box 295, York, Pa.
SPARKS, Frank B. (Associate 1921), Supt. (for mail) Jas. Spear Stove & Heat. Co., 1823 Market St., and 5904 Chestnut St., Philadelphia, Pa.
SPECKMAN, Charles H. (1918), (for mail) 572 The Bourse, Philadelphia, Pa.
SPELLER, Frank N.* (1908), Metallurgical Engr., National Tube Co., 1810 Frick Bldg., and 6411 Darlington Rd., Pittsburgh, Pa.
SPERZEL, Henry J. (1919), N. W. Br. Mgr. (for mail) Kewanee Boiler Co., 708 Builders Ex., and 4644 Bryant Ave., S., Minneapolis, Minn.
SPIELMAN, Gordon P. (Junior 1923), Harrison-Spielman Co., 480 Milwaukee Ave., Chicago, and 515 N. Prospect Ave., Park Ridge, Ill.
SPITZLEY, Ray L. (1920), (for mail) R. L. Spitzley Heat. Co., 246 W. Larned St., and 1050 Yorkshire Rd., Grosse Pointe, Detroit, Mich.
SPOFFORD, Harry H. R. (1923), Copper & Brass Research Assn., 25 Broadway, New York.
SPOONER, Harold R. (1921), Engr. and Estimator, Atlas Heating Co., Inc., Jamaica, and (for mail) 33 Woodhull Ave., Hollis, L. I., N. Y.
SPRAGUE, Frank H. (1923), Skidmore Corp., 1535 Dayton St., Chicago, and 1522 Forest Ave., Wilmette, Ill.
SPROULL, Howard E. (1920), Dist. Mgr., American Blower Co. (for mail) 1109-11 Keith Bldg., Cincinnati, O., and Bedford, Ind.
SPURGEON, Joseph H. (1924), 2403 First National Bank Bldg., Detroit, Mich.
STACEY, Alfred E., Jr.* (1914), Research Engr., Carrier Eng. Corp., 750 Frelinghuysen Ave., Newark; (for mail) Wootton Rd., Essex Fells, N. J.
STACKHOUSE, Raymond M. (1919), Mgr. American Radiator Corp., (for mail) 509 Hannah Bldg., Parkside Dwellings, Cleveland, O.
STAMMER, Edward L.* (1919), Heat. and Vent. Supt., Bd. of Education, Ninth and Locust Sts., St. Louis, Mo.
STANGER, Ralph B. (1920), Sales Engr., Robinson & Stanger, Empire Bldg., Pittsburgh, Pa.
STANFORD, Leland E. (1921), Mgr., Forbs-Stanford Co., 756 Upson St., and (for mail) 120 E. Cuyahoga Falls Ave., Akron, O.
STANGLAND, B. F. (Charter Member), (Board of Managers 1895; Council 1896, 1897; Board of Managers 1899; Board of Governors 1905-1906; 2nd Vice-Pres. 1908; Board of Governors 1909), Morton, N. Y.
STANNARD, James M.* (1906), (Board of Governors 1913; Council 1914, 1917), Pres., Stannard Power Equipment Co., 925 Monadnock Block, Chicago, Ill.
STANWOOD, J. B. (1924), Vice-Pres. and Consulting Engr., The Stanwood Corp., and (for mail) 2415 Maplewood Ave., Cincinnati, O.
STAPLES, Wm. H. (Associate 1924), Gillis & Geoghegan, 537 West Broadway, and 137 West 96th St., New York, N. Y.
STARK, Edward A. (Associate 1914; 1916), Br. Mgr., U. S. Radiator Corp., 1248 First Ave., S., and 2338 Broadway, N., Seattle, Wash.
STARK, Ira. S. (Junior 1920; Associate 1925), Sales Engr. (for mail) C. A. Dunham Co., 710 14th St., N.W., and 127-3100 Connecticut Ave., Washington, D. C.
STARKS, Verne E. (1921), Dist. Mgr., Ilg Electric Vent. Co., 1314 Schofield Bldg., and (for mail) 13502 Fourth Ave., Cleveland, O.
STEARNS, William F. (Associate 1925), Stearns & Eaton (for mail) 100 Boylston St., Boston, and 2 Salisbury Rd., Winchester, Mass.
STEDMAN, C. N. (1921), (for mail) C. N. Stedman Co., 610 Wrigley Bldg., and 6917 Crandon Ave., Chicago, Ill.
STEEL, Lilburn H. (Associate 1924), Mgr. N. Y. Br., Abram Cox Stove Co., 113 East 34th St., New York, and (for mail) Edgewood Hall, Pelham Manor, N. Y.
STEIM, Charles J., Jr. (1923), Samuel Sloan & Co., 67 Exchange St., and 436 Rosewood Terrace, Rochester, N. Y.
STEINER, John G. (Associate 1922), (for mail) Utica Heater Co., 235 15th St., and 1368 Elizabeth St., Denver, Colo.
STEINHORST, Theo. F. (1919), Engr. and Est., Emil Steinhorst & Sons, 1158 Mohawk St., and 1664 Brinckerhoff Ave., Utica, N. Y.
STEINKE, C. B. (1924), Pres. (for mail), 103 Park Ave., and 2730 Decatur Ave., Brooklyn, N. Y.
STEPHENSON, Lewis A. (1917), Mgr. (for mail) Powers Regulator Co., 409 East 13th St., and 801 West 57th St., Terrace, Kansas City, Mo.
STERN, H. Richard (1923), (for mail) Johnson & Morris, 538 West 23rd St., and 225 West 86th St., New York, N. Y.

STETSON, Lawrence R. (1913), (for mail) McMurrer Co., 303 Congress St., Boston, and 35 Bradfield Ave., Roslindale, Mass.
STEVENS, Frank H. (Associate 1924), Sales Engr. (for mail) Heggie Simplex Boiler Co., 242 W. Larned St., Detroit, Mich., and 4618 Kenmore Ave., Chicago, Ill.
STEVENS, Harry L. (Junior 1924), (for mail) M. M. Stevens Co., 108 W. Sherman St., and 111 West 16th St., Hutchinson, Kan.
STEWART, Charles W. (1918), Pres., Haynes Selling Co., 1711 Sansom St., and (for mail) 716 South 51st St., Philadelphia, Pa.
STEWART, Earl A. (1922), Assoc. Prof. Agr. Physics, Univ. of Minnesota, University Farm, St. Paul, Minn.
STEWART, R. G. (Associate 1924), Chandler Pump & Supply Co., 931 West 8th St., and (for mail) 1823 Houston St., Kansas City, Mo.
STILL, Fred R.* (1904; Pres. 1918), (Council 1916; 2nd Vice-Pres. 1917, Council 1919), Vice-Pres. and Secy. (for mail) American Blower Co., 50 Church St., New York, N. Y.
STITT, Eugene W. (1917), Sales Repr., Hoffman Specialty Co., 1535 Fairlawn Ave., S. Hill Br., Dormont, Pittsburgh, Pa.
STITT, Howard B. (Associate 1922), Heat. Engr. (for mail) 506 West 29th St., Indianapolis, Ind.
STOCK, Edward L. (Associate 1918), Pres. (for mail) The Republic Boiler & Radiator Co., 1214 New York Ave., N.W., Washington, D. C. and Bradley Hills, Bethseda, Md.
STOCKENBERG, Ruben (1922), Sales Engr. (for mail) Johnson Service Co., 1355 W. Washington Blvd., and 1314 Columbia Ave., Chicago, Ill.
STOCKLY, Harold A. (1925), 240 S. El Molins St., Alhambra, Calif.
STOCKWELL, William R. (Junior 1901; 1903), Gen. Mgr., Weil-McLain Co., Michigan City, Ind.
STOKES, Ralph E. (1920), Residence Mgr., Vent. Engr. (for mail) Ilg Elec. Vent. Co., 1024 Bessemer Bldg., Pittsburgh, and 843 River Rd., Avalon Borough, Pa.
STOLENBERG, Thomas R. (1922), Sales Rep. Heat. and Vent. Engr. (for mail) Box 1168, and Kenmark Hotel, Denver, Colo.
STONE, Eugene R. (1913), Pres., Stone-Underhill Heat. & Vent. Co., 171 Harrison Ave., Boston, Mass.
STONE, George F. (1918), Engr. and Estimator, A. M. Barclay, 113 North 6th St., and (for mail) 4520 N. Carlisle St., Philadelphia, Pa.
STORM, Edwin S. (1916), Vice-Pres., Hoffman Specialty Co., 130 N. Wells St., Chicago, Ill.
STRANDWITZ, William J. (1919), Secy. and Treas. (for mail) Strandwitz & Scott, Inc., 537-49 South 2nd St., Camden and Hawthorne Ave., Haddonfield, N. J.
STROH, William H. (1921), Mgr., Heat. Dept., Bridgeman Co., 120 South 30th St., and (for mail) 5405 Chestnut St., Apt. A, Philadelphia, Pa.
STRONG, Ralph C. (1919), Salesman (for mail) 4515 Larchwood Ave., and Pierce, Butler & Pierce Mfg. Corp., 31st and Oxford Sts., Philadelphia, Pa.
STROUSE, Sidney B. (1921), Dist. Mgr. (for mail) Warren Webster & Co., 429 Guarantee Trust Bldg., and 22 S. Illinois Ave., Atlantic City, N. J.
SUITS, George A. (1920), Mgr., Hoffman Specialty Co., 26 Stanley Ave., Medford, Mass.
SULLIVAN, Daniel A. (1923), Ch. Engr., Miller & Brady, Inc., 210 East 38th St., and (for mail) 3178 Rochambeau, Bronx, New York, N. Y.
SUTCLIFFE, Arthur G. (Associate 1918; 1922), Engr., Ilg Elec. Vent. Co., 2850 N. Crawford Ave., and (for mail) 4146 N. St. Louis Ave., Chicago, Ill.
SUTER, George (1921), Heat. Contr. (for mail) 210 East 2nd St., and 1842 Barrett Ave., Sedalia, Mo.
SUTTERLEY, W. W. (1919), 503 North 52nd St., Philadelphia, Pa.
SWANEY, Carroll R. (Junior 1921), Sales Engr. (for mail) 16 Fairfax St., West Somerville, Mass.
SWARTWOUT, Jay D. (1917), Contr. Engr., 349 S. Weadock Ave., Saginaw, Mich.
SWEENEY, Sylvester H. (1915), Engr. and Contr. (for mail) S. H. Sweeney, Inc., 208 East 45th St., and 1916 Loring Pl., New York, N. Y.
SZEKELY, Ernest (1920), Consulting Engr. (for mail) 500 B. & R. T. Bldg., and 12537 Arliss Dr., Cleveland, O.

T

TAGGART, Ralph G. (1912), Ch. Engr., Dept. of Archt. (for mail) 14 Lyon Ave., Menands, Albany, N. Y.
TAIT, George M. (1909), Heat. Vent. and Sanitary Engr., 34 West 1st St., Mansfield, O.
TALIAFERRO, Robert R. (1919), (for mail) Carrier Eng. Corp., 1402 Land Title Bldg., and Beechwood Park, Philadelphia, Pa.
TALLMADGE, Webster (1924), 150 Broadway, New York, N. Y.
TANGEMAN, Bruno W. (Associate 1919), Mgr. (for mail) A. Y. McDonald Mfg. Co., 822 Third St., S., and 2716 Aldrich, S., Minneapolis, Minn.
TANNEHILL, Louis W. (1925), 1420 S. Flower St., Los Angeles, Calif.
TAVERNA, Frederick F. (Junior 1924), Estimator, Raisler Heating Co., 129 Amsterdam Ave., New York, N. Y., and (for mail) 406 Savoye St., Union City, N. J.
TAYLOR, Fred K. (1919), (for mail) Sales Dept., Taylor Instrument Cos., 95 Ames St., and 111 Trafalgar St., Rochester, N. Y.
TAYLOR, Milton Adam (Associate 1925), Asst. to Pres. (for mail) Taylor Forbes Co., Ltd., and 178 Queen St., Guelp, Ont.
TAYLOR, Reginald F. (1915), Consulting Engr., R. F. Taylor, 1020 Western Indemnity Bldg., and 5742 Richmond Ave., Dallas, Tex.
TAYLOR, Thomas Smith (1921), Chief Research Physicist (for mail) Bakelite Corp., 230 Grove St., Bloomfield, and 57 Arlington Ave., Caldwell, N. J.
TAZELAAR, Peter (Junior 1916), Sales Engr. (for mail) Commonwealth Brass Corp., 48 East 41st St., New York, N. Y., and 43 Fulton St., Bloomfield, N. J.
TEMPLIN, Charles L. (1921), Ch. Engr. (for mail) American Heat. & Vent. Co., P. O. Box 876, 801 Fayetteville St., and 720 Nash Dr., Raleigh, N. C.
TENKONOHY, Rudolph J. (1923), Sales Engr. (for mail) American Blower Co., 2136 Oliver Bldg., Pittsburgh, Pa., and 37 Stevens Ave., Highland Park, Mich.
TERRELL, Herbert A. (1915), Secy. and Treas., Atmospheric Conditioning Corp., 921 Lafayette Bldg., Philadelphia, Pa., and (for mail) Wenonah, N. J.
TERRY, Frank W. (Associate 1923), Sales Engr., Richmond Radiator Co., 1480 Broadway, New York, N. Y., and (for mail) 301 Central Ave., Orange, N. J.
THATCHER, George S. (1919), Pres. (for mail) Thatcher Heat. Co., 455 E. Exchange St., and 140 Morningside Dr., Akron, O.
THEISEN, Edwin F. (1922), Pres. and Heat. Engr., Industrial Plbg. and Heat. Co., 606 Second St., and (for mail) 1835 Des Moines St., Ft. Madison, Ia.
THEORELL, Hugo G. T.* (1902), Consulting Engr., 4 Skoldungatan, Stockholm, Sweden.
THINN, Christian A. (1921), Asst. Sales Mgr. and Engr. (for mail) C. A. Dunham Co., 230 E. Ohio St., and 1721 Humboldt Blvd., Chicago, Ill.
THOMAS, Bernard A. (Junior 1923), Sales Engr. (for mail) U. S. Radiator Corp., 303 Crosby Bldg., and 3193 Main St., Buffalo, N. Y.
THOMAS, Glegge (1923), Br. Mgr. (for mail) B. F. Sturtevant Co., 900 F St., N.W., Washington, D. C., and Box 71, Route 1, Roslyn, Va.
THOMAS, Herbert G. (1917), Sales Engr., Warren Webster & Co., 549 W. Washington Blvd., Chicago, and (for mail) 2312 Ridge Ave., Evanston, Ill.
THOMAS, Melvern F. (1909), Consulting Engr. (for mail) Rm. 30-34, 229 College St., and 24 Ralph Ave., Toronto, Ont.

THOMAS, R. H. (1920), Pres. (for mail) Economy Pumping Mach. Co., 122-124 N. Curtis St., Chicago, and 426 Forest Ave., Oak Park, Ill.
THOMPSON, James (1920), Pres. (for mail) Philadelphia Boiler Works, 1737 Filbert St., and Sunderland Apts., 35th and Powelton Ave., Philadelphia, Pa.
THOMPSON, Nelson S.* (Junior 1897; 1917), Ch. Mech. and Elec. Engr., Office of Supv. Archt. U. S. Treas. Dept., and (for mail) 1615 Hobart St., N.W., Washington, D. C.
THOMPSON, William P. (1915), (for mail) Thompson Bros., 520 Buttonwood St., and 1349 Colwyn St., Philadelphia, Pa.
THOMSEN, William T. (1919), Secy. and Treas. (for mail) 609-611 Tower Bldg., and 3408 Magnolia Ave., St. Louis, Mo.
THORNTON, Roger T. (1919), Sales Engr. (for mail) Buffalo Forge Co., 490 Broadway, and 108 Claremont Ave., Buffalo, N. Y.
THRUSH, Homer A. (1918), Pres. (for mail) H. A. Thrush & Co., 21-23 E. River St., and 271 S. Broadway, Peru, Ind.
THUEM, Adolph E. (Junior 1922), Heat. Engr., Board of Education, Concord St., and Flatbush Ave., Ext., Brooklyn, N. Y., and (for mail) 132 Gardner St., Union City, N. J.
TIBBETS, John C. (1920), Heat. and Vent. Engr., B. & O. R. R. Co., 1303 B. & O. Central Bldg., Baltimore, and (for mail) Ellicott City, Howard County, Md.
TILDEN, Elwyn E. (1924), (for mail) Warren Webster & Co., 220 Devonshire St., Boston, and Holbrook, Mass.
TIMM, William H. (1915), Consulting Engr. and Archt. (for mail) 726 Perry Bldg., and 3322 N. Park Ave., Philadelphia, Pa.
TIMMERMAN, Manford M. (Junior 1921; Associate 1925), Westinghouse Elec. & Mfg. Co., East Pittsburgh, and (for mail) 859 E. Hutchinson Ave., Swissvale, Pa.
TIMMIS, Pierce (1920), Mech. Eng. (for mail) Dwight P. Robinson & Co., Inc., 125 East 46th St., New York, and Little Neck Rd., Douglas Manor, L. I., N. Y.
TIMMIS, Walter S.* (1911; Pres. 1919), (Council 1916; 1917; 1920; 1st Vice-Pres. 1918), Consulting Engr. (for mail) 315 Fifth Ave., New York, and Hillsdale and Homer Lee Aves., Jamaica, N. Y.
TIMMIS, William Walter (Associate 1925), Sales Engr. Hoffman Specialty Co., 512 Fifth Ave., New York, and (for mail) 8828 181st St., Jamaica, N. Y.
TINKER, William E. (Associate 1922), National Radiator Co., 121 N. Broad St., and 600 South 48th St., Philadelphia, Pa.
TISNOWER, William (1923), Heat. Engr. (for mail) 131 Livingston St., Brooklyn, N. Y.
TITZELL, J. Edgar (1923), Mgr., Eastern Dist. Sales Office, Gen. Boilers Co., 101 Park Ave., and (for mail) 132 West 88th St., New York, N. Y.
TJERSLAND, Alf (Junior 1906; 1916), E. Sunde & Co., Christiania, Norway.
TOBIN, George J. (1905), Contr. Engr. (for mail) 187 North Ave., and 510 Grant Ave., Plainfield, N. J.
TODD, James (1922), Pres. (for mail) Sterling Varnish Co., 528 Fulton Bldg., Pittsburgh, and Sewickley, Pa.
TODD, James M. (Junior 1924; Associate 1925), (for mail) 617 Maison Blanche Bldg., and 2433 Pine St., New Orleans, La.
TOENNIGES, George C. (1915), Sales Engr., 3417 N. Lincoln St., Chicago, Ill.
TOMLINSON, Malcolm C. W. (1924), Mech. Engr., Development Br., Hawthorne Wks., Western Elec. Co., and (for mail) 1376 Greenleaf Ave., Chicago, Ill.
TOOKER, Charles C. (1918), Heat. Engr., 113 North 27th St., and (for mail) 208 Terry Ave., Billings, Mont.
TRANE, Reuben N. (1915), 1514 King St., La Crosse, Wis.
TREAT, Edwin J. (Associate 1911; 1912), Autoforce Vent. System, and 661 West 188th St., New York, N. Y.
TREE, Russell T. (1921), Engr. (for mail) Carrier Eng. Corp., 39 Cortlandt St., New York, N. Y.
TRIPP, Louis H. (1915), Ch. Engr., U. S. Veterans Bureau, Arlington Bldg., and (for mail) 3721 Fulton St., N.W., Washington, D. C.
TRUITT, Joseph E. (Associate 1911; 1920), Pres., Autovent Fan & Blower Co., 730-738 W. Monroe St., Chicago, Ill.
TURNO, Walter G. W. (Associate 1912; 1917), Engr. and Estimator, 71 Lafayette Ave., East Orange, N. J.
TUSCH, Walter (1917), Heat. and Vent. Engr. (for mail) Tenney & Ohmes, 101 Park Ave., New York, and 881 Sterling Pl., Brooklyn, N. Y.
TUTTLE, J. Frank (1913), Mgr. (for mail) Warren Webster & Co., 220 Devonshire St., Boston, and Winchester, Mass.
TWEED, Carleton F. (1916), Chief Engr., Arlington Engr. Corp., Rm. 812, 111 W. Jackson Blvd., and 338 N. Latrobe Ave., Chicago, Ill.
TWIST, Charles F. (1921), Ashwell & Twist, 2127 First Ave., Seattle, Wash.
TYLER, Frank T. (1922), Mgr. (for mail) Estimating Dept., Herman Nelson Corp., and 1615 Eighth Ave., Moline, Ill.

U

UHL, Edwin J. (1925), Sales Engr., Uhl Co., 132 South 10th St., Minneapolis, Minn.
UHL, Willard (1918), Sales Engr. (for mail) Uhl Co., 132 South 10th St., and 4716 Lyndale Ave., S., Minneapolis, Minn.
UHLHORN, W. J. (1920), Sales Engr., Drying Systems, Inc., 11 S. Desplaines St., Chicago, and (for mail) 733 S. Highland Ave., Oak Park, Ill.
UNDERHILL, William W. (1913), Treas., Stone-Underhill Heat. & Vent. Co., 171 Harrison Ave., Boston, and 15 Kenwood St., Brookline, Mass.
UPINGTON, George P. (1917), Sales Engr., Clarage Fan Co., 149 Broadway, New York, and 770 Greene Ave., Brooklyn, N. Y.

V

VAILE, Rawson (1921), Asst. Secy. (for mail) American Blower Co., 6004 Russell St., and 4744 Second Blvd., Detroit, Mich.
VALENTINE, Howard D.* (1924), Peoples Gas Light Bldg., 122 S. Michigan Ave., Chicago, Ill.
VAN ALEN, Walter T. (1924), Sales Eng. Heat. Dept., Standard Sanitary Mfg. Co., 439 Water St., Pittsburgh, and (for mail) 1300 Darlington Rd., R. F. D. 1, Beaver Falls, Pa.
VANCE, Louis G. (1919), Dist. Mgr. (for mail) Warren Webster & Co., 510 Garrett Bldg., and 3601 Garrison Ave., Baltimore, Md.
VAN INWAGEN, Frank (1916), Pres., Central Brake Shoe & Foundry Co., Railway Exchange, Chicago, and (for mail) 151 County Line Rd., Hinsdale, Ill.
VAN NORDEN, Ernest M. (1923), N. Y. Edison Co., 130 East 15th St., New York, N. Y.
VAN SICKLE, William B. (1915), Pres. (for mail) W. B. Van Sickle Co., 707 Frankfort Ave., Cleveland, and 1530 Grace Ave., Lakewood, O.
VAN ZANDT, John H. (1914), (for mail) John H. Van Zandt, 1903 Santa Fe Bldg., and 4416 Bryan St., Dallas, Tex.
VAUX, Frederick J. (1919), Vice-Pres. and Gen. Mgr., Monitor Bi-Loop Radiator Co., 202 E. King St., Lancaster, Pa.
VAUX, Noble (Associate 1923), Heat. Engr., R. T. Vaux & Son, 12 Fawcett St., and (for mail) 11 Holemelands Park S., Sunderland, England.
VERNER, William F.* (1913), Secy. and Treas., Mech. Engr. (for mail) Verner, Wilhelm, & Molby, 824 Book Bldg., Detroit, and 908 Lincoln Ave., Ann Harbor, Mich.
VIVARTTAS, Eugene A. (1910), Consulting Engr. (for mail) 139 Lafayette Ave., Brooklyn, N. Y.

VOGELBACH, Oscar (1923), Heat. and Vent. Engr., Guilbert & Betell, Archts., Chamber of Commerce Bldg., Newark, and 195 Devon St., Kearney, N. J.
VOIGT, Charles O. (1921), Sales Engr., The Stearns Roger Mfg. Co., 1720 California St., and 60 Albion St., Denver, Colo.
VOLK, Joseph H. (1923), Thos. E. Hoye Heat. Co., 1910 St. Paul Ave., Milwaukee, Wis.
VOORHEES, Guy A. (1922), Engr., Century Heat. Service Co., 32-36 West 10th St., and (for mail) 3451 Broadway, Indianapolis, Ind.
VOSE, Richard H. (1923), Johnson & Morris, 538 West 23rd St., New York, and (for mail) 18 Leland Ave., New Rochelle, N. Y.

W

WACHTER, John A. (1914), Pres. (for mail) Wachter, Hoskins & Russell, Inc., 723-725 W. Pratt St., and 112 Ailsa Ave., Hamilton, Baltimore, Md.
WADDINGTON, Bertram C. (1922), Engr., W. B. Irwin, Engrs., 911 Bankers Mortgage Bldg., Houston, Tex.
WADDINGTON, Earle C. (1917), Sales Engr. (for mail) Natkin Eng. Co., 208 Mutual Bldg., and 3230 Tracy Ave., Kansas City, Mo.
WADLEY, Calvin Page (1919), Pres. (for mail) Excelso Specialty Works, Inc., 119 Clinton St., and 60 Agassiz Circle, Buffalo, N. Y.
WAGNER, A. M. (Associate 1921), Mgr., American Radiator Co., Cor. Prior and Minnehaha, St. Paul and 1626 West 25th St., Minneapolis, Minn.
WAGNER, John P. (Associate 1921), Pres. and Gen. Mgr., Dowagiac Mfg. Co., P. O. Box 95, Dowagiac, Mich.
WALDRON, Chas. W. (Associate 1924), (for mail) American Larson Vent. Co., 204 Keystone Bank Bldg., Pittsburgh, Pa., and 1006 Ninth St., Portsmouth, O.
WALKER, Alex. (Associate 1925), Br. Mgr. (for mail) C. A. Dunham & Powers Regulator, 311-312 Dominion Bank Bldg., Calgary, Can.
WALKER, James B. (1919), Secy. and Treas. (for mail) Pittsburgh Heat. Co., 715 Magee Bldg., and 202 Iroquois Apt., Pittsburgh, Pa.
WALKER, James H.* (1916), Supt., Central Heat. (for mail) Detroit Edison Co., 2000 Second Ave., and 1520 Virginia Park, Detroit, Mich.
WALKER, Wm. K. (Junior 1924), Mech. Engr. (for mail) McKenzie, Voorhees & Gmelin, 342 Madison Ave., New York, and 191 Central Ave., St. Albans, L. I., N. Y.
WALLACE, Albert (1921), Mfgrs. Repr., A. Wallace & Co., 402 Jacobson Bldg., and (for mail) 2971 Irving St., Denver, Colo.
WALLACE, George J. (1923), 206 East 57th St., New York, and (for mail) 27-36 Ericsson St., East Elmhurst, L. I., N. Y.
WALLACE, John F. (1921), Secy. and Treas., Wallace Plbg. Co., 1238 California St., and 1320 S. Josephine, Denver, Colo.
WALLICH, A. C. (1919), (for mail) Wallich Ice Machine Co., 517 E. Larned St., and 1211 E. Grand Blvd., Detroit, Mich.
WALSH, Arthur F. (Associate 1923), Heat. and Vent. Contr., A. F. Walsh, 7445 Exchange Ave., and 7536 S. Shore Dr., Chicago, Ill.
WALSH, Joseph G. (1919), Sales Engr. (for mail) 720 Pioneer Trust Bldg., and 4406 Main St., Kansas City, Mo.
WALSH, Malcolm (1924), Secy. (for mail) Walsh & Wortheim, 55 W. Houston St., New York, and 25 Sherman Ave., Tompkinsville, S. I., N. Y.
WALTERS, Arthur Lee (Junior 1924; Associate 1925) Buck's Stove & Range Co., 3500 North 2nd St., St. Louis, Mo.
WALTERS, Victor (Junior 1924), Draftsman, I. C. R. R. Bldg. Dept., Dowie Bldg., 109 East 12th St., and (for mail) 1422 East 69th St., Chicago, Ill.
WALTERS, William T. (1917), Engr., Illinois Eng. Co., West 21st St. and Racine Ave., and (for mail) 1422 East 69th St., Chicago, Ill.
WALTHERTHUM, John J. (Associate 1922), J. J. Waltherthum, 173 East 62nd St., New York, N. Y., and 834 Grand St., Jersey City, N. J.
WALTHER, Owen N. (1919), Treas. (for mail) York Heating & Ventilating Corp. 1502 Locust St., and Engineers' Club, Philadelphia, Pa.
WALTHER, Vernon H. (Junior 1925), Asst. Mech. Dept. (for mail) E. W. & Geo. L. Rapp, Arch., Rm. 1200, 190 N. State St., and 4537 Greenview Ave., Chicago, Ill.
WALTON, Hiram L. (1916), Mech. Engr., Smith, Hinchman & Grylls, 800 Marquette Bldg., Detroit, and 218 Monterey Ave., Highland Park, Mich.
WARD, Oscar G. (1919), Dist. Mgr. (for mail) Johnson Service Co., 1230 California St., and 1515 East 9th Ave., Denver, Colo.
WARNKE, Fred E. (Associate 1921), Sales Engr. (for mail) Spencer Turbine Co., 5005 Euclid Ave., and 2641 Taylor Rd., Cleveland Heights, O.
WARREN, Clarence N. (1919), Vice-Pres. and Engr., Hayes Bros., Inc., 236 W. Vermont St., and (for mail) 419 East 48th St., Indianapolis, Ind.
WASH, Wm. Percy (1923), Sales Engr. (for mail) Richmond Radiator Co., P. O. Box 381, and 131 Wellington Ave., Roanoke, Va.
WATKINS, James A. (1919), Sales Engr., American Blower Co., 140 S. Dearborn St., and (for mail) 7526 Kingston Ave., Chicago, Ill.
WATTERS, Peter J. (1921), Mgr., John Watters, 55 Church St., and (for mail) 52 Ann St., Port Richmond, Staten Island, N. Y.
WEAGER, T. A. (1920), Mgr. Cleveland Office (for mail) Buffalo Forge Co., Rockefeller Bldg., Cleveland, and 3124 Berkshire Rd., Cleveland Heights, O.
WEBB, John S. (1920), Pres. (for mail) Willey & Calhoun Co., 46 Market St., and 45 Lincoln St., Woodfords, Portland, Me.
WEBER, Erwin L. (1921), Consulting Engr. (for mail) 723 Seaboard Bldg., and 3046 18th Ave., S., Seattle, Wash.
WEBER, G. A. (1922), Engr., McGinness, Smith & McGinness Co., 527 1st Ave., and (for mail) 618 Chautauqua St., Pittsburgh, Pa.
WEBSTER, E. Kessler (1915), Secy. and Asst. Gen. Mgr. (for mail) Warren Webster & Co., 17th and Federal Sts., Camden, and 320 Washington Ave., Haddonfield, N. J.
WEBSTER, Warren (1906), Pres. and Gen. Mgr. (for mail) Warren Webster & Co., 17th and Federal Sts., Camden, N. J.
WEGMANN, Albert (1918), Blower and Vent. Engr., A. & W. Wegmann, 2813 W. Fletcher St., and (for mail) 2842 N. Bonsall St., Philadelphia, Pa.
WEIBERT, Chas. J. (1921), (for mail) Weibert & Zibold Corp., 331 Vanderbilt Ave., and 89 Lewis Ave., Brooklyn, N. Y.
WEIDER, Frederick J. (1919), Mgr. and Treas. Barr & Creelman Co., 74 Exchange St., and 40 Kenwood Ave., Rochester, N. Y.
WEIMER, Fred G. (Associate 1919), Br. Mgr., Kewanee Boiler Co., 440 Barclay St., and (for mail) 1308 Stowell Ave., Milwaukee, Wis.
WEINSHANK, Theodore* (1906), (Board of Governors 1913), (for mail) Weinshank & Fenstermaker, 821 Hume-Mansur Bldg., and 2341 N. Delaware St., Indianapolis, Ind.
WEISS, Carl A. (Associate 1924), (for mail) Kornbradt Kornice Ko., 1811 Troost Ave., and 4920 Walroud, Kansas City, Mo.
WELAMB, Victor N. (1918), Contr., V. N. Welamb Co., 2313 Walnut St., and 1741 North 33rd St., Philadelphia, Pa.
WELKER, Arthur E. (1918), Price & Welker, 707 Canal Rd., Cleveland, and 1299 Hall Ave., Lakewood, O.
WELSH, Harry S.* (1906), Pres. and Mgr., Boiler & Radiator Corp. (for mail) 999 E. Main St., and 37 Flower City Park, Rochester, N. Y.

WELTER, Michael A. (Associate 1925), (for mail) M. A. Welter & Co., 2118 Lyndale Ave., S., and 4306 Garfield Ave., S., Minneapolis, Minn.
WENDT, Edgar F. (1918), Vice-Pres. and Treas. (for mail) Buffalo Forge Co., 490 Broadway, and 731 Lafayette Ave., Buffalo, N. Y.
WENDT, Henry W. (1917), Pres. (for mail) Buffalo Forge Co., 490 Broadway, and 120 Lincoln Parkway, Buffalo, N. Y.
WESCHLER, Geo. A. (1923), Prof. of Mech. and Consulting Engr. (for mail) 820 Transportation Bldg., and 1243 Monroe St., N.E., Washington, D. C.
WEST, Perry* (1911), (Council 1920-1923; Treas. 1924-1925), Consulting Engr. (for mail) 13 Central Ave., and 322 Park Ave., Newark, N. J.
WHEELER, Charles W. (1916), Br. Mgr. (for mail) C. A. Dunham Co., 1104 May Bldg., and Allison Park, Pittsburgh, Pa.
WHEELER, Otto J. (1923), Mgr. and Secy., Samuel A. Esswein Heat. & Plbg. Co., 96 W. Broad St., and (for mail) 504 Linwood Ave., Columbus, O.
WHEELOCK, Harry C. (1919), 118 College St., Burlington, Vt.
WHELAN, William J. (1923), Harrigan & Reid, 1705 First St., Detroit, Mich.
WHELLER, Harry S. (1916), Vice-Pres., L. J. Wing Mfg. Co., 352 West 13th St., New York, N. Y., and (for mail) 230 Stiles St., Elizabeth, N. J.
WHITAKER, Earnest C. (1925), Engr., Buerkel & Co., Inc., 24 Union Park St., Boston, and (for mail) 35 Sherborn St., Arlington, Mass.
WHITBY, Stephen S. (Associate 1922), Treas., Culbert-Whitley Co., 1503 Sansom St., Philadelphia, Pa., and (for mail) 208 Yale Rd., Audubon, N. J.
WHITE, Everett A. (1921), Mgr. Heat. Dept. (for mail) Crane Co., 30 South 16th St., and 4611 Delor St., St. Louis, Mo.
WHITE, Elwood S. (1921), Pres. and Treas. (for mail) Thermal Appliance Co., Inc., 342 Madison Ave., and 21 Washington Square, New York, N. Y.
WHITE, Harold A. (Associate 1923), Mulley & White, 245 Greenpoint St., New York, and (for mail) 852 Knickerbocker Ave., Brooklyn, N. Y.
WHITELEY, James (1919), Consulting Engr., Whiteley & Sanders, 3000 Grand River Ave., and 520 Navahoe Ave., Detroit, Mich.
WHITTEMORE, Edward H. (1920), Engr. (for mail) Stone & Webster, 147 Milk St., Boston, and 96 Church St., West Roxbury, Mass.
WHITTEN, Herbert W.* (Associate 1908; 1909), Mech. Engr., Chamberlin Metal Weather Strip Co., 1644 Lafayette Blvd., W., Detroit, Mich.
WHITTEN, H. E. (1924), Pres. and Treas. (for mail) H. E. Whitten Co., 9 Federal St., Boston, and 56 Highland Rd., West Somerville, Mass.
WHY, H. Berkeley (1919), Construction Engr. (for mail) 312 Earlham Terrace, Germantown, Pa.
WIDDICOMBE, Robert A. (1903), 26 N. Jefferson St., Chicago, Ill.
WIEGNER, Henry B. (1919), Mgr., Johnson Service Co., 31 Waltham St., Boston, and 77 Chester Rd., Belmont, Mass.
WIGGS, Gordon L. (Junior 1924), Engr. (for mail) Mechanics Supply Co., Ltd., 80 St. Paul St., and 189 Grande Alles, Quebec, P. Q.
WILCOX, Oscar H. (Associate 1917), Salesman, Ideal Furnace Co., 530 Jefferson Ave., and (for mail) 2545 Canton Ave., Detroit, Mich.
WILCOX, William (1916), Dist. Engr. (for mail) Whitlock Coil Pipe Co., Rm. 511, 6 Beacon St., Boston, and 7 Biltmore St., Jamaica Plain, Mass.
WILD, Walter H. (Associate 1921), Mfgr. Agt. (for mail) 1212 Land Title Bldg., Philadelphia, and 122 Cynwyd Rd., Bala, Pa.
WILDE, Ray S. M. (1916), Consulting Engr. (for mail) 305 Huron Bldg., Detroit, and 194 Connecticut Ave., Highland Park, Mich.
WILDER, Edward L. (1915), Mgr. Industrial Sales Dept. (for mail) Rochester Gas & Elec. Corp., 34 Clinton Ave., N., and 16 Ericsson St., Rochester, N. Y.
WILEY, Chas S. (1921), Heat. and Vent. Engr., Eastman Kodak Co., Kodak Park, and 239 Mulberry St., Rochester, N. Y.
WILEY, Edgar C. (1909), Consulting Engr., Wiley & Wilson, Lynchburg, Va.
WILLARD, Arthur C.* (1914), Prof. of Heat. and Vent. and Head of Dept. of Mech. Eng. (for mail) University of Illinois, and 1208 W. California Ave., Urbana, Ill.
WILLIAMS, Allen W. (Associate 1915), Secy., National Warm Air Heat. and Vent. Assn., 52 W. Gay St., Columbus, O.
WILLIAMS, Jesse M. (Associate 1925), Pres., and (for mail) Williams Radiator Co., 1864 W. Washington St., and 861 Harcourt Ave., Los Angeles, Calif.
WILLIAMS, J. Walter (1915), Pres. and Treas., Forest City Plbg. Co., 332 E. State St., Ithaca, N. Y.
WILLIAMSON, Arthur H. (Associate 1915), Mgr., American Radiator Co., Broadway and Grand River Ave., Barlum Bldg., and 1242 Glynn Court, Detroit, Mich.
WILLIAMSON, Fred W. (1914), Consulting Engr., 324 New York Ave., Brooklyn, N. Y.
WILLIAMSON, George R. (1920), Sales Engr., The Mouat Co., 1246 West 4th St., and (for mail) 11016 St. Clair Ave., Cleveland, O.
WILLIS, F. H. (1921), Ch. Engr. (for mail) Wm. N. Bowerman Co., 612 Insurance Bldg., and 1110 Jackson St., Denver, Colo.
WILLIS, Ralph P. (1923), Sales Engr. (for mail) Peerless Unit Vent. Co., Inc., 511 Duffy-Powers Bldg., Rochester, and 227 Audubon Ave., New York, N. Y.
WILMOT, Charles S. (1919), Research Engr. and Works, Mgr., Monitor Bi-Loop Radiator Co., Harrisburg Ave., Lancaster, Pa., and (for mail) Phoenixville, Pa.
WILSON, Benjamin W. (1922), Heat. and Vent. Engr., Ballinger Co., S.E. Cor. 12th and Chestnut Sts., and (for mail) 5935 Windsor Ave., Philadelphia, Pa.
WILSON, Charles H. (1920), Heat. and Vent. Engr., Fuller & Warren Co., and (for mail) 468 Pawling Ave., Troy, N. Y.
WILSON, Ernest J. F. (1923), Consulting Engr., Wiley & Wilson, 908 National Bank Bldg., Lynchburg, Va.
WILSON, Eugene K. (1919), (for mail) Wilson & Co., 1017 Duke St., and 12 Lafayette Blvd., Norfolk, Va.
WILSON, Frederick A. (1910), (for mail) 20945 110th Ave., Bellaire, N. Y.
WILSON, Harry A. (1903), Box 155, Washington, R. I.
WILSON, Howard M. (Associate 1925), Br. Mgr. (for mail) Standard Heater Co., 136 Federal St., Boston, and 21 Seaver St., Wellesley Hills, Mass.
WILSON, J. J. (Charter Member), Consulting Engr., 5514 Paschall Ave., Philadelphia, Pa.
WILSON, William H. (Associate 1923), Mgr. Wis. Br. (for mail) Johnson Service Co., 149-159 Michigan St., and 431 Olive St., Milwaukee, Wis.
WILSON, Wm. S. (Associate 1924), Mgr. Lands Dept. (for mail) Lake Superior Corp., and 210 McGregor Ave., Sault St., Marie, Ontario, Can.
WINCH, Franklin R. (1925), Mech. Engr. (for mail) Walker & Eisen, 746 S. Spring St., and 5462 Carlin St., Los Angeles, Calif.
WINTERBOTTOM, John W. (1915), Vice-Pres. and Engr., Lock Box 2045 Sta. A., Waterloo, Ia.
WINTERBOTTOM, R. F. (Associate 1923), Mgr., Faultless Heater Mfg. Co., and (for mail) Box 2217 Sta. A., Waterloo, Ia.
WINTERER, Frank C. (1920), Heat. Dept. (for mail) Cochran-Sargent Co., Fifth and Sibley Sts., and 836 Juno St., St. Paul, Minn.
WINTERER, Raymond J. (1919), Mgr., Heat. Dept., Crane & Ordway Co., Fifth and Rosabel Sts., and (for mail) 197 S. Fairview St., St. Paul, Minn.
WISE, Frank W. (Associate 1918), Sales Engr. (for mail) General Boilers Co., 207 Davidson Bldg., and 2751 Charlotte, Kansas City, Mo.

WISE, Mason W. (1923), Mgr. (for mail) 215 Glenn Bldg., and R. F. D. No. 2, Atlanta, Ga.
WOHLMAN, Anton C. (Associate 1923), Pres. (for mail) Metal Equipment Co., 2033 West 106th St., and 1257 Beach Ave., Cleveland, O.
WOLF, J. C. (1923), Bayley Mfg. Co., 732 Greenbush St., Milwaukee, Wis.
WOLFE, Roy (1923), Vice-Pres. and Engr. (for mail) Huffman-Wolfe Co., 669 N. High St., and 150 Kenworth Rd., Columbus, O.
WOLFF, Richard A. (Junior 1915; 1919), Pres. (for mail) Wolff & Munier, Inc., 405 Lexington Ave., New York, and Hewlett, L. I., N. Y.
WOLFSFELD, Charles F. (1923), Ch. Draftsman, Bd. of Education, Brooklyn and (for mail) Vista Ave., Bayside, L. I., N. Y.
WOOLLEY, Thomas R. (1916), Sales Engr., Woolley Eng. Co. (for mail) 2457 Woodward Ave., and 920 Seward Ave., Detroit, Mich.
WOOLSTON, A. H. (1919), Ch. Engr., Bowers Bros. & Co., 2015 Sansom St., and 4815 North 12th St., Philadelphia, Pa.
WOOLSTON, C. Elmer (1924), Bowers Bros. & Co., 2015 Sansom St., Philadelphia, Pa.
WORM, Amdi (Associate 1924), Factory Repr., Flaxlinum Insulating Co., 1425 Grand Ave., and (for mail) 2424 East 58th St., Kansas City, Mo.
WORSHAM, Herman (Junior 1918; Associate 1925) Sales Engr. (for mail) Carrier Eng. Corp., 1144 Prudential Bldg., and 37 Manchester Place, Buffalo, N. Y.
WORTHING, E. (1923), Pres. (for mail) Bayley Mfg. Co., 732 Greenbush St., and 546 Prospect Ave., Milwaukee, Wis.
WORTHINGTON, Thomas (1922), Heat. Engr., *Kewanee Boiler Co.*, 141 Albany Ave., Toronto, Ont.
WORTHINGTON, Thomas E. (Associate 1924), (for mail) Worthington Burner, 1322 McGee St., and 3920 East 19th St., Kansas City, Mo.
WRIGHT, Harris H. (1917), Mgr., C. A. Dunham Co. (for mail) General Boilers Co., 207 Davidson Bldg., and 1214 E. Gillham Rd., Kansas City, Mo.
WRIGHT, K. (1921), Mgr. (for mail) Johnson Service Co., 1113 Race St., and Westminster Apts., Lane Seminary, Cincinnati, O.
WYLIE, Howard McWilliam (Junior 1917; 1925), Vice-Pres. Charge of Sales (for mail) The Nash Engineering Co., S. Norwalk, Conn.

Y

YAGER, John J. (1921), Pres. and Gen. Mgr., Goergen-Mackwith Co., Inc., 817 Sycamore St., and (for mail) 272 Carlton St., Buffalo, N. Y.
YAGLOU, Constantin P.* (1923), Instr. in Vent. and Illumination (for mail) Harvard University, Harvard School of Public Health, 55 Van Dyke St., Boston 17, and 213 Aspinwall Ave., Brookline, Mass.
YAMASAKI, Kanjiro (Associate 1923), Heat. Engr. (for mail) Takata & Co., Marunouchi, Tokyo, Japan.
YARDLEY, Ralph W. (1920) Asst. Supt. of Constr., Ill. Penitentiary Commission, 717 Heggie Bldg., Joliet, Ill.
YATES, Walter (1902), Managing Director, Matthews & Yates, Ltd., Swinton, Manchester, England.
YOUNG, Robert L. (1915), Mech. Engr., Johns-Manville, Inc., 210 N. Broad St., and 522 N. 55th St., Philadelphia, Pa.

Z

ZECK, Alex. (1904), Pres., Alex. Zeck & Son Co., Morgantown, W. Va.
ZIEL, Herbert E. (1924), Albert Kahn, 1000 Marquette Bldg., Detroit, Mich.
ZIMMER, George J. (1921), Engr. (for mail) Bryce Heat. & Vent. Co., 415 Spitzer Bldg., and 2221 Maplewood Ave., Toledo, O.
ZIRHUT, George A. (Associate 1922), Onarga Plbg. & Heat. Co., P. O. Box 33, Onarga, Ill.
ZOKELT, C. G. (1921), Mgr. (for mail) Northwest Engr. Co., 414 Central Bldg., and 2355 16th Ave., S., Seattle, Wash.
ZOPATA, Edward L. (Associate 1924), Ch. Mech. Draftsman, University of Michigan, 1310 Granger Ave., Ann Arbor, Mich.
ZUEHLKE, Rudolph (1923), (for mail) Zuehlke-Stoehr Heating Co., 1701 Clybourn St., Milwaukee, and 579 15th Ave., Wauwatosa, Wis.

Summary of Membership

(Corrected to July 1, 1925)

UNITED STATES

Alabama	4	Montana	4
California	23	Nebraska	4
Colorado	26	New Jersey	71
Connecticut	20	New York	353
Delaware	5	North Carolina	5
District of Columbia	13	North Dakota	1
Florida	2	Ohio	88
Georgia	15	Oklahoma	6
Illinois	216	Oregon	2
Indiana	29	Pennsylvania	268
Iowa	12	Rhode Island	7
Kansas	11	Tennessee	6
Kentucky	3	Texas	10
Louisiana	1	Utah	1
Maine	4	Vermont	4
Maryland	20	Virginia	16
Massachusetts	98	Washington	22
Michigan	106	West Virginia	6
Minnesota	57	Wisconsin	36
Mississippi	1	Wyoming	1
Missouri	109		
			1686

FOREIGN COUNTRIES

Canada	64	Norway	1
China	4	Russia	1
Denmark	1	Sweden	1
England	20	Switzerland	1
France	3	Turkey	1
Germany	1		
Ireland	1		105
Japan	5		
New Zealand	1	Total Membership	1791

SUMMARY OF MEMBERSHIP BY GRADES

Honorary Members	1
Presidential Members	19
Members	1402
Associate Members	288
Junior Members	81
	1791

LIST OF MEMBERS

(In good standing July, 1925)

Arranged Geographically

UNITED STATES

ALABAMA

Birmingham—
Bunnell, E. W.
Festorazzi, A. O.
Lichty, A. J.
Lichty, C. P.

CALIFORNIA

Alhambra—
Stockly, H. A.

Huntington Park—
Berg, A. H.

Los Angeles—
Anderson, C. S.
Boschke, F. G.
Hanes, J. W. E.
Heibel, W. E.
Hubbard, A. M.
Jones, E. A.
Kilpatrick, W. S.
Larimer, G. B.
Moler, W. H.
Ott, O. W.
Peticolas, L. D.
Russel, D. P.
Tannehill, L. W.
Williams, J. M.
Winch, F. R.

Oakland—
Cummings, G. J.

Pasadena—
Gifford, R. L.

San Francisco—
Duncan, G. W., Jr.
Haley, H. S.
Krueger, J. l.
Leland, W. E.

COLORADO

Boulder—
Erwin, J. P.

Denver—
Adams, C. W.
Bradbury, G. L.
Brickey, J. P.
Cullyford, F. S.
Daly, J. H.
Deranleau, R. L.
Elderman, B. E.
Fielding, H. H.
Foley, W. J.
Fuller, R. K.
Gillespie, R. B.
Larimer, W. M.
Michael, L. A.
Pfeiffer, J. F.
Price, F. E.
Pursell, H. E.
Reuter, A. G.
Steiner, J. G.
Stoltenberg, T. R.
Voigt, C. O.
Wallace, A.
Wallace, J. F.
Ward, O. G.
Willis, F. H.

Colorado Springs—
McCarthy, T.

CONNECTICUT

Bridgeport—
Clement, E. R.

Hartford—
Libby, L. R.
Purcell, A. J.

New Britain—
Cadwell, W. H.

New Haven—
Dibble, A. B.
Donnelly, W. C.
Hoyt, W. B.
Lockwood, E. H.

New London—
Forsberg, W.
Hopson, W. T.

Norton Heights—
Ashley, E. E., Jr.

S. Norwalk—
Harvey, A. D.
Jennings, I. C.
Wylie, H. M. W.

Springdale—
Broderick, J. F.

Stamford—
Blackman, A. O.

Waterbury—
Byrnes, T. F.
Simpson, W. K.

Winsted—
Griffin, P. C.
Hutton, W.

DELAWARE

Wilmington—
Bulkeley, C. A.
Gawthrop, F. H.
Kershaw, M. G.
Lownsbery, B. F.
Schoenijahn, R. P.

DISTRICT OF COLUMBIA

Washington—
Bradbury, C. R.
Coward, H.
Dickinson, H. C.
Febrey, E. J.
Gardner, S. F.
Goldstein, A. M.
Munro, E. A.
Stark, I. S.
Stock, E. L.
Thomas, G.
Thompson, N. S.
Tripp, L. H.
Weschler, G. A.

FLORIDA

Jacksonville—
Gray, W. E.

Tampa—
Smith, V. A.

GEORGIA

Atlanta—
Alger, R. W.
Baker, I. C.
Beggs, D. T.
Carder, W. W.
Guest, P. L.
Kent, L. F.
Klein, E. W.
Markel, F. E.
Pottinger, C. T.
Rhodes, S. V.
Wise, M. W.

Columbus—
Denson, W.
Dexter, MacD.
Hartpence, C. C.

Decatur—
Kirby, W. C.

ILLINOIS

Bloomington—
Howell, L.
Soper, H. A.

Belleville—
Karr, T., Jr.

Champaign—
Brownell, C. D.

Chicago—
Ahlff, A. A.
Allan, C. D.
Allen, H. D.
Amstein, A. W.
Arenberg, M. K.
Armspach, O. W.
Atkinson, R. E.
Baker, E. V.
Barrows, C. E.
Benoit, W. E.
Birkholz, H. E.
Black, F. C.
Bloom, S. C.
Bolling, J. E.
Boswin, G. A.
Boylston, A. W.
Boylston, J.
Braun, L. T.
Burger, J. C.
Burns, W. A.
Carnahan, G. C.
Cartland, S.
Casey, R. L.
Casserly, T. D.
Chenoweth, W. H., Jr.
Cheyney, C. C.
Claffey, E. J.
Crawford, W. B.
Crone, C. E.
Cutler, J. A.
Cutter, E. H.

Davis, J. H.
Deland, C. W.
Dewar, J. G.
Doherty, J.
Douglass, T. C.
Dunham, C. A.
Ebin, L.
Emmert, L. D.
Evans, R. S.
Finan, J. J., Sr.
Fleming, J. P.
Furman, J. R.
Gardner, W., Jr.
Gaylord, F. H.
Gemeny, W. J.
Getschow, G. M.
Getschow, R. M.
Gilmore, R. E.
Good, M. S.
Gordon, E. G.
Gossett, E. J.
Graves, W. B.
Grebe, H. W.
Gross, R. A.
Gustafson, T. E.
Haas, S. L.
Haines, J. J.
Hansen, J.
Harbula, M. G.
Harrison, B. S.
Hart, H. M.
Hayes, J. J.
Hayward, R. B.
Heck, G. L., Jr.
Heckel, E. P.
Henrich, G. A.
Herlihy, G. F.
Herlihy, J. J.
Hill, E. V.
Hoier, W. V.
Hoover, H. E.
Hornung, J. C.
Howatt, J.
Hubbard, G. W.
Impey, P. F.
Jackson, C. J.
Jenson, J. S.
Johnson, C. W.
Jolliffe, A. H.
Jones, D. J.
Jones, E. F.
Kaiser, H. S.
Keeney, F. P.
Kehm, A.
Kellogg, C. V.
Kimbrough, H. C.
Kirk, G. H.
Kohlbry, E. G.
Kreissl, H. G.
Kroeger, A.
Lagodzinski, H. J.
Lamb, F. W.
Lang, L. P.
Larson, J. M.
Larson, W. C.
Lautenschlager, F.
Lees, H. K.
Lenone, J. M.
Lewis, S. R.
Lippe, E. V.
Lippman, O. S.
Luce, G. D., Jr.
McCauley, J. H., Jr.
McClellan, J. E.
McConner, C. R.
McDonnell, E. N.
McEvoy, W. J.
McFarland, W. P.
McGregor, G. H.
McLelland, H. B.
Martin, A. B.
Matchett, J. C.
Mathis, E.
Mathis, H.
Mathis, J. W.
Mathy, J., Jr.
Matzen, H. B.
Mehring, G.
Mertz, W. A.
Miller, F. A.
Miller, J. E.
Milliken, J. H.
Monaghan, T. H.
Montgomery, W. R.
Moran, F. E.
Murch, G. E.
Muth, H.
Nacey, H. M.
Narowetz, L. L., Jr.
Neiler, S. G.
Newport, C. F.
Nilson, A.
Nulsen, C. A.
O'Brien, J. H.
Olsen, C. F.
Orr, F. B.
Pask, R. J.
Pitcher, L. J.
Pope, S. A.
Pope, W. A.
Powers, F. W.
Richardson, A. H.
Rietz, E. W.
Rogers, C. W.
Rollins, F. D.
Rosenbach, R. G.
Ryan, H. B.
Scheidecker, D. B.
Seltzer, A. P.
Sheriffs, W. A.
Shultz, E.
Simonsen, L. A.
Small, J. D.
Soper, I. N.
Spielman, G. P.
Sprague, F. H.
Stannard, J. M.
Stedman, C. N.
Stevens, F. H.
Stockenberg, R.
Storm, E. S.
Sutcliffe, A. G.
Thinn, C. A.
Thomas, R. H.
Toenniges, G. C.
Tomlinson, M. C. W.
Truitt, J. E.
Tweed, C. F.
Valentine, H. D.
Walsh, A. F.
Walters, V.
Walters, W. T.
Walther, V. H.
Watkins, J. A.
Widdicombe, R. A.

Decatur—
Shorb, W. A.

Edwardsville—
Blackmore, F. H.

Evanston—
Chubb, J. E.
Cuyler, D. H.
Mauer, W. J.
Thomas, H. G.

Granite City—
Bergner, W. G.

Hinsdale—
Van Inwagen, F.

Hubbard Woods—
Frank, J. M.

Joliet—
Menk, R. W.
Yardley, R. W.

Kewanee—
Baker, E. E.
Bronson, C. E.
Dickson, R. B.

LaGrange—
Eaton, B. K.
Ellis, W. C.
Linn, H. R.

Moline—
Nelson, H. W.
Nordine, L. F.
Otis, G. E.
Tyler, F. T.

Oak Park—
Blanding, G. H.
Chatterdon, B. W.
March, R. C.
May, E. A.
Muir, G. A.
Uhlhorn, W. J.

Olney—
French, B. P.

Onarga—
Zirhut, G. A.

Peoria—
Robb, J. M.

Urbana—
Day, V. S.
Kratz, A. P.
Willard, A. C.

Waukegan—
Reynolds, H. M.
Skinner, H. W.

Winnetka—
Ellis, E. E.

INDIANA

Elkhart—
Shreiner, D. C.

Hammond—
Crannell, C. A.

Indianapolis—
Ammerman, C. R.
Cones, Benj.
Fenstermaker, S. E.
Hagedon, C. H.
Hayes, J. G.
LaFollette, B. F.
Perham, S. H.
Repp, H. L.
Rotz, J. M.
Shipp, C. C.
Sproull, H. E.
Stitt, H. B.
Voorhees, G. A.
Warren, C. N.
Weinshank, T.

Lafayette—
Hoffman, J. D.
Noland, R. W.
Orth, J. W.

La Porte—
Shrock, J. H.

Michigan City—
Stockwell, W. R.

Muncie—
Hutzel, M. H.
Hutzel, V. C.

Peru—
Pyle, J. W.
Thrush, H. A.

Terre Haute—
Prox, R. F.

Washington—
Mewshaw, J. P.
Myers, D. R.

IOWA

Ackley—
Nelson, G. O.

Cedar Rapids—
Motejl, J. A.

Clinton—
Brown, W. H.

Des Moines—
Gunton, W.

Dubuque—
Molo, H. E.

Fort Madison—
Theisen, E. F.

Le Mars—
Mathey, N. J.

Sioux City—
Orr, M. J.

Waterloo—
Bartley, J. S., Jr.
Irwin, C. W.
Winterbottom, J. W.
Winterbottom, R. F.

KANSAS

Emporia—
Burnap, C. W.
Hill, C. H.

Hutchinson—
Barnes, A. R.
Hertz, H. P.
Stevens, H. L.

Independence—
Sellers, F. J.

Lindsborg—
Holmberg, J. A.

Manhatten—
Hull, B. R.

Wichita—
Buckley, R. B.
Cloud, O. E.
O'Connor, J. M.

KENTUCKY

Louisville—
Lewis, J. C.
Lissauer, A. W.
Murphy, H. C.

LOUISIANA

New Orleans—
Todd, J. M.

MAINE

Portland—
Fels, A. B.
Merrill, C. J.
Webb, J. S.

Woodfords—
Haskell, B. E.

MARYLAND

Baltimore—
Adams, H.
Berger, C. D.
Collier, W. I.
Dorsey, F. C.
Eisert, H.
Groscup, W. F.
Huether, C. G. L.
Kries, H. A.
Leilich, R. L.
McCrea, L. W.
Moore, D. S.
Munroe, E. K.
Posey, J.
Reeder, C. L.
Vance, L. G.
Wachter, J. A.

Chevy Chase—
Cooley, M. S.

Howard County—
Tibbets, J. C.

Linthicum Heights—
Roger, G. H.

Rockville—
Brunett, A. L.

MASSACHUSSETTS

Arlington—
Connell, H. E.
Higgins, J. M.
Whitaker, E. C.

Auburndale—
Mason, O. A.

Belmont—
Newcomb, R.

Boston—
Abboud, A.
Andrews, B. R.
Bartlett, A. C.
Barton, R. E.
Boardman, W. E.
Bostwick, C. G.
Boyden, D. S.
Brinton, J. W.
Brooks, T. C.
Bryant, Dr. A. G.
Carey, J. J.
Cooper, F. I.
Davidson, P. L.
Densmore, E. D.
Doody, C. A.
Drinker, P.
Duquet, A. M.
Dusossoit, E. A.
Ehrenzeller, A.
Foulds, P. A. L.
Franklin, R. S.
Gleason, G. H.
Gilmore, F. P.
Goodrich, C. F.
Herrick, D. A.
Hosterman, C. C.
Hubbard, A.
Ingalls, F. D. B.
Kelley, J. J.
Kellogg, A.
Kenneally, V. J.
Kimball, C. W.
Kirmes, E. W.
Lyle, E. T.
McCoy, T. F.
McKenna, Wm. N.
McLean, I. D.
Matthews, C. R.
Miller, M. P.
Mower, W. P.
Myrick, J. W. H.
Osborne, M. M.
Preble, J. J.
Shaw, E.
Shaw, R. E.
Smallman, W. T.
Stearns, W. F.
Stetson, L. R.
Stone, E. R.
Tilden, E. E.
Tuttle, J. F.
Underhill, W. W.
Whittemore, E. H.
Whitten, H. E.
Wiegner, H. B.
Wilcox, Wm.
Wilson, H. M.
Yaglou, C. P.

Cambridge—
Baker, R. H.
Cox, C. J.
Flint, C. T.
Heath, F. R.
Klonower, A. A.
Norton, Prof. A. E.

Dorchester—
Plunkett, J. H.
Shaw, N. J. H.

Everett—
McMurrer, L. J.

Fitchburg—
Karlson, A. F.

Framingham—
Scott, A. P.

Hyde Park—
Ellis, F. R.
Scheibel, A. H.

Lowell—
Foisy, G. A.
Jenkins, H. E.

Lynn—
Feehan, J. B.
Morgan, F. H.
Pool, S. H.
Reardon, J. A.

Medford—
Dane, I. S.
Suits, G. A.

Melrose—
Pierce, C. F., Jr.
Smallman, E. W.

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Mitchell, C. H.

Newtonville—
Jones, W. T.

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Robbins, L. G.

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Gilling, W. F., Jr.

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Cousens, W. S.

West Roxbury—
Roberts, W. L.

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Swaney, C. R.

Weymouth—
Clough, L.

Woburn—
Parker, P.

Wollaston—
Hodgdon, H. A.

MICHIGAN

Ann Arbor—
Backus, T. H. L.
Brender, P. E.
Cuthbert, I. N.
Emswiler, Prof. J. E.
Giguere, G. H.
Hutzel, A. F.
Zopata, E. L.

Detroit—
Addy, R.
Baier, W. P.
Barth, H. E.
Bishop, F. R.
Boales, W. G.
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Calvert, N. W.
Clark, E. H.
Cockburn, L. S.
Collamore, R.
Connell, R. F.
Coon, T. E.
Dauch, E. O.
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Decker, E. M.
Degan, J. E.
Donahue, E. S.
Dubry, E.
Dwyer, J. V.
Emerick, S. H.
Fuller, J. L.
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Graeff, R. J.
Hamlin, H. A.
Harms, W. T.
Harrigan, E. M.
Harris, E. E.
Heydon, C. G.
Hill, N. J.
Hillman, R. W.
Hogan, E. L.
Hubbard, N. B.
Johnson, F. W.
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Knight, A. B.
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Skagerberg, R.
Smith, L. L.
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Soderberg, C. H.
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Walker, J. H.
Wallich, A. C.
Walton, H. L.
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Whitten, H. W.
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Whiteley, J.
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Wooley, T. R.
Ziel, H. E.

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Winterer, R. J.

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Worm, A.
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Wright, H. H.

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Haller, A. L.
Hallett, E. S.
Halley, W. H.
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Harris, H. W.
Hester, T. J.
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Keiser, W.
Kinealy, J. H.
Klein, W. A.
Lane, A. M.
Langenberg, E. B.
Legier, E. W.
Lohman, W. J.
Milward, R. K.
Moon, L. W.
Moritz, C. J.
Mueller, B. H.
Nader, J. H.
Niestrath, W. H.
Pickett, C. A.
Quentin, E. H.
Riley, A. H.
Rosebrough, R. M.
Rossman, V. D.
Russell, W. L. A.
Sachleben, E. H.
Schulze, B. H.
Sodemann, W. C.
Stammer, E. L.
Thomsen, W. T.
Walters, A. L.
White, E. A.

Sedalia—
Suter, G.

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Tooker, C. C.

Bozeman—
Powers, F. I.

Helena—
Bain, J. G.

NEBRASKA

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Gedney, K. H.

Omaha—
McCulley, D. E.
Merwin, G. E.
Shea, M. B.

NEW JERSEY

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Krueger, W. E.

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Nesbitt, J. J.
Strouse, S. B.

Audubon—
Whitby, S. S.

Bloomfield—
Taylor, T. S.

Bogota—
Heebner, W. M.

Camden—
Eveleth, C. F.
Kappel, G. W. A.
Lind, C. C.
Strandwitz, W. J.
Webster, E. K.
Webster, W.

Closter—
Atkinson, H. G.

East Orange—
Crone, T. E.
Merkel, F. P.
Schroth, A. H.
Turno, W. G. W.

Elizabeth—
Cornwall, G. T.
Pearce, C. E.
Wheller, H. S.

Essex Fells—
Stacey, A. E., Jr.

Gloucester—
Schrader, C. C.

Haddonfield—
Braemer, W. G. R.
Dobbs, C. E.

Hasbrouck Heights—
Goodwin, S. L.

Hilton—
Heiles, F. C.

Jersey City—
Butler, P. D.
Calahan, J. J.
Jones, H. L.
Ritchie, W.
Walterthum, J. J.

Jobstown—
Allinson, O. H.

Kearney—
Vogelbach, O.

Lyndhurst—
Ehrlich, M. W.

Maplewood—
Cadmus, R.
Smith, M. S.

Merchantville—
Binder, C. G.

Newark—
Bailey, J. H.
Bartlett, C. D.
Beatty, D. J.
Bentz, H.
Carrier, W. H.
Duncan, J. R.
Janet, H. L.
Kieb, A. A.
Lewis, L. L.
Lindeman, H.
Lyle, J. I.
Noble, M.
Soule, L. C.
West, P.

North Bergen—
Reichwald, C. W.

Orange—
Hochuli, H. W.
Terry, F. W.

Passaic—
Hankin, R.
Morris, C. R.

Paterson—
Pryor, F. L.

Plainfield—
MacDougall, B. W.
Tobin, G. J.

Ridgefield—
Davis, A. C.

Riverton—
Brunt, T. B.
Nesdahl, E.

Short Hills—
Fouilhoux, J. A.

Trenton—
Black, J. J. A.
Piper, A.
Piper, E. R. W.
Russell, W. E.

Union City—
Taverna, F. F.
Thuem, A. E.

Wenonah—
Terrell, H. A.

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Hynes, L. P.
Murray, T. F.
Naden, L. J.
Ryan, H. J.
Taggart, R. G.

Amsterdam—
Dwyer, F. A.

Bronxville—
Barr, G. W.

Brooklyn—
Atwater, L. W.
Bender, C. P.
Blest, F. S.
Crutchley, E., Jr.
Dailey, J. A.
Dwyer, T. F.
Emery, W. D.
Gardner, B. F.
Gornston, M. H.
Grotz, A. B.
Hanley, J. H., Jr.
Hinchman, E. G.
Kiewitz, C.
McCann, F. G.
McCloskey, J.
Mandeville, E. W.
Moss, E.
Musaus, J., Jr.
Phillips, F. W., Jr.
Robertson, G. A.
Ruppert, E. H.
Scollay, U. G.
Seward, P. H.
Shay, R. A.
Siegel, L.
Snyder, C. B. J.
Tisnower, W.
Upington, G. P.
Vivarttas, E. A.
Weibert, C. J.
White, H. A.
Wilson, F. A.
(Bellaire, L. I.)
Williamson, F. W.

Buffalo—
Booth, C. A.
Bresnahan, J. J.
Case, E. W.
Cherry, L. A.
Criqui, A. A.
Danforth, N. L.
Dempsey, H. P.
Dillman, E. J.
Drake, G. H.
Dyer, O. K.
Eddy, E. J.
Eggleston, L. W.
Evans, C. A.
Farnham, R.
Farrar, C. W.
Flink, C. H.
Frank, O. E.
Frank, G. W.
Fraser, W. G.
Gibbs, H. E.
Harding, L. A.
Hedley, P. S.
Howell, F. B.
Hutzel, H. F.
Jackson, M. S.
Kamman, A. R.
Landers, J. J.
Laperle, L. G.
Love, C. H.
Monin, E. H.
Mosher, C. H.
Padginton, G.
Quigley, W. J.
Reinhard, E. L.
Riley, D. H.
Rooney, M. A.
Ruckel, J. B.
Scheer, F. W.
Schoepflin, P. H.
Snyder, J. S.
Thomas, B. A.
Thornton, R. T.
Wadley, C. P.
Wendt, E. F.
Wendt, H. W.
Worsham, H.
Yager, J. J.

Dunkirk—
Sawade, C. A.

Eastwood—
Longwell, H. E.

Elmira—
Davenport, E. A.
Davis, B. C.
Frutchy, A. E.
McGlenn, G. R.

Freeport—
Ellison, J. H.

Geneva—
Herendeen, F. W.

Glens Falls—
Robinson, A. G.

Harrison—
Schluter, H.

Hempstead—
Hinkle, E. C.

Herkimer—
Ertman, B. R.

Irvington-on-Hudson—
Angell, W. T.
Bastedo, A. E.
Kittle, F. C.

Ithaca—
Sawdon, W. M.
Williams, J. W.

Kingston—
Meyer, J. S.

Larchmont—
Gaylor, W. S.

Lockport—
Bishop, C. R.

Middletown—
Sanborn, S. H.

Morton—
Stangland, B. F.

Mt. Vernon—
Hunt, R. B.
Obert, C. W.

New Rochelle—
Vose, R. H.

New York City—
Abrams, A.
Addams, H.
Adler, A. A.
Alling, H. W.
Almirall, J. A.
Amiral, J. H.
Angus, R. A.
Armagnac, A. S.
Bachler, L. J.
Bailey, W. C.
Bampton, C. M.
(Hollis, L. I.)
Barwick, T.
Baum, A. L.
Beebe, F. E. W.
Bennitt, G. E.
Berman, L. K.
Binder, I.
Birch, H. A.
Blackmore, J. J.
Blizard, J.
Bloom, W.
Bolton, R. P.
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Callahan, M. J.
(L. I. City)
Carpenter, R. H.
Carty, T.
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Chadeayne, G. D.
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(Jamaica, L. I.)
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Darts, J. A.
Davis, P. L.
(Jamaica, L. I.)
Dill, H. O.
Dillon, H. R.
Doherty, J. A.
Donnelly, J. A.
Donnelly, R.
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Eadie, J. G.
Easterbrooks, C. C.
Edelston, S. H.
Emerson, R. R.
Engle, A.
Engle, H. J.
Evans, W. A.
Fay, F. C.
Feldman, A. M.
Fiedler, H. W.
Fink, R.
Fitz, G. L.
Fleisher, W. L.
Fletcher, S. W.
Fogg, O. H.
Forgee, F. A.
Friedman, A.
Fuller, C. A.
Glore, E. F.
Goldberg, H. M.
Goldschmidt, O. E.
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Hanson, H. A.
Heatherton, J. M.
Hedges, H. B.
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Hoffman, G. D.
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Houghten, F. C.
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Lawrence, C. E.
LeBeau, J. F.
LeCompte, W. G.
London, I.
Lucke, C. E.
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McMahon, W. W.
McMillan, L. B.
Macon, W. W.
Maier, G. M.
Marshall, H. H.
Martin, G. W.
Matthiessen, H. G. F.
Medway, F. J.
Merritt, J. H.
Meyer, H. C., Jr.
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Miller, E. A.
Miller, R. B.
Munder, J. F., Jr.
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Musselman, J. F.
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Norton, F. W.
Oaks, O. O.
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Reed, J. F.
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Riblet, W. H.
Richardson, D. R.
Riley, C. L.
Ritchie, E. J.
Ritter, A.
Rodman, R. W.
Ross, J. O.
Rudio, H. M.
Russell, W. A.
Schmidt, G. G.
Schneider, C.
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Scott, E. A.
Scott, G. M.
Sellman, N. T.
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Spofford, H. H. R.
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Timmis, W. S.
Timmis, W. W.
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Coe, R. T.
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Steim, C. J., Jr.
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Wilder, E. L.
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Willis, R. P.

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Janes, A.

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Syracuse—
Acheson, A. R.
Bradley, R. H.
Dennis, C. K.
Driggs, L. L.

Tomkinsville—
Heap, W. E.

Troy—
Brown, S. J.
Wilson, C. H.

Utica—
Baxter, R. A.
Brandeles, H. J.
Cantwell, W. T.
Hamjy, P. W.
Hoffman, C. F.
Hughes, W. C.
Norris, E.
Norris, J. K.
Phegley, F. G.
Schneider, P. W.
Steinhorst, T. F.

West Point—
Bryant, P. J.

White Plains—
Callahan, T. H.

Yonkers—
Greason, D. R.
Kelly, J. G.
Rainger, W. F.

NORTH CAROLINA

Charlotte—
Christian, C. W.
Hackney, H.

Greensboro—
MacKenzie, B.

Raleigh—
Templin, C. L.

Winston-Salem—
Bahnson, F. F.

NORTH DAKOTA

Fargo—
Kurke, W. F.

OHIO

Akron—
Humphrey, D. E.
Stanford, L. E.
Thatcher, G. S.

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Bostain, J. C.
Doyle, W. J.
Green, W. C.
Grier, W.
Kiefer, C. J.
Schlemmer, O. H.
Stanwood, J. B.
Wright, K.

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Anderson, E. L.
Beyer, J. E.
Bray, D. S.
Bridges, F. G.
Brueggeman, A. R.
Clark, H. J.
Clark, W. C. M.
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Daugherty, F. M.
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Deex, C. J.
Empkey, G. J.
Farley, J. W.
Friday, L. M.
Gottwald, C.
Graham, W. D.
Greene, W. C.
Harrison, J. M.
Hautz, E. H.
Kinner, J. E.
Kissick, J. J.
Klie, W.
Leonhard, F.
Mason, J. J.
Mayer, R. S.
Mouat, T. G.
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Poole, E. F.

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Wilson, H. A.

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Russell, H. C.

Knoxville—
Reeder, F. C.

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Sodemann, P.

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Fort Worth—
Burnett, E. S.

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Helphingstein, O.

Houston—
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Waddington, B. C.

San Angelo—
Hogue, C. T.

San Antonio—
Ebert, W. A.

UTAH

Salt Lake City—
Coogan, J.

VERMONT

Burlington—
Austin, F. L.
Raine, J. J.
Wheelock, H. C.

N. Ferrisburg—
Breckenridge, L. P.

VIRGINIA

Lynchburg—
Doering, F. L.
Wiley, E. C.
Wilson, E. J. F.

Newport News—
Noland, L. U.

Norfolk—
Montagna, C. J.
Peebles, J. K.
Wilson, E. K.

Richmond—
Austin, W. E.
Beverley, R. C.
Childress, W. L.
Johnston, J. A.
Koch, H. O.
Schulz, H. I.

Roanoke—
Wash, W. P.

Staunton—
Moffett, W. S.
Moran, F. N.

WASHINGTON

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Bysom, L. L.

Seattle—
Ayers, A. E.
Carsten, W. H.
Cox, W. W.
DeLong, F. B.
Dudley, W. L.
Eastwood, Prof. E. O.
Eckart, C. H.
Godfrey, F. H.
Lavan, P. J.
Mallis, W.
Moore, J. C.
Nevins, J. R.
O'Connell, P. M.
Ruddell, W. H.
Santmyer, W. J.
Stark, E. A.
Twist, C. F.
Weber, E. G. L.
Zokelt, C. G.

Spokane—
DeLong, H. B.
Nelson, R. L.

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Charleston—
Matthews, J. K.
Meyers, S. H.
Shanklin, J. R.

Morgentown—
Zeck, A.

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Hare, E. S.
Seabright, L. C.

WISCONSIN

Eau Claire—
Grosvold, F. E.

Fond Du Lac—
Ahern, T. L.

Fort Akinson—
Shodron, J. G.

Green Bay—
Kingsbury, J. W.

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Jackson, C. H.
Jung, J. S.
Juttner, O. J.
Meadows, F. H.
Miller, C. W.
Miller, H. M.
Mueller, P. E.
Olson, R. G.
Ostrander, L. F.
Page, H. W.
Rice, C. J.
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Weimer, F. G.
Wilson, W. H.
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Worthing, E.
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Jarvis, G. E.

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Cheyenne—
Meyring, A. S.

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Druce, J. J.

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Bladon, J. B.
Fry, J. D.
Friedman, F. J.
Hamlet, F. A.
Hamlet, T. F.
Higgins, T. J.
Hills, A. H.
Kastello, A.
Osborne, G. H.
Peterson, E. A.
Wiggs, G. L.

Sault Ste.—
Wilson, W. S.

Toronto, Ont.—
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Baldwin, W. H.
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Blackhall, W. R.
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Dickey, A. J.
Doughty, C. J.
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Flett, H. R.
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Jennings, S. A.
Laidlaw, E. J.
Leitch, A. S.
McHenry, R. W. M.
McMichael, P.
Mansell, P. C.
Moore, H. S.
O'Neill, J. W.
Owens, C. B.
Paterson, J. S.
Paterson, W. B.
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Mackie, J.
Kirk, C. D.

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1st Vice-President ..... Andrew Harvey
2nd Vice-President ..... Robert C. Clarkson
Treasurer ..... Judson A. Goodrich
Secretary ..... Wm. M. Mackay

Board of Governors

Chairman, A. E. Kenrick

John Gormly, *Vice-Chm.*	J. H. Kinealy
R. C. Carpenter	C. B. J. Snyder
Wm. Kent	Wm. M. Mackay, *Secy.*

1903

President ..... H. D. Crane
1st Vice-President ..... Wm. Kent
2nd Vice-President ..... R. P. Bolton
Treasurer ..... Judson A. Goodrich
Secretary ..... Wm. M. Mackay

Board of Governors

Chairman, H. D. Crane

C. B. J. Snyder, *Vice-Chm.*	A. E. Kenrick
R. C. Carpenter	Geo. Mehring
John Gormly	Wm. M. Mackay *Secy.*

1904

President ..... Andrew Harvey
1st Vice-President ..... John Gormly
2nd Vice-President ..... Robert C. Clarkson
Treasurer ..... Ulysses G. Scollay
Secretary ..... Wm. M. Mackay

Board of Governors

Chairman, Andrew Harvey

John Gormly	H. D. Crane
Robert C. Clarkson	A. E. Kenrick
J. J. Blackmore	C. B. J. Snyder
R. C. Carpenter	Wm. M. Mackay, *Secy.*

1905

President ..... Wm. Kent
1st Vice-President ..... R. P. Bolton
2nd Vice-President ..... C. B. J. Snyder
Treasurer ..... Ulysses G. Scollay
Secretary ..... Wm. M. Mackay

Board of Governors

Chairman, Wm. Kent

R. P. Bolton	James Mackay
C. B. J. Snyder	B. F. Stangland
B. H. Carpenter	J. C. F. Trachsel
A. B. Franklin	Wm. M. Mackay, *Secy.*

1906

President ..... John Gormly
1st Vice-President ..... C. B. J. Snyder
2nd Vice-President ..... T. J. Waters
Treasurer ..... Ulysses G. Scollay
Secretary ..... Wm. M. Mackay

Board of Governors

Chairman, John Gormly

C. B. J. Snyder, *Vice-Chm.*	A. B. Franklin
T. J. Waters	James Mackay
R. C. Carpenter	B. F. Stangland
Frank K. Chew	Wm. M. Mackay, *Secy.*

1907

President ..... C. B. J. Snyder
1st Vice-President ..... James Mackay
2nd Vice-President ..... Wm. G. Snow
Treasurer ..... Ulysses G. Scollay
Secretary ..... Wm. M. Mackay

Board of Governors

Chairman, C. B. J. Snyder

James Mackay, *Vice-Chm.*	Edmund F. Capron
Wm. G. Snow	Frank K. Chew
R. E. Atkinson	A. B. Franklin
R. C. Carpenter	Wm. M. Mackay, *Secy.*

1908

President ..... James Mackay
1st Vice-President ..... Jas. D. Hoffman
2nd Vice-President ..... B. F. Stangland
Treasurer ..... Ulysses G. Scollay
Secretary ..... Wm. M. Mackay

Board of Governors

Chairman, James Mackay

Jas. D. Hoffman, *Vice-Chm.*	John F. Hale
B. F. Stangland	August Kehm
R. C. Carpenter	C. B. J. Snyder
Frank K. Chew	Wm. M. Mackay, *Secy.*

1909

President ..... Wm. G. Snow
1st Vice-President ..... August Kehm
2nd Vice-President ..... B. S. Harrison
Treasurer ..... Ulysses G. Scollay
Secretary ..... Wm. M. Mackay

Board of Governors

Chairman, Wm. G. Snow

August Kehm, *Vice-Chm.*	Samuel R. Lewis
B. S. Harrison	James Mackay
John R. Allen	B. F. Stangland
R. C. Carpenter	Wm. M. Mackay, *Secy.*

1910

President ..... Jas. D. Hoffman
1st Vice-President ..... R. P. Bolton
2nd Vice-President ..... Samuel R. Lewis
Treasurer ..... Ulysses G. Scollay
Secretary ..... Wm. M. Mackay

Board of Governors

Chairman, Jas. D. Hoffman

R. P. Bolton, *Vice-Chm.*	Judson A. Goodrich
Samuel R. Lewis	John F. Hale
Geo. W. Barr	James Mackay
R. C. Carpenter	Wm. M. Mackay, *Secy.*

1911

President ..... R. P. Bolton
1st Vice-President ..... John R. Allen
2nd Vice-President ..... A. B. Franklin
Treasurer ..... Ulysses G. Scollay
Secretary ..... Wm. W. Macon

Board of Governors

Chairman, R. P. Bolton

John R. Allen, *Vice-Chm.*	James H. Davis
A. B. Franklin	Jas. D. Hoffman
John T. Bradley	August Kehm
R. C. Carpenter	Wm. W. Macon, *Secy.*

1912

President ..... John R. Allen
1st Vice-President ..... John F. Hale
2nd Vice-President ..... Edmund F. Capron
Treasurer ..... James A. Donnelly
Secretary ..... Wm. W. Macon

Board of Governors

Chairman, John R. Allen

John F. Hale, *Vice-Chm.*	Dwight D. Kimball
Edmund F. Capron	Samuel R. Lewis
R. P. Bolton	Wm. M. Mackay
Jas. D. Hoffman	Wm. W. Macon, *Secy.*

1913

President ..... John F. Hale
1st Vice-President ..... A. B. Franklin
2nd Vice-President ..... Edmund F. Capron
Treasurer ..... James A. Donnelly
Secretary ..... Edwin A. Scott

Board of Governors

Chairman, John F. Hale

A. B. Franklin, *Vice-Chm.*	James A. Donnelly
John R. Allen	Dwight D. Kimball
Edmund F. Capron	Wm. W. Macon
R. P. Bolton	James M. Stannard
Frank T. Chapman	Theodore Weinshank
Ralph Collamore	Edwin A. Scott, *Secy.*

1914

President ..... Samuel R. Lewis
1st Vice-President ..... Edmund F. Capron
2nd Vice-President ..... Dwight D. Kimball
Treasurer ..... James A. Donnelly
Secretary ..... J. J. Blackmore

Council

Chairman, Samuel R. Lewis

E. F. Capron, *Vice-Chm.*	John F. Hale
Dwight D. Kimball	Harry M. Hart
John R. Allen	Frank G. McCann
Frank T. Chapman	Wm. W. Macon
Frank I. Cooper	James M. Stannard
James A. Donnelly	J. J. Blackmore, *Secy.*

1915

President ..... Dwight D. Kimball
1st Vice-President ..... Harry M. Hart
2nd Vice-President ..... Frank T. Chapman
Treasurer ..... Homer Addams
Secretary ..... J. J. Blackmore

Council

Chairman, Dwight D. Kimball

Harry M. Hart, *Vice-Chm.*	Samuel R. Lewis
Frank T. Chapman	Frank G. McCann
Homer Addams	J. T. J. Mellon
Frank I. Cooper	Henry C. Meyer, Jr.
E. Vernon Hill	Arthur K. Ohmes
Wm. M. Kingsbury	J. J. Blackmore, *Secy.*

1916

President ..... Harry M. Hart
1st Vice-President ..... Frank T. Chapman
2nd Vice-President ..... Arthur K. Ohmes
Treasurer ..... Homer Addams
Secretary ..... Casin W. Obert

Council

Chairman, Harry M. Hart

F. T. Chapman, *Vice-Chm.*	E. Vernon Hill
Arthur K. Ohmes	Dwight D. Kimball
Homer Addams	Henry C. Meyer, Jr.
Charles R. Bishop	Fred R. Still
Frank I. Cooper	Walter S. Timmis
Milton W. Franklin	Casin W. Obert, *Secy.*

1917

President ..... J. Irvine Lyle
1st Vice-President ..... Arthur K. Ohmes
2nd Vice-President ..... Fred R. Still
Treasurer ..... Homer Addams
Secretary ..... Casin W. Obert

Council

Chairman, J. Irvine Lyle

A. K. Ohmes, *Vice-Chm.*	Charles A. Fuller
Fred R. Still	Harry M. Hart
Homer Addams	E. Vernon Hill
Davis S. Boyden	James M. Stannard
Bert C. Davis	Walter S. Timmis
Milton W. Franklin	Casin W. Obert, *Secy.*

Roll of Membership

1918

President.....Fred R. Still
1st Vice-President.....Walter S. Timmis
2nd Vice-President.....E. Vernon Hill
Treasurer.....Homer Addams
Secretary.....Casin W. Obert

Council

Chairman, Fred R. Still
W. S. Timmis, *Vice-Chm.* — J. Irvine Lyle
Homer Addams — E. Vernon Hill
William H. Driscoll — Frank G. Phegley
Howard H. Fielding — Fred. W. Powers
H. P. Gant — Champlain L. Riley
C. W. Kimball — Casin W. Obert, *Secy.*

1919

President.....Walter S. Timmis
1st Vice-President.....E. Vernon Hill
2nd Vice-President.....Milton W. Franklin
Treasurer.....Homer Addams
Secretary.....Casin W. Obert

Council

Chairman, Walter S. Timmis
E. Vernon Hill, *Vice-Chm.* — Frank G. Phegley
Homer Addams — Fred. W. Powers
Howard H. Fielding — Robt. W. Pryor, Jr.
Milton W. Franklin — Champlain L. Riley
Harry E. Gerrish — Fred R. Still
George B. Nichols — Casin W. Obert, *Secy.*

1920

President.....E. Vernon Hill
1st Vice-President.....Champlain L. Riley
2nd Vice-President.....Jay R. McColl
Treasurer.....Homer Addams
Secretary.....Casin W. Obert

Council

Chairman, E. Vernon Hill
C. L. Riley, *Vice-Chm.* — Jay R. McColl
Homer Addams — George B. Nichols
Jos. A. Cutler — Robt. W. Pryor, Jr.
Wm. H. Driscoll — W. S. Timmis
A. C. Edgar — Perry West
Alfred Kellogg — Casin W. Obert, *Secy.*

1921

President.....Champlain L. Riley
1st Vice-President.....Jay R. McColl
2nd Vice-President.....H. P. Gant
Treasurer.....Homer Addams
Secretary.....Casin W. Obert

Council

Chairman, Champlain L. Riley
Jay R. McColl, *Vice-Chm.* — E. S. Hallett
Homer Addams — E. Vernon Hill
Jos. A. Cutler — Alfred Kellogg
Samuel E. Dibble — E. E. McNair
Wm. H. Driscoll — Perry West
H. P. Gant — Casin W. Obert, *Secy.*

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1926

1922

President.....Jay R. McColl
1st Vice-President.....H. P. Gant
2nd Vice-President.....Samuel E. Dibble
Treasurer.....Homer Addams
Secretary.....Casin W. Obert

Council

Chairman, Jay R. McColl
H. P. Gant, *Vice-Chm.* — L. A. Harding
Homer Addams — E. E. McNair
Jos. A. Cutler — H. J. Meyer
Samuel E. Dibble — C. L. Riley
Wm. H. Driscoll — Perry West
E. S. Hallett — Casin W. Obert, *Secy.*

1923

President.....H. P. Gant
1st Vice-President.....Homer Addams
2nd Vice-President.....E. E. McNair
Treasurer.....Wm. H. Driscoll
Secretary.....C. W. Obert

Council

Chairman, H. P. Gant
Homer Addams, *Vice-Chm.* — E. S. Hallett
W. H. Carrier — Alfred Kellogg
J. A. Cutler — Thornton Lewis
S. E. Dibble — J. R. McNair
Wm. H. Driscoll — Perry West
Casin W. Obert, *Secy.*

1924

President.....Homer Addams
1st Vice-President.....S. E. Dibble
2nd Vice-President.....William H. Driscoll
Treasurer.....Perry West
Secretary.....F. C. Houghten

Council

Chairman, Homer Addams
S. E. Dibble, *Vice-Chm.* — W. E. Gillham
F. Paul Anderson — L. A. Harding
W. H. Carrier — Alfred Kellogg
J. A. Cutler — Thornton Lewis
William H. Driscoll — Perry West
H. P. Gant — F. C. Houghten, *Secy.*

1925

President.....S. E. Dibble
1st Vice-President.....Wm. H. Driscoll
2nd Vice-President.....F. Paul Anderson
Treasurer.....Perry West
Secretary.....F. C. Houghten

Council

Chairman, S. E. Dibble
Wm. H. Driscoll, Vice-Chm. — W. T. Jones
Homer Addams — Thornton Lewis
F. Paul Anderson — J. H. Walker
W. H. Carrier — Perry West
J. A. Cutler — A. C. Willard
W. E. Gillham — F. C. Houghten, *Secy.*