



GUIDE

HEATING AND VENTILATING GUIDE



1924-25

AMERICAN SOCIETY OF HEATING
HEATING VENTILATING AND AIR CONDITIONING ENGINEERS
VOL 3 1923



628.8

AMERICAN

3

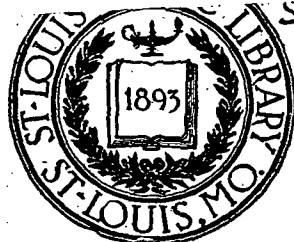
ST. LOUIS
PUBLIC
LIBRARY



American Society of Heating and St
Ventilating Engineers
Heating ventilating air
conditioning guide.
VOL 3 192

628.8
AMERICAN

21718 75807



No. 934127
This Book Shall Not Be Taken From The Library.

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.

AMERICAN SOCIETY *of*
HEATING *and* VENTILATING
ENGINEERS GUIDE
1924-25

CONTAINING REFERENCE AND DESIGN 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 CATALOG AND REFERENCE DATA
SECTION CONTAINING ESSENTIAL
AND RELIABLE FACTS CONCERNING
MODERN EQUIPMENT

AND

THE ROLL OF MEMBERSHIP OF THE
SOCIETY

Vol. 3

\$3.00 PER VOLUME

934127

PUBLISHED ANNUALLY BY

AMERICAN SOCIETY *of* HEATING *and* VENTILATING
ENGINEERS

29 WEST 39TH STREET NEW YORK

COPYRIGHT, 1924

BY

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

Printed and Bound by
THE HORN-SHAFER COMPANY
BALTIMORE :--: MARYLAND

73-157
Ref. 628.8

PREFACE

IN an effort to render a greater service to the science of heating and ventilating than heretofore, this, the third annual edition of THE GUIDE, has been increased in size and usefulness by the addition of many important technical subjects and by improving the character of manufacturers' catalog data.

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 and the second edition published in 1923 the new GUIDE 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.

This third edition is designated THE GUIDE 1924-25 as it is the judgment of the Guide Publication Committee that this later appearance in the year permits more effective handling of the work and fits in more advantageously with the Society's meetings and has the additional value of reaching the users at a most logical time. Future editions are to be designated 1925-26, etc.

The Technical Data have been amplified by additions to both the Heating and Ventilation Sections. The Code for Testing Low Pressure Heating Boilers, Pumps for Heating and Ventilating Service, Oil Burning, and Pipe Sizes for Water Service Lines are new features in the Heating Section while new data are given on Infiltration, Capacities of Steam Heating Risers and Hot Water Heating.

For the Ventilation Section, new chapters outline the present status of the science, give facts about Air Washers, Duct Design, the Pitot Tube and additional data on the Comfort Zone and Effective Temperatures as well as a complete revision of the Ventilator Chapter.

In every case the various chapters are the product of several specialists and revisions have generally been made by the original authors. Other publications of the Society 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, automatic heat control systems, ventilation, air conditioning, exhaust and collecting systems and other related facts that must be considered in the design and installation of a modern Heating and Ventilating Plant.

In connection with an enlarged Catalog Data Section, whereby manufacturers may inform engineers, architects and contractors of the most modern equipment available, a list of products made by the users of Catalog Data Pages is offered as a helpful supplement to this section, affording an accurate Index of the Modern Equipment available. As in the case of both the First and Second Editions all Catalog Data have been carefully edited in an effort to eliminate exaggerated statements or claims. An endeavor has been made to secure line drawings and engineering data from users of Catalog Data space rather than photographic reproductions and general statements for it is believed that data of this character is of greatest interest and of most value to engineers, architects and contractors who use THE GUIDE as a reference volume and to the Manufacturers who wish to helpfully present facts about their Equipment.

The endeavor has been made to materially improve this Third Edition of THE GUIDE from the suggestions of its Users and it is believed that this enthusiastic cooperation from the Profession at large has resulted in making THE GUIDE 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 dedicates 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.

Any funds which may accrue from this activity will be devoted to Research, and will thus react to the mutual advantage of the entire Profession and Trade.

THE GUIDE, for 1924-25, is released with the sincere hope that it will again perform a worth-while service in advancing the ideals of modern Heating and Ventilating.

GUIDE PUBLICATION COMMITTEE

F. D. MENSING, *Chairman*
J. ESTEN BOLLING
C. V. HAYNES
PERRY WEST

Contents

	Page
CODE OF ETHICS	Insert
PREFACE	
HEATING SECTION.....	1-164
CHAPTER I. Heat Losses from Buildings.....	3
CHAPTER II. Heating by Radiation.....	23
CHAPTER III. Pipe Sizes for Steam Heating.....	39
CHAPTER IV. Pipe Sizes for Steam with Counter Flow of Condensate.....	51
CHAPTER V. The Boiler.....	57
CHAPTER VI. Code for Testing Low-Pressure Steam Heating Boilers.....	65
CHAPTER VII. Pumps for Heating and Ventilating Equipment.....	75
CHAPTER VIII. Hot Water Heating.....	97
CHAPTER IX. Warm-Air Furnace Heating.....	113
CHAPTER X. Oil Fuel for Industrial and Domestic Heating.....	125
CHAPTER XI. Gas Heating.....	131
CHAPTER XII. Automatic Heat Control.....	137
CHAPTER XIII. Insulation.....	143
CHAPTER XIV. Pipe.....	151
CHAPTER XV. Pipe Sizes for Water Supply Service.....	161
VENTILATION SECTION.....	165-234
CHAPTER XVI. Ventilation.....	165
CHAPTER XVII. How to Use the Synthetic Air Chart.....	167
CHAPTER XVIII. How Temperature, Humidity and Air Motion Affect Human Comfort.....	175
CHAPTER XIX. Air Washers and Filters.....	187
CHAPTER XX. Air Conditioning.....	191
CHAPTER XXI. Design and Construction of Air Ducts.....	197
CHAPTER XXII. How to Use the Pitot Tube.....	202
CHAPTER XXIII. Exhaust and Collecting Systems.....	207
CHAPTER XXIV. Refrigeration.....	219
CHAPTER XXV. Ventilators and Natural Ventilation.....	227
CATALOG DATA SECTION.....	235-458
MANUFACTURERS' CATALOG DATA.....	235
INDEX TO MODERN EQUIPMENT.....	446
INDEX TO ADVERTISERS.....	456
ROLL OF MEMBERSHIP.....	1-52
OFFICERS AND COUNCIL—1924.....	2
OFFICERS OF LOCAL CHAPTERS—1924-25.....	4
ALPHABETICAL LIST.....	5
SUMMARY OF MEMBERSHIP.....	39
GEOGRAPHICAL LIST.....	40
PAST OFFICERS.....	49

AMERICAN SOCIETY of
HEATING and VENTILATING
ENGINEERS GUIDE

1924-25



PART I

HEATING

INTRODUCTION

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.

Each step in the planning of a heating installation is logically taken up, consideration being given to heat loss, heating apparatus, the piping system and all other items that go to make up a successful system for heating any type of building whether it is a home, factory, school, church or other public building and no matter what the fuel or climate. Examples are given in connection with the text, tables and illustrations so that the procedure is clearly set forth and the results to be expected from the use of the rules given will be in accord with the best engineering practice.

PARTIES RESPONSIBLE FOR
HEATING PLANT PERFORMANCE

It is well to first determine the responsibilities of the three parties upon whom the successful performance of the heating plant depends before setting forth the various factors that must be considered in the proper design of a heating plant. The parties primarily responsible for the performance of the heating plant are the owner, the heating contractor, and the boiler manufacturer. The owner is held responsible for the acts of his agents, such as the consulting engineer and the architect, also the builder.

The owner is responsible: *first*, for the proper construction of the building, according to the plans and specifications furnished to the heating contractor; *second*, for the proper construction of a smoke tight chimney, having at least the minimum dimensions and height to produce the required quantity of draft as recommended by the boiler

manufacturer; *third*, for the quality and kind of fuel furnished; *fourth*, for the proper design of the heating plant when designed by a consulting engineer; *fifth*, for the proper operation of the plant according to the instructions of the heating contractor and the boiler manufacturer.

The heating contractor is responsible: *first*, for the proper construction of the heating plant in a good workmanlike manner according to the plans and specifications; *second*, for the proper design of the heating plant when designed under his own directions.

The boiler manufacturer is responsible: *first*, for the proper rating of the boiler; *second*, for the proper performance of the boiler when operated under standard conditions as to the conditions of the boiler, quantity of draft, kind and quality of fuel, methods of firing and operation, and proper functioning of piping system.

If any one of these nine basic requirements for the successful performance of a heating plant is below par, it is enough to cause failure of a heating plant that otherwise would be a success. A heating plant like a chain is no stronger than its weakest link.

CHAPTER I

HEAT LOSSES FROM BUILDINGS

STRIKING A HEAT BALANCE

THE engineer designing a heating system must strike a balance between the output of heat loss from the building and the input of heat from the heat producing boiler or furnace. The output falls under two main classifications: *infiltration* and *transmission*; and in some cases in the group heating of buildings from line losses. The proper input depends upon the proper size and type of heat distributing units, such as radiators or registers, the proper design or sizes of ducts, piping and other apparatus, and the proper capacity and type of boiler or furnace installed, and with proper and intelligent operating conditions an efficient performance should result. The total heat the heating apparatus must furnish includes the total heat loss plus a heating up factor when the building is to be heated periodically with unheated period in between. The heating up factor is determined by the rate at which the initial heat is required to raise the temperature of the cold building or buildings and their contents to a desired degree in a given time. This heating up factor is often added to the infiltration losses and expressed in terms of *air changes*. The number of air changes per hour which will occur in a room, building or group of buildings depends upon the building construction, exposure, number and type of windows, doors, open fire places, vent registers, and the air admitted by opening and closing doors, and other openings.

Heat loss by transmission is essentially the way in which solid materials transfer heat and is therefore essential that the insulating value of all materials used in building construction be known to the heating engineer that he may calculate the heat loss through these materials when heating rooms or buildings. The rates of this transmission of heat is given in the form of transmission constants and are generally figured for a degree difference between inside and outside temperature.

The heating engineer is confronted with the problem of generating and transmitting heat in a building or group of buildings and delivering that heat to the point or points from which it escapes to the outer atmosphere in quantities equal to the heat loss to the outer atmosphere.

Before going any further, it is proper at this time to say that heat for heating systems is produced at the present time by combustion, that is, such materials as wood, coal and oil are combined with the oxygen of the air into various chemical combinations.

Material for this section was especially prepared for THE GUIDE by P. J. Dougherty, W. L. Durand, W. H. Driscoll and C. V. Haynes. New Infiltration Data by F. C. Houghten.

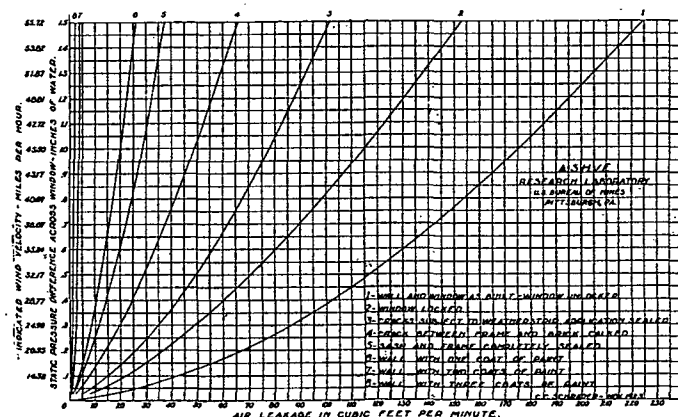


FIG. 1. RESULTS OF TESTS OF LEAKAGE THROUGH VARIOUS PARTS OF WINDOW AND FRAME

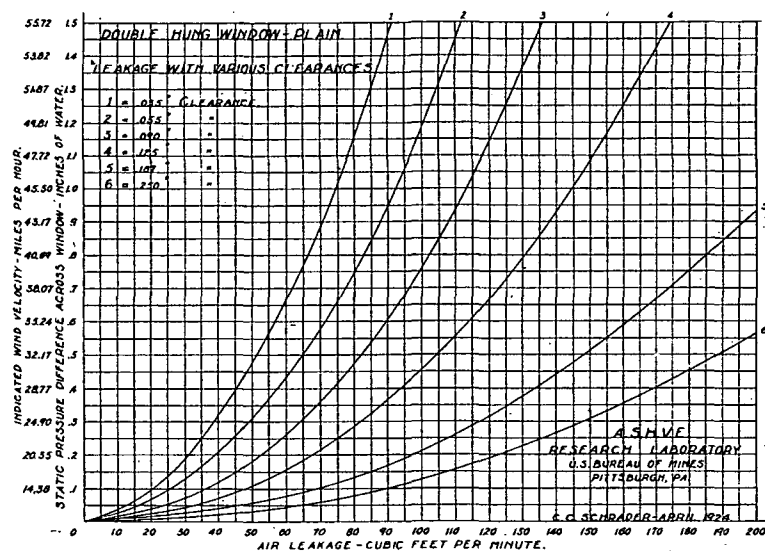


FIG. 2. LEAKAGE THROUGH PLAIN WINDOW WITH VARIOUS CLEARANCES

The measure of heat most commonly accepted in engineering work in the United States of America and Great Britain is the British thermal unit, abbreviated, the B.t.u. and represents the amount of heat required to raise the temperature of one pound of water 1 deg. fahrenheit, abbreviated, fahr. The fahrenheit scale which is commonly used divides temperature between the freezing point of water, 32 deg. and the boiling point 212 deg. into 180 equal parts. In other parts of the world, there is another system in which the calorie is the common unit of heat, of which one B.t.u. equals 0.252 calories or 1 calorie equals 3.968 B.t.u. Instead of the fahrenheit thermometer, the centigrade system is generally used with the calorie in which the thermometer is divided into 100 equal parts between freezing point and the boiling points of water. To convert centigrade temperature the following method can be used:

$9/5 \times \text{centigrade temperature plus } 32 \text{ equals fahr. temperature.}$

To convert fahr. temperature to the centigrade temperature the following method can be used:

$\text{Fahr. temperature minus } 32 \times 5/9 \text{ equals centigrade temperature.}$

INFILTRATION

Infiltration losses can be materially reduced by the use of storm doors, and windows, metal weather-stripping on doors and windows, by calking around doors, and casing in frame construction by close fitting tongue and groove strips covered with heavy building paper, and by the use of insulating materials against the sheathing or in combination with the lath and plaster. There are also various manufactured products used as substitutes for lath and plaster that are of value for the foregoing purpose.

Infiltration losses through brick walls are considerable, and still higher through hollow tile walls, due to the many openings and thin mortar bearing points where the ends of tile abutt. Whitten and March (See A. S. H. & V. E. TRANSACTIONS, Vol. 22, 1916, p. 195), show that it is as difficult to heat an exposed room 25 deg. above zero with 25 mile wind velocity as it would be to heat the same room 25 deg. below zero with no wind velocity.

Strong winds seldom prevail at temperatures below 15 deg. above zero. The drop in temperature for each mile wind velocity is given in an accompanying table (see Table 15) and it can be readily seen that this matter of wind velocity must receive careful consideration in planning and designing heating plants that will render efficient service under all conditions of weather.

This cold air entering through the building construction cracks, and crevices, windows, etc., is a load that the heating plant must meet and each installation presents a particular problem in this respect.

The cold air leaking into the room must be heated from the temperature of the outside air to that of the room temperature. One cubic foot of air at zero weighs 0.086 lb., while at 70 deg. 1 cu. ft. of air weighs only 0.075 lb. Therefore, 0.87 cu. ft. of air leakage into a room at 0 deg. becomes 1 cu. ft. of air at the room temperature of 70 deg. The specific heat of air at constant pressure, or the number of heat units

required to raise 1 lb. of air 1 deg., is 0.2415. To raise 0.87 cu. ft. of air which weighs 0.075 lb. only 1 deg., requires $0.075 \times 0.2415 = 0.0181$ heat units, and to raise it 70 deg. from zero to room temperature, requires $70 \times 0.0181 = 1.267$ heat units.

In every day practice of figuring, the approximate value of 0.02 heat units per cu. ft. per deg. rise in temperature is used in place of 0.0181.

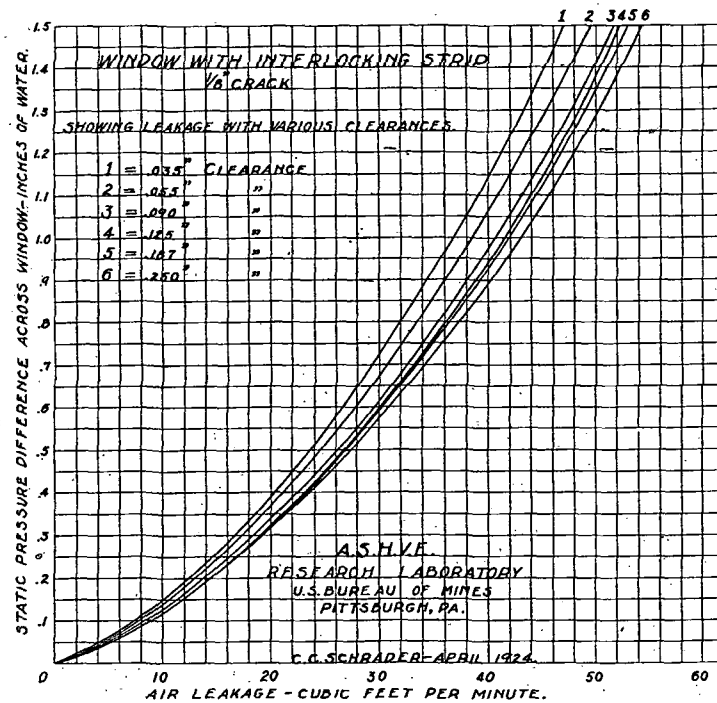


FIG. 3. LEAKAGE THROUGH WEATHER-STRIPPED WINDOW WITH VARIOUS CLEARANCES

Therefore, in order to obtain the heat loss due to infiltration multiply together these four factors: (1) contents of room in cubic feet times (2) number of air changes per hour times (3) the difference in temperature between the inside and outside times (4) 0.02 heat units.

Leakage of air into and from buildings takes place largely around the sash and frame of windows, and around the doors and depends in large measure upon the wind velocity.

The quantity of air leaking through various types of windows with and without weather-stripping has been determined by the Research Laboratory of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

and others as Fig. 1 gives the amount of air leakage through a brick wall, and the various cracks around the sash and frame of a window in such a wall with various wind velocities. The various curves from 1-8 were

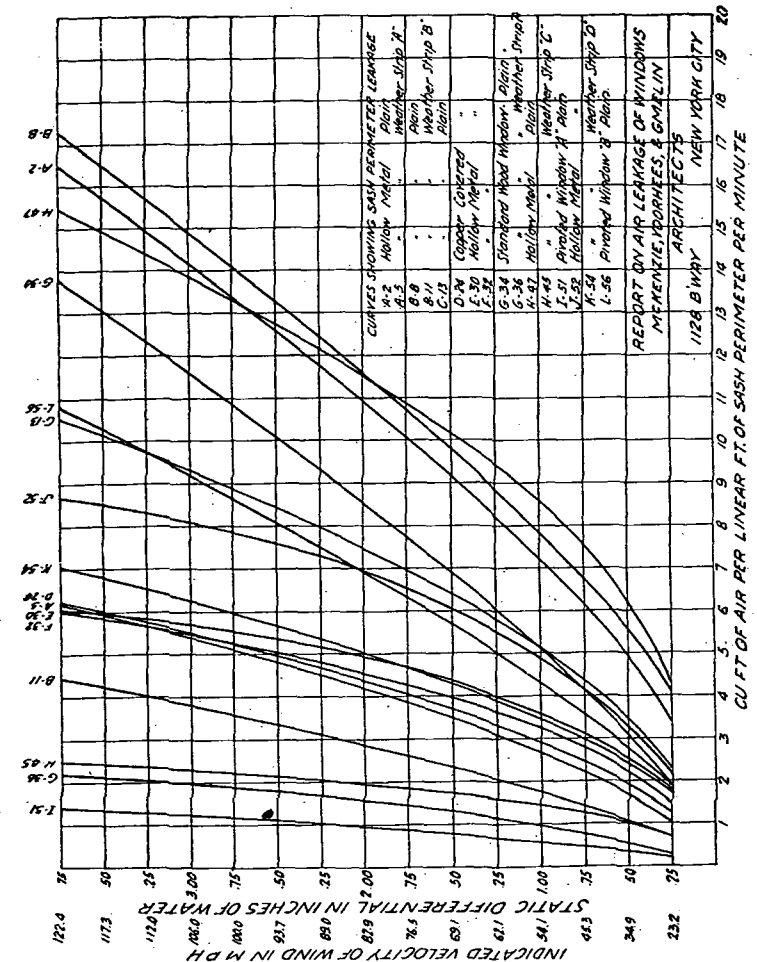


FIG. 4. TOTAL INFILTRATION LEAKAGE FOR VARIOUS WINDOWS TESTED

obtained after sealing off the various cracks through which air leaked as indicated in the legend. A very surprising fact is brought out by curve 5 which shows that considerable air actually leaked through the 50 sq. ft. of 13 in. brick wall tested. Only one such wall has been tested, however,

and infiltration calculations cannot be based with great certainty on this curve.

Fig. 2 gives the leakage around the sash of a double hung window with various clearances.

Fig. 3 gives similar data on the same type of window fitted with an interlocking weather-strip.

Fig. 4 and 5 give the results of test upon other windows.

Table 1 gives the leakage in cubic feet per minute for the whole window and per linear foot of cracks for wind velocities of 14.4 and 24.9 miles per hour. It is of interest to note that for a plain window with crack varying from 1/16 to 1/4 in. the leakage is 46 cu. ft. per min., while, for the two types of weather-stripping tested, it varies from 9 to 18, and 7 to 10 cu. ft. per min.: respectively. The heat loss is given for two temperature differences. Radiation required to supply this heat loss is given for the larger temperature difference. The saving in coal based upon certain conditions is given in the last columns of the table.

Table 2 gives the leakage between the frame and the brick, the elsewhere leakage (leakage which cannot be stopped by perfect weather-strip), the leakage for a plain window not weather-stripped, the leakage for the same window fitted with a rib strip, and with interlocking strip for various wind velocities.

Table 3 gives the leakage in cubic feet per hour per foot of crack per mile wind velocity for a plain frame window and also for frame window fitted with the two types of weather-stripping. The leakage is given for various cracks around the sash perimeter and also for various clearances between the sash and the stop and parting bead.

In determining the heat loss from buildings, infiltration is expressed either as so many air changes per hour, or, more scientifically speaking, as so many cubic feet per minute per linear foot of crack. When the infiltration is estimated as so many air changes per hour the heat loss in B.t.u. per hour is given by,

$$H = NCh (T_i - T_o)$$

where

H = heat loss in B.t.u. per hour.
 N = number of air changes per hour.
 C = cubical contents of the space to be heated.
 h = number of B.t.u. required to raise the temperature of 1 cu. ft. of air 1 deg. fahr. This may be taken as 0.02.
 T_i = inside temperature.
 T_o = outside temperature.

Where the heat loss by infiltration is to be based upon the leakage per linear foot of crack the heat loss for each window and door is given by,

$$H = 160 W_p h (T_i - T_o)$$

where

I = infiltration in cubic feet per minute per linear foot of crack
 W_p = total length of crack.

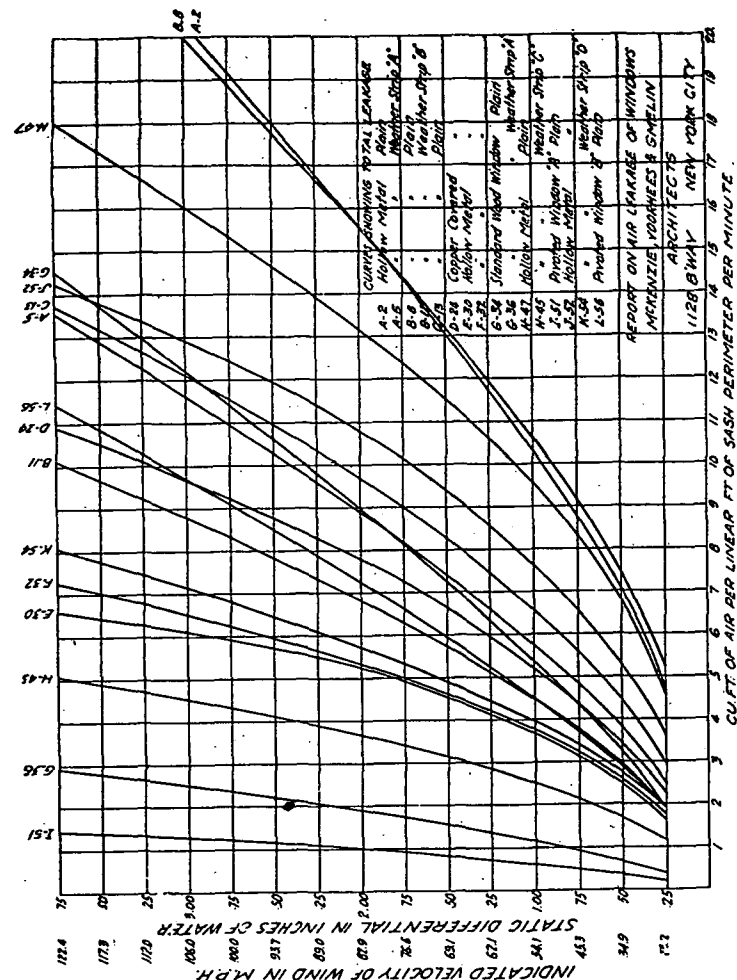


FIG. 5. INFILTRATION LEAKAGE THROUGH THE PERIMETER OF THE SASH ONLY

The other factors have the same significance as in the formula based upon cubical contents.

Substituting the value 0.02 for h this formula becomes

$$H = 1.2 I W_p (T_i - T_o)$$

Infiltration of air into a building or room is always accompanied by an equal out-leakage. The heat loss is that required to heat the incoming

TABLE 2. LEAKAGE IN C.F.M.

TABLE 2. LEAKAGE IN C.F.M.										
WIND VELOCITY M.P.H.		FRAME 17 FT. PERIMETER		ELSEWHERE	WINDOW WITH 1/8 IN. CRACK—PERIMETER 18 FT. 4 IN.					
					Plain		Rib Strip		Interlocking Strip	
					For Total Window	Per Ft. Crack	For Total Window	Per Ft. Crack	For Total Window	Per Ft. Crack
5	0.50	0.0294	0.7	15.0	0.818	1.3	0.071	1.0	0.0546	
7.5	2.3	0.1325	1.8	24.0	1.31	3.0	0.164	2.2	0.1200	
10	4.0	0.2350	2.8	32.5	1.77	5.0	0.273	4.0	0.2180	
15	8.0	0.4710	5.2	47.5	2.59	9.7	0.529	7.8	0.4260	
20	11.0	0.6470	7.6	61.5	3.36	14.8	0.808	11.8	0.6440	
30	19.0	1.1180	13.6	89.0	4.86	25.5	1.390	20.0	1.0920	
40	25.5	1.5000	20.0	118.0	6.44	37.0	2.020	30.0	1.6380	
50	31.5	1.8530	26.0	149.0	8.13	48.5	2.650	41.0	2.2400	

11

CRACK		PLAIN		INTERLOCKING TYPE STRIP								RIB TYPE STRIP							
		$\frac{1}{8}$ "- $\frac{1}{4}$ "		$\frac{1}{8}$ "		$\frac{1}{2}$ "		$\frac{1}{4}$ "		$\frac{1}{8}$ "		$\frac{1}{2}$ "		$\frac{1}{4}$ "					
		Lkg.	B.t.u.	Lkg.	B.t.u.	Lkg.	B.t.u.	Lkg.	B.t.u.	Lkg.	B.t.u.	Lkg.	B.t.u.	Lkg.	B.t.u.				
$\frac{1}{16}$ "	$\frac{1}{8}$ "	4.3	5.45	1.32	1.67	1.48	1.87	1.63	2.07	1.79	2.27	2.31	2.93	2.51	3.18	2.80	3.55	3.34	4.23
$\frac{1}{8}$ "	$\frac{1}{4}$ "	6.6	8.56	1.56	1.98	1.72	2.18	1.88	2.39	2.05	2.59	2.52	3.19	2.71	3.43	3.04	3.85	3.56	4.51
$\frac{3}{16}$ "	$\frac{1}{2}$ "	8.9	11.9	1.67	2.11	1.83	2.32	2.00	2.54	2.17	2.75	2.63	3.33	2.83	3.58	3.17	4.02	3.71	4.70
$\frac{1}{2}$ "	$\frac{3}{4}$ "	11.2	14.2	1.71	2.17	1.89	2.39	2.06	2.62	2.24	2.84	2.68	3.39	2.89	3.66	3.26	4.12	3.83	4.85
$\frac{5}{8}$ "	$1\frac{1}{8}$ "	15.7	19.9	1.74	2.20	1.94	2.45	2.13	2.70	2.33	2.95	2.72	3.44	2.95	3.74	3.35	4.24	3.98	5.04
$1\frac{1}{8}$ "	$1\frac{1}{4}$ "	20.2	25.6	17.5	2.22	1.96	2.48	2.17	2.75	2.38	3.02	2.73	3.46	2.99	3.78	3.41	4.32	4.10	5.19

air up to the temperature of the room. In-leakage takes place on the windward side, and out-leakage on the leeward side of the building. Heat loss by infiltration should, therefore, be figured only for windows and doors on the windward side of the room to be heated. Since the wind will, at different times, come from all directions, radiation must, in practice, be based upon the windows and doors on the side having the greatest window and door area.

Example: What will be the heat loss by infiltration from a room 20 x 12 x 9 ft. high with west, north and east exposure, having one 3 x 6 ft. double hung frame window on each the east and west exposures, and two on the north. Also one 3 x 7 ft. door on the north. Assume a 15 mile wind velocity, 0 deg. outside, and 70 deg. inside temperature. Also assume that the cracks between the frame and the wall are well caulked.

Infiltration must be based on the greatest number of windows and doors in any exposure, or, in this instance, two windows and one door. Each window has 21 ft. of crack, or together 42 ft., and the door 20 ft. of crack making a total of 62 ft. of crack.

Answer: A—If windows and doors are fairly tight (1/16 in. crack), but without weather-stripping the leakage will be 2.5 ft. per min. per ft. of crack. (See Table 1).

$$H = 1.2 \times 2.5 \times 62 (70 - 0) = 13,020 \text{ B.t.u. per hr.}$$

$$\frac{13,020}{240} \text{ or } 52 \text{ sq. ft. of radiation will be required to supply this loss.}$$

Answer: B—If windows and doors are tight and well weather-stripped, the leakage will be 0.38 cu. ft. per min. per ft. of crack.

$$H = 1.2 \times 0.38 \times 62 (70 - 0) = 1,979 \text{ B.t.u. per hr.}$$

$$\frac{1,979}{240} \text{ or } 8.2 \text{ sq. ft. of radiation will be required to supply this loss.}$$

COMPARISON OF FUEL QUANTITIES AND COSTS TO HEAT AIR ENTERING VARIOUS SLIDING SASH WINDOWS, AS AIR INFILTRATION OR IN-LEAKAGE, ASSUMING 65 PER CENT OVER ALL EFFICIENCY OF HEATING PLANT

Window, 3 x 7 ft. Crack, 23 lin. ft.
Wind, 15 miles per hr.

B.t.u. to raise 1 cu. ft. air from zero to 70 deg., 1.439
B.t.u. per lb. best coal, 13,080
Duration heating season, 130 days
Cost coal, \$6.00 per ton
Overall efficiency of heating plant, 65 per cent (high)
B.t.u. available per lb. of coal = $13,080 \times 0.65 = 8500 \text{ B.t.u.}$

- A. Unstripped window, 2.53 cu. ft. per min. or 132 cu. ft. per hr. per ft. crack
B. Plain Rib Strip, 0.6 cu. ft. per min. or 36.0 cu. ft. per hr. per ft. crack
C. Interlocking weather-strip, 0.46 cu. ft. per min. or 27.6 cu. ft. per hr. per ft. crack

$$A. \frac{23 \times 132 \times 1.439}{8500} = 0.513 \text{ lb. coal per hr.}$$

$$\frac{0.513 \times 24 \times 130}{2000} = 0.800 \text{ tons per season}$$

$$\$6.00 \times 0.800 = \$4.80 \text{ per season}$$

$$B. \frac{23 \times 36.0 \times 1.439}{8500} = 0.140 \text{ lb. coal per hr.}$$

$$\frac{0.140 \times 24 \times 130}{2000} = 0.22 \text{ tons per season}$$

$$\$6.00 \times 0.22 = \$1.31 \text{ per season}$$

$$C. \frac{23 \times 27.6 \times 1.439}{8500} = 0.107 \text{ lb. coal per hr.}$$

$$\frac{0.107 \times 24 \times 130}{2000} = 0.167 \text{ tons per season}$$

$$\$6.00 \times 0.167 = \$1.00 \text{ per season}$$

Saving per window per year by using rib strip

$$\$4.80 - \$1.31 = \$3.49$$

Saving per window per year by using interlocking weather-strip

$$\$4.80 - \$1.00 = \$3.80$$

TRANSMISSION LOSSES

Heat flows from a higher to a lower temperature at a definite rate, depending upon the difference in temperature and the character and thickness of the material through which it passes.

The accompanying heat transmission tables are for average conditions of construction and the rate of transmission for any material is given in

TABLE 4. HEAT TRANSMISSION FROM ROOFS

CONSTRUCTION	B.t.u.
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

TABLE 5. HEAT TRANSMISSION FROM WINDOWS, ROOF GLASS AND SKYLIGHT

	1.10 B.t.u.
GLASS	WOOD
	0.60 "
GLASS	
	1.10 "
GLASS	SOLID METAL
	0.60 "
GLASS	
	1.10 "
GLASS	HOLLOW METAL
	0.60 "
GLASS	

TABLE 6. HEAT TRANSMISSION FROM FLOORS

CONSTRUCTION	B.T.U.
4" CONCRETE GROUND	.31
4" CONCRETE CINDER FILL GROUND	.29
1" TILE 4" CONCRETE GROUND	.30
2 1/2" BRICK 4" CONCRETE GROUND	.29
1 1/2" WOOD FLOOR WATERPROOFING 5" CONCRETE GROUND	.10
1 1/2" WOOD FLOOR 3" CONCRETE CINDER FILL GROUND SLEEPERS	.07
1 1/2" WOOD FLOOR 5" CINDER FILL GROUND SLEEPERS	.11
1 1/2" WOOD FLOOR AIR SPACE GROUND SLEEPERS	.13

TABLE 7. HEAT TRANSMISSION FROM CEILINGS

CONSTRUCTION	B.T.U.
Unheated Space Joists Lath Plaster	.60
Floor Joists Lath Plaster	.26
Floor Joists Metal Ceiling	.36
1" Floor	.40
Floor Paper Floor Joists	.21
4" Reinforced Concrete	.41
4" Reinforced Concrete	.100
6" Reinforced Concrete	.86
8" Reinforced Concrete	.41
10" Reinforced Concrete	.36

the number of B.t.u. which will be transmitted per degree difference in temperature per hour per square foot of surface.

The Research Bureau of the AMERICAN SOCIETY OF HEATING and VENTILATING ENGINEERS are making heat transmission tests of different material and when results are published, all heat transmission tables may be revised.

TABLE 8. HEAT TRANSMISSION FROM INTERIOR WALLS

CONSTRUCTION	B.t.u.
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 9. HEAT TRANSMISSION FROM WOOD DOORS AND WOOD PARTITIONS

3/4" to 1" Thick Tongued and Grooved	= 0.65 B.t.u.
1" " 1 1/4" " " " "	= 0.60 "
1 1/4" " 1 1/2" " " " "	= 0.50 "
1 1/2" " 2" " " " "	= 0.42 "
2" " 2 1/2" " " " "	= 0.35 "
2 1/2" " 3" " " " "	= 0.30 "

TABLE 10. HEAT TRANSMISSION FROM WALLS OF VARIOUS CONSTRUCTIONS

THICKNESS OF BOARD IN IN.	TWO BOARDS WITH PAPER BETWEEN	BOARD AND CORRUGATED IRON	BOARD AND SHEET IRON
1/2"	0.32 B.t.u.	0.45 B.t.u.	0.50 B.t.u.
1"	0.24 "	0.36 "	0.40 "
1 1/2"	0.19 "	0.30 "	0.33 "
2"	0.16 "	0.26 "	0.28 "
2 1/2"	0.14 "	0.23 "	0.25 "

TABLE 11. HEAT TRANSMISSION FROM WALLS OF CLAPBOARD

CONSTRUCTION	B.t.u.
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

TABLE 12. HEAT TRANSMISSION FROM VARIOUS TYPES OF WALL CONSTRUCTION

[illegible]

CALCULATING HEAT LOSSES

If air within a room is maintained at a higher temperature than air surrounding the room, there will be a loss of heat through the walls, partitions, ceiling or floor to air of lower temperature. This heat loss may be to the outside, an adjoining room or space above or below.

To heat and maintain a predetermined temperature in a room, an equal amount of heat must be supplied at the rate at which it is lost. In practice heat losses are figured on an hourly basis and the unit of measure is the B.t.u.

Warm air rises, hence the temperature in a room at various levels will differ according to conditions. For rooms not over 12 ft. high this difference can be taken at 1 deg. per ft. and the average can be taken at the temperature to be maintained at the breathing line (5 ft. from the floor) and 5 ft. from the wall.

There is a greater temperature difference at or near the ceiling than at the breathing line or at the floor but in actual practice this is usually neglected in calculating the heat losses.

In computing glass surface, figure the entire window opening. It is customary to figure outside doors as all glass, taking the entire door opening.

In order to accurately calculate the transmission heat loss from a room or building multiply the number of square feet of each kind of surface by its constant and then by the difference in temperature between the air in the room or building and the outside air and add together to obtain the total.

Compute the heat losses for a zero to 70 deg. fahr. condition as follows:

A room 10 x 10 x 8 ft. with two windows 3 x 5 ft. has two sides exposed, is heated above and below and walls are of clapboard, paper, sheathing, studs, lath and plaster. One and one-half air changes should be allowed. Then,

Cubical contents	=	$10 \times 10 \times 8$	=	800 cu. ft.
Windows	=	$3 \times 5 + 3 \times 5$	=	30 sq. ft.
Gross wall	=	$10 + 10 \times 8$	=	160 sq. ft.
Net wall	=	$160 - 30$	=	130 sq. ft.

Refer to Table 11 and find heat loss per square foot per degree for walls of clapboard, paper, sheathing, studs, lath and plaster to be 0.3 B.t.u. per hr.

Do not give consideration to inside partition, ceiling or floor if the surrounding space is also to be heated. Then,

*Cubical contents	$800 \times 1\frac{1}{2} \times 0.02 \times 70$	$= 1480 \text{ B.t.u.}$
Glass	$30 \times 1.1 \times 70$	$= 2310 \text{ B.t.u.}$
Net wall	$130 \times 0.3 \times 70$	$= 2730 \text{ B.t.u.}$

Total heat loss from room **= 6520 B.t.u.**

**Cubical Contents.*—There is no heat loss due to cubical contents. In this particular case, it has been assumed that the infiltration of air is equal to $1\frac{1}{2}$ times the cubical contents of the room or 1200 cu. ft. of air per min. For explanation see Heat Losses by Infiltration, p. 5.

When windows and other openings are not weather-stripped an allowance of 10 to 15 per cent for exposure due to prevailing winds should be added to the computed heat losses.

As the room mentioned faces the north, and is not weather stripped add 15 per cent of computed heat losses.

Then, $6520 \times 1.15 = 7498$, total heat loss

If the ceiling construction in the room was lath and plaster with floor above and the space above was not heated the room should be figured as follows:

Referring to Table 7 it is found that the heat loss per degree, per square foot to be 0.26 B.t.u. per hr. Special note should be taken that this space will be only 35 deg. fahr. when it is zero outside, and as the room is heated to 70 deg. fahr. the temperature difference will be $70 - 35 = 35$ deg.

Cubical contents $800 \times 1\frac{1}{2} \times 0.02 \times 70 = 1480$ B.t.u.
Glass $30 \times 1.1 \times 70 = 2310$ B.t.u.
Net wall $130 \times 0.3 \times 70 = 2730$ B.t.u.
Ceiling $100 \times 0.26 \times 35 = 910$ B.t.u.

Total Heat Loss from Room = 7430 B.t.u.
Adding 15 per cent for Northern Exposure = 8544 B.t.u.

EFFECT OF EXPOSURE AND WIND VELOCITY

As shown in the section on calculation of heat loss, it is customary to add 10 per cent to 15 per cent to the heat loss of rooms on the sides of the building exposed to the prevailing winds in coldest weather. The coldest exposure varies with the location. North and west are usually considered the coldest exposure. According to the U. S. Weather Bureau (Table 14), the coldest exposure in Salt Lake City is S.E.; in Denver, S.; in Chicago, S.W.; in Albany, S., which indicates how important it is to know not only the average and lowest temperatures of a place but also the prevailing wind directions in winter. Every plan should show the "points of the compass."

TABLE 13. DROP IN TEMPERATURE FOR EACH MILE WIND VELOCITY

Temp. Deg. Fahr.	Wind Velocity	Deg. of Temp. Drop
50 deg. to 40 deg.	1 mile per hr. equals	0.75 deg. drop
40 deg. to 30 deg.	1 mile per hr. equals	1.0 deg. drop
30 deg. to 20 deg.	1 mile per hr. equals	1.1 deg. drop
20 deg. to 10 deg.	1 mile per hr. equals	1.2 deg. drop
10 deg. to 0 deg.	1 mile per hr. equals	1.3 deg. drop
0 deg. to -10 deg.	1 mile per hr. equals	1.4 deg. drop
-10 deg. to -20 deg.	1 mile per hr. equals	1.5 deg. drop

In other words a temperature of 5 deg. above zero with a 30-mile wind should be equivalent to 34 deg. below zero with no wind blowing. It will be found, however, that the coefficients for transmission allow for a wind velocity of from 10 to 15 miles per hr.

TABLE 14. 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 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	40.3	-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 14. 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 Tempera- ture	Average Wind Vel- ocity Dec., Jan., Feb., Miles per Hr.	Direction of Prevail- ing 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

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 should not be more than 15 deg. fahr. above the lowest recorded temperature as reported by the U. S. Weather Bureau Table 14, during the preceding 10 years for the locality in which the heating system is to be installed.

HEAT SOURCES

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 15. 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 $\times$ number of lamps $\times$ 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.	

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.

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. $\times$ 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.

ROOM TEMPERATURES
USUALLY SPECIFIED

In the accompanying Table 16 are the inside temperatures ordinarily specified for the many kinds of rooms, buildings, shops, factories and it

will be noted that they vary in accordance with the service for which they are intended. It is obvious that a Turkish bath room requires a higher temperature than a gymnasium or machine shop. In providing these temperatures the engineer must necessarily know the conditions and solve the problem accordingly.

TABLE 16. INSIDE TEMPERATURES USUALLY SPECIFIED

	Deg. Temp.		Deg. Temp.
Warm Air Baths.....	120	Factories.....	65
Steam Baths.....	110	Stores.....	65
Hospital Operating Room.....	85	Gymnasium.....	55 to 60
Bath Rooms.....	85	Machine Shops.....	60 to 65
Paint Shops.....	80	Foundries, Boiler Shops, etc.....	50 to 60
Hospitals.....	72 to 75		
Public Buildings.....	68 to 72	Unheated spaces such as cellars, vestibules, attics, etc., are usually taken at	
Residences.....	70	35 deg. fahr.	
Schools.....	70		

The inside air temperature which must be maintained within a building, is 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 in making the actual heat loss computations for the various rooms in a building it is often necessary to modify the temperatures given in Table 16 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 16, 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.

CHAPTER II

HEATING BY RADIATION

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 17 to 23 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. 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 Table 24 to find the proper size radiator.

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 and add 40 per cent then divide by 240.

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. ÷ by 240 = 100 sq. ft. of semi-indirect radiation to heat the room.

To determine the amount of indirect radiation required to heat a room, figure all the heat losses, making allowance for exposure, and add 80 per cent, then divide by 240.

Example.—The heat losses including allowance for exposure for a given size room is 17,200 B.t.u. + 80 per cent for 30,860 B.t.u. ÷ by 240 = 129 sq. ft. of indirect radiation to heat the room.

For rooms over 12 ft. in height and not over 20 ft. in height figure as above and add 2 per cent of each additional foot of height over 12 ft. and up to 20 ft. Should the room be over 20 ft. in height add 25 per cent to the total height. If rooms are to be heated in the day time only, figure as above and make proper allowance for heat of rooms and add the number of B.t.u. required to heat the amount of air in the room

in the time in which the room was supposed to be heated. This heating-up factor is sometimes taken care of by increasing the radiation by 10 per cent. If the building is to be heated intermittently after long intervals of unheated periods, this can be figured as above or 25 per cent is often added to the radiation to take care of this difference.

Table 20 conforms very closely to the ratings for direct radiation as given for radiators of heat shown with sections $2\frac{1}{2}$ in. on centers, except in the case of four-column radiation, which are 3 in. on centers.

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 $1\frac{1}{4}$ or $1\frac{1}{2}$ 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 18 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 24 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 $13,300 \times 0.864$ (the equivalent heat loss) = 11,480 B.t.u. In Table 16 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.
COPYRIGHT 1921

TABLE 17. HEAT EMITTED BY DIRECT RADIATION—SINGLE-COLUMN RADIATORS
Room Temperature at 70 deg. fahr.
Steam Temperature at 215 deg. fahr.

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

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.
COPYRIGHT 1921

TABLE 18. HEAT EMITTED BY DIRECT RADIATION—TWO-COLUMN RADIATORS
Room Temperature at 70 deg. Fahr.
Steam Temperature at 215 deg. Fahr.

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
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
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
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	4970	16.33	4376	14	3786
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
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
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
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
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
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
20	100	22478	80	18656	66.66	16080	53.33	13211	46.66	11736	40	10196

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.
COPYRIGHT 1921

TABLE 19. HEAT EMITTED BY DIRECT RADIATION—THREE-COLUMN RADIATORS
Room Temperature at 70 deg. Fahr.
Steam Temperature at 215 deg. Fahr.

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	6	2241	5	1898	4.5	1665	3.75	1372	3	1138	2.25	878
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
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
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
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
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
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
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
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
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
20	120	25776	100	21990	90.0	20088	75.00	16995	60	14040	45.00	10989

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.
COPYRIGHT 1921

TABLE 20. HEAT EMITTED BY DIRECT RADIATION—FOUR-COLUMN RADIIATORS
Room Temperature at 70 deg. Fahr.
Steam Temperature at 215 deg. Fahr.

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	10	3092	8	2567	6.5	2166	5	1730	4	1430	3	1125
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
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
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
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
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
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
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
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
18	180	35537	144	29506	117.0	25049	90	19961	72	16567	54	12987
19	190	37430	152	31084	123.5	26395	95	21140	76	17459	57	13685
20	200	39340	160	32652	130.0	27742	100	22220	80	18352	60	14382

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.
COPYRIGHT 1921

TABLE 21. HEAT EMITTED BY DIRECT RADIATION—HOSPITAL RADIIATORS—TWO COLUMNS
Room Temperature at 70 deg. Fahr.
Steam Temperature at 215 deg. Fahr.

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
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
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
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
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
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
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
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
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
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
20	100	23850	80	19888	66.66	17142	53.33	14111	46.66	12544	40	10920

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.
COPYRIGHT 1921

TABLE 22. HEAT EMITTED BY DIRECT RADIATION—WALL RADIATORS
Room Temperature at 70 deg. Fahr.
Steam Temperature at 215 deg. Fahr.

No. OF SECTIONS	9B—29 IN.		7B—22 IN.		5A—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	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

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.
COPYRIGHT 1921

TABLE 23. HEAT EMITTED BY DIRECT RADIATION—WINDOW RADIATORS
Room Temperature at 70 deg. Fahr.
Steam Temperature at 215 deg. Fahr.

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
2	10	2761	7.50	2156	6	1762
3	15	3816	11.25	2979	9	2441
4	20	4872	15.00	3803	12	3119
5	25	5930	18.75	4626	15	3798
6	30	6987	22.50	5450	18	4477
7	35	8043	26.25	6274	21	5156
8	40	9098	30.00	7098	24	5836
9	45	10152	33.75	7921	27	6516
10	50	11210	37.50	8745	30	7194
11	55	12265	41.25	9570	33	7871
12	60	13320	45.00	10395	36	8550
13	65	14378	48.75	11217	39	9227
14	70	15435	52.50	12038	42	9908
15	75	16490	56.25	12864	45	10589
16	80	17544	60.00	13686	48	11266
17	85	18598	63.75	14510	51	11944
18	90	19656	67.50	15336	54	12625
19	95	20710	71.25	16160	57	13304
20	100	21770	75.00	16988	60	13986

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.
COPYRIGHT 1921

TABLE 24. 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.

RADIATION REQUIRED FOR VARIOUS 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 25. 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

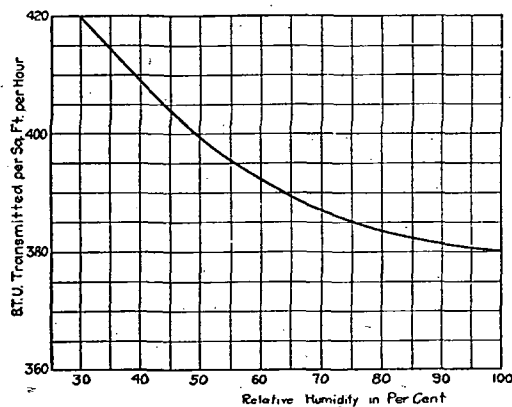


FIG. 6. EFFECT OF HUMIDITY ON HEAT TRANSMISSION

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.

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. 6 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.

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

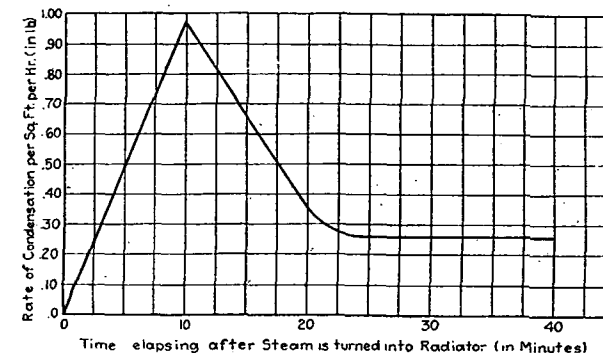


FIG. 7. CHART SHOWS DEMAND UPON BOILER FOR HEATING-UP PLANT

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 26 shows the heat loss from a two-column 38-in. radiator, 10 sections long, when painted with different kinds of paints:

TABLE 26. 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

WARMING THE RADIATOR

It is often very important to know the maximum condensation that occurs in a radiator when steam is turned on. Fig. 7 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 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 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. 8, 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 $2\frac{1}{2}$ 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. 9. 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. 10. 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. 11. In such cases, the height, D , is very important. With D equal to $2\frac{1}{2}$ 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. 12. 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 , $2\frac{1}{2}$ in., the reduction will be 40 per cent.

Case No. 6.—Radiators are often placed under seats as in Fig. 13. 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 tests¹ by Prof. K. Brabbee will be found other cases than those cited above.

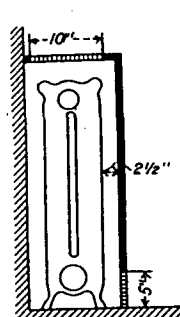


FIG. 8

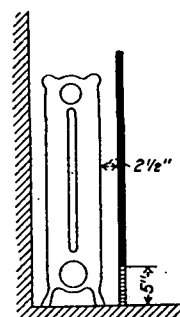


FIG. 9

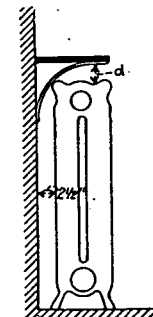


FIG. 10

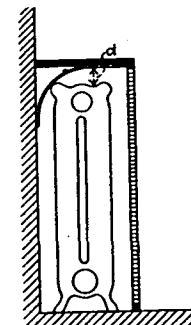


FIG. 11

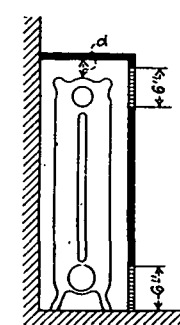


FIG. 12

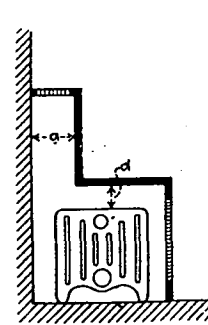


FIG. 13

DIFFERENT ARRANGEMENTS OF RADIATORS IN ENCLOSURES

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 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 effec-

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

tively 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 temperatures 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.

CHAPTER III

PIPE SIZES FOR STEAM HEATING

THERE are two broad divisions that may be very definitely made in the subject of steam main sizes. 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 than 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 or average conditions of use should be applied for sizing the pipes within the buildings.

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 condensate so that defective circulation or water hammer will not occur.

During periods of maximum load on distributing mains, the velocity of flow is often so far above the critical velocity that little, if any, condensation is withdrawn by the drips. At the ends of the runs and especially where the pipe sizes are smaller, the velocities used should be well below the critical velocity so that the condensate is completely withdrawn and not carried into the branch supply mains within the buildings.

There is no formula of flow available for estimating the friction drop of mixtures of steam and condensation or water primed from the boiler. Excessive moisture in the steam, or boiler priming, may so increase the drop in pressure that an entire failure in operation may result. It is therefore, good practice to provide hand hole or equivalent cleaning means at the bottom of all boilers and a permanent surface blow for boiling off, so that clean water and dry steam may be always maintained. It is quite probable that field research where boilers are priming would show a surprisingly high friction drop in the steam main.

Steam mains should not be dripped on the main trunk lines, and the riser connections and laterals pitched back to the mains. Much better results are obtained by dripping the mains to take care of their condensation, and then pitching the riser connections and laterals to first floor radiators away from the main, and providing additional drips to take care of their condensation separately. In a carefully designed plant, no branch or lateral larger than the supply to a single radiator should be pitched

back against the flow of steam, and if it is not certain that the velocity is below the critical limit, the pipe should be provided with a separate drip.

The following tables for the carrying capacities of pipes as used in steam heating installations with the exception of dry returns have been determined by Unwin's formula for the flow of steam in pipes which reads as follows:

$$W = 87.5 \sqrt{\frac{P C d^5}{L \left(1 + \frac{3.6}{d}\right)}}$$

where

- W = Weight of steam flowing through the pipe in lb. per min.
 P = Difference of pressure between the two ends of the pipe.
 C = Density of steam in lb. per cu. ft.
 d = Actual inside diameter of pipe.
 L = Length of pipe in feet.

This formula with the capacity expressed in sq. ft. of radiation on the basis of each sq. ft. of radiation with connected piping condensing 0.3 lb. of steam per hour will be as follows:

$$R = 17,400 \sqrt{\frac{P C d^5}{L (d + 3.6)}} \text{ where } R = \text{Sq. ft. of radiation.}$$

Capacities of dry returns have been calculated by the Chezy formula for flow in open conduits which is expressed in the form

$$Q = a c \sqrt{r s}$$

where

- Q = Discharge in cu. ft. per sec.
 a = Wet area of pipe in sq. ft.
 r = Hydraulic mean depth (areas of wet cross-section divided by the wet-perimeter.)
 c = Constant from Kutter's formula.
 s = Slope or grade.

In the tables for one-pipe, two-pipe and vapor systems without the use of thermostatic traps the tables have been calculated on the basis of the water occupying one-eighth the area of the pipe while for vapor systems using thermostatic traps the capacity is based on water occupying three-sixteenth the area.

All supply mains, branches to riser, when dripped, where steam and condensation flow in the same direction, and supply risers (with the exception of up-feed one-pipe risers), are based on a pressure drop of 1 oz. per 100 ft. length of pipe or equivalent.

All supply mains, branches to risers, not dripped where condensation and steam are flowing in opposite directions and up-feed one-pipe risers are based on a velocity of 16 ft. per second.

Branches to radiators 5 ft. in length or less are based on velocities from 10 to 19 ft. per second depending on the size of branch while branches to radiators 5 to 10 ft. in length are based on a velocity of approximately 10 ft. per second.

Wet returns are calculated on a drop of $\frac{1}{2}$ oz. per 100 ft. length of pipe or equivalent.

Radiator valve sizes for one and two-pipe gravity systems are based on standard practice.

An allowance must be made for ells and fittings in the line of flow by adding the number of feet given in Table 27 to the straight run of pipe plus 25 ft. for entrance to last radiator to obtain the total equivalent length.

TABLE 27. 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. $W = 87.5 \sqrt{\frac{P D d^5}{L \left(1 + \frac{3.6}{d}\right)}}$ $P = .000131 \left(1 + \frac{3.6}{d}\right) \frac{W^2 L}{D d^5}$							
PRESS. LOSS IN OZ.	COL. 1 $87.5 \sqrt{\frac{P}{100}}$	INSIDE DIA. PIPE	COL. 2 $\sqrt{\frac{d^5}{1 + \frac{3.6}{d}}}$	STEAM PRESS. 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	1 $\frac{1}{4}$	1.177	0.3	0.195	40	1.580
3	3.767	1 $\frac{1}{2}$	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	2 $\frac{1}{2}$	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	3 $\frac{1}{2}$	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	4 $\frac{1}{2}$	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 $\times$ 2 $\times$ 3 $\times$ 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 — $2.175 \times 3.709 \times 0.201 \times 1 = 1.615$ lb. per min., then $1.615 \times 60 = 20$ 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:

SELECTING THE PROPER PIPE SIZES

The steam pressure at the boiler and the allowable loss in pressure in a low-pressure gravity return heating system control the sizing of the piping. The allowable drop in pressure is determined by the available height between the water line of the boiler and where the piping is run, together with the type of boiler and kind of fuel used. In good practice a total pressure drop of not over 2 oz., between the boiler and the farthest radiator, is generally used.

Pipe sizing tables are usually given in capacities of square feet of direct radiation based on a rate of condensation of $\frac{1}{4}$ lb. per sq. ft. per hr.

Pipe should be graded at least as follows:

	Inches	Feet
Supply Mains.....	1	20
Wet Return Mains.....	1	20
Dry Return Mains.....	1	20
Horizontal Branches.....	1	5

Except in rare cases, supply mains should not be made less than 2 in. in size and a supply main starting over $2\frac{1}{2}$ in. in size should not end less than $2\frac{1}{2}$ in.

Pipes of less size than the following should not be used:

	Inches
Dry Return Mains.....	1
Wet Return Mains.....	$1\frac{1}{4}$
Supply Risers.....	1
Return Risers.....	$\frac{3}{4}$

The end of all supply mains where dripped into wet mains should be vented through proper size air valves.

The lowest point in a steam main should always be at least 18 in. above the water line of the boiler and more if possible. The lowest point in a dry return main should always be at least 24 in. above the water line of the boiler and more if possible.

In residences, small apartments and smaller buildings where the firing of the boiler is intermittent, frequently extending over a period of 6 to 10 hr., the pressure at the boiler will vary and a pressure drop of over 2 oz. should not be considered in designing the piping. In large apartments, public buildings and smaller buildings, where the boiler is fired as often as necessary and pressure is maintained constantly, greater pressure drops than 2 oz. can be used in designing the piping.

Capacities given in Table 27 are based on an initial pressure of at least twice the pressure drop, and for a straight run of pipe 100 ft. long and no allowance is made for friction due to valves, elbows and tees.

Table 28 gives the number of feet to be added, for various kinds of valves and fittings, to the measured length.

Example.—A 4-in. pipe measures 160 ft. and contains one gate valve, and 6 elbows. Then from Table 28 find:

1-4" Gate Valve.....	= 5'-0"
6-4" Elbows.....	= 6×14 = 84'-0"
Length to be Added.....	= 89'-0"
Measured Length.....	= 160'-0"
Equivalent Length.....	= 249'-0"

Table 27, under Column 4, gives factors for changing amounts of radiation as given in Table 29 for other lengths than 100 ft.

Example.—The above example gave an equivalent length of 249 ft. for 4-in. pipe. To find how many square feet of direct radiation this pipe will supply for any given pressure drop, take square feet of radiation given in Table 29 for 4-in. pipe 100 ft. run and multiply by factor given in Column 4 Table 27. Factor for 250 ft. run as taken from Column 4 Table 27 = 0.632.

Amount of radiation a 4-in. pipe will supply with 2-oz. pressure drop with an initial pressure of at least 4 oz. if 100 ft. long as taken from Table 29 = 2866 sq. ft., then, $2866 \times 0.632 = 1811$ sq. ft. a 4-in. pipe will supply if it has an equivalent length of 259 ft.

Valves and fittings of similar sizes of different manufacturers vary in the resistance they offer to the flow of steam or water. In estimating lengths of pipes it is necessary to include the resistance offered by the various fittings.

The following Table 28 gives this in units of length, in feet, to be added to the measured length of pipe for a given kind of fitting.

TABLE 28. LENGTH IN FEET OF PIPE TO BE ADDED TO ACTUAL LENGTH OF RUN

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
$2\frac{1}{2}$ "	7	20	3	25	12
3"	10	26	3	33	16
$3\frac{1}{2}$ "	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.

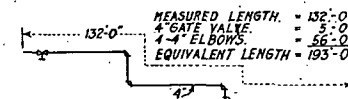


TABLE 31. TWO-PIPE STEAM
Capacity of Pipes in Sq. Ft. of Radiation

A Com- mercial Pipe Sizes	B Supply Main Branch to Risers (dipped); Up-Feed Risers. Steam and water flowing same direc- tion.	C Branches to Risers Steam and water flowing opposite direction.	D BRANCHES TO RADIATORS		E Wet Return Main	F DRY RETURN MAINS		G Radiator Valves		H Allowance in ft. of Pipe for
			5 ft. in length or less	5 ft. to 10 ft. in length		Not Exceeding 400 ft. in Length Graded not less than 1 in. in 30 ft.		Supply	Re- turn	
1 1/4	40	40	24	60	800	180	40	20	40	0.8
1 1/2	75	75	60	100	1,800	420	80	40	80	1.3
2	150	100	100	200	3,000	900	160	80	160	2.1
2 1/2	300	170	200	400	6,000	1,500	320	160	320	3.2
3	500	220	.....	.....	9,000	3,000	.....	.....	.....	4.2
3 1/2	800	280	.....	.....	13,000	4,500	.....	.....	.....	5.4
4	1,500	400	.....	.....	26,000	9,000	.....	.....	.....	7.0
4 1/2	2,000	600	.....	.....	37,000	13,000	.....	.....	.....	8.2
5	2,800	.....	.....	.....	.....	18,500	.....	.....	.....	9.4
6	3,600	.....	.....	.....	.....	.....	.....	.....	.....	10.6
7	9,000	.....	.....	.....	.....	.....	.....	.....	.....	11.7
8	13,000	.....	.....	.....	.....	.....	.....	.....	.....	12.9
10	23,000	.....	.....	.....	.....	.....	.....	.....	.....	14.0
12	37,000	.....	.....	.....	.....	.....	.....	.....	.....	15.2

NOTES

Length Factors—For supply mains where steam and water are flowing in the same direction and for wet returns where lengths are other than 100 ft. multiply the factor here given by the sq. ft. of radiation to obtain the carrying capacity of the pipe.

Length in Feet 200 400 600 800 1,000 2,000 3,000
Factors..... 0.710 0.876 0.800 0.447 0.316 0.223 0.182

Supply mains to be sized according to Column B.

Where branches to risers are taken from top of main the main should be dipped at the end either by a separate drip line or into the main return line. The end of steam mains, if reduced, to be one size larger than table calls for. Where the main changes size branch connections should be taken from the bottom of the main, and either connected into separate drip main or into main return line. If this is not done eccentric couplings should be used for making reduction. The bottom of down-feed supply risers should be carried down to the basement level and connected to separate drip mains or into the main return.

In buildings where risers are 100 ft. in length or over, horizontal run-outs, to take care of expansion, or where necessary, due to design of building, should have separate drips, carried down to basement into separate drip main or into the main return.

TABLE 32. LOW PRESSURE GRAVITY VAPOR WITH OR WITHOUT USE OF RADIATOR RETURN TRAPS
Capacity in Pipes in Sq. Ft. of Radiation

A Com- mercial Pipe Sizes	B Supply Main Up-feed Risers; Branches to Risers (dipped). Steam and water flowing same direc- tion.	C Branches to Risers Steam and water flowing opposite di- rection.	D BRANCHES TO RADIATORS		E Wet Return Main	F DRY RETURN MAINS		G Allowance in feet of Pipe for	
			5 ft. in length or less	5 ft. to 10 ft. in length		Not Exceeding 400 ft. in Length Graded not less than 1 in. in 30 ft.		Ells	Globe Valves
1 1/4	40	40	24	60	800	180	40	0.8	1.2
1 1/2	75	75	60	100	1,800	420	80	1.3	1.9
2	150	100	100	200	3,000	900	160	2.1	3.2
2 1/2	300	170	200	400	6,000	1,500	320	2.8	4.2
3	500	220	.....	.....	9,000	3,000	.....	7.0	10.6
3 1/2	800	280	.....	.....	13,000	4,500	.....	10.6	14.0
4	1,500	400	.....	.....	26,000	9,000	.....	12.9	17.1
4 1/2	2,000	600	.....	.....	37,000	13,000	.....	14.0	18.2
5	2,800	.....	.....	.....	.....	.....	.....	15.2	20.3
6	3,600	.....	.....	.....	.....	.....	.....	18.2	24.4
7	9,000	.....	.....	.....	.....	.....	.....	22.3	28.5
8	13,000	.....	.....	.....	.....	.....	.....	24.4	30.6
10	23,000	.....	.....	.....	.....	.....	.....	28.5	36.7
12	37,000	.....	.....	.....	.....	.....	.....	30.6	38.8

NOTES

Length Factors—For supply mains where steam and water are flowing in the same direction and for wet returns where lengths are other than 100 ft. multiply the factor here given by the sq. ft. of radiation to obtain the carrying capacity of the pipe.

Length in Feet 200 400 600 800 1,000 2,000 3,000
Factors..... 0.710 0.876 0.800 0.447 0.316 0.223 0.182

Supply mains to be sized according to Column B.

Where branches to risers are taken from the top of the main, the main should be dipped at the end either by a separate drip line or into the main dry return line through a trap. The end of steam mains, if reduced, to be one size larger than the table calls for.

Where the main changes size branch connections should be taken from the bottom of the main and either connected into separate drip main or into main dry return line through a trap. If this is not done eccentric couplings should be used for making reductions.

The bottom of risers should be carried down to the basement and connected to separate drip main or into dry return main through a trap.

In buildings where risers are 100 ft. in length or over, horizontal run-outs, to take care of expansion, or where necessary, due to the design of the building, should have separate drips, carried down to basement into separate drip main or into the dry return through a trap.

PIPE SIZES FOR VAPOR SYSTEMS

Table 33 is computed for pressure loss of 2 oz. at the farthest radiator for length of main, allowing for average amount of elbows, tees, etc., and condensation in covered piping—steam and condensation flowing in same direction. Then to size a main for a gravity return vapor job using radiator return traps—measure length of piping from boiler to farthest radiator and use column for this length for sizing entire length.

Example.—Measured length from boiler to farthest radiator = 295 ft., then use Column F, for sizing main for entire length.

At end of main = 280 sq. ft. = $2\frac{1}{2}$ " Main
 50' from end of main = 450 sq. ft.
 Total load to this point = 730 sq. ft. = $3\frac{1}{2}$ " Main
 Near boiler = 400 sq. ft.
 Total load to boiler = 1130 sq. ft. = 4" Main

TABLE 33. CAPACITY OF SUPPLY MAINS IN SQ. FT.

COL. A SIZE OF PIPE	MEASURED LENGTH OF PIPE IN FT. FROM BOILER TO FARTHEST RADIATION					
	Col. B 100'	Col. C 150'	Col. D 200'	Col. E 250'	Col. F 300'	Col. G 400'
2	325	260	-----	-----	-----	-----
$2\frac{1}{2}$	550	450	390	347	310	275
3	1,000	810	710	632	578	500
$3\frac{1}{2}$	1,500	1,215	1,065	948	860	750
4	2,100	1,700	1,500	1,325	1,200	1,050
$4\frac{1}{2}$	2,900	2,350	2,060	1,830	1,670	1,450
5	3,700	3,000	2,600	2,340	2,140	1,850
6	5,700	4,600	4,047	3,600	3,300	2,850
7	8,000	6,480	5,680	5,050	4,600	4,000
8	11,000	8,900	7,810	6,950	6,350	5,500
10	20,000	16,200	14,200	12,600	11,500	10,000
12	30,000	24,300	21,300	18,960	17,300	15,000

For steam and condensation flowing in opposite directions use pipe one size larger than given in table.

TABLE 34. CAPACITIES OF SUPPLY RISERS IN SQ. FT.

COL. A Size of Pipe	LENGTH IN FT. FROM BOILER TO END OF RISER					
	Col. B 100'	Col. C 150'	Col. D 200'	Col. E 250'	Col. F 300'	Col. G 400'
1"	40	32	28	25	23	20
$1\frac{1}{4}$ "	75	60	53	47	43	37
$1\frac{1}{2}$ "	150	120	105	95	86	75
2"	300	240	210	190	173	150
$2\frac{1}{2}$ "	500	400	355	315	285	250
$3\frac{1}{2}$ "	900	730	630	565	520	450

Horizontal branches to risers to be one size larger than riser.

TABLE 35. CAPACITY OF WET RETURN MAINS IN SQ. FT.

SIZE OF PIPE	$1\frac{1}{4}$ "	$1\frac{1}{2}$ "	2"	$2\frac{1}{2}$ "	3"	$3\frac{1}{2}$ "
Length 100'	1,500	3,000	6,000	10,000	18,000	26,000
Length 200'	1,200	2,500	5,000	8,000	14,000	20,000
Length 300'	1,000	2,000	4,000	6,000	11,000	16,000

RETURN RISERS

Size of Pipe	$\frac{3}{4}$ "	1"	$1\frac{1}{4}$ "	$1\frac{1}{2}$ "
Capacity in Sq. Ft.	300	630	1,300	2,200

TABLE 36. RADIATOR CONNECTIONS

SUPPLY		RETURN	
Vertical Inlet Pipe to Valve	Horizontal Runout from Vertical Inlet Pipe to Riser or Main	Stub to Valve	Horizontal Runout to Riser or Main
	Up to 5' Long		
$\frac{1}{8}$ "	24 sq. ft. = 1"	$\frac{1}{2}$ "	$\frac{3}{4}$ "
$\frac{3}{8}$ "	70 sq. ft. = $1\frac{1}{4}$ "		
1"	150 sq. ft. = $1\frac{1}{2}$ "		
$1\frac{1}{4}$ "	200 sq. ft. = 2"		

Radiators to be water type of not over 200 sq. ft. capacity, tapped or bushed at the top for supply valve and at the bottom $\frac{3}{8}$ in. eccentric turned down for return trap.
 Supply and return connections can be made at same or opposite ends as desired.
 All radiators to be washed clean of core sand before making valve connections.

PIPE SIZES FOR VACUUM HEATING

Table 37 is computed for pressure loss of 16 oz. at the farthest radiator for length of main, allowing for average amount of elbows, tees, etc., and condensation in covered piping. Steam and condensation flowing in same direction.

To size a main—measure length of piping from boiler or pressure reducing valve to farthest radiator and use column for this length for sizing entire length.

TABLE 37. CAPACITY OF SUPPLY MAINS IN SQ. FT.

COL. A Size of Pipe Inches	MEASURED LENGTH OF PIPE IN FT. FROM BOILER OR P. R. V. TO FARTHEST RADIATOR						
	Col. B 100'	Col. C 200'	Col. D 300'	Col. E 400'	Col. F 500'	Col. G 750'	Col. H 1,000'
2	940	667	543	470	-----	-----	-----
$2\frac{1}{2}$	1,570	1,115	800	785	-----	-----	-----
3	2,800	1,988	1,610	1,400	1,250	1,090	880
$3\frac{1}{2}$	4,200	2,982	2,427	2,100	1,877	1,638	1,320
4	6,000	4,260	3,480	3,000	2,680	2,340	1,895
$4\frac{1}{2}$	8,250	5,857	4,770	4,125	3,687	3,215	2,607
5	11,000	7,810	6,360	5,500	4,917	4,290	3,475
6	17,300	12,280	10,000	8,650	7,733	6,745	5,465
7	25,500	18,100	14,750	12,750	11,398	9,945	8,055
8	36,000	25,560	20,800	18,000	16,080	14,040	11,375
10	65,590	46,570	38,000	32,795	29,320	25,580	20,730
12	94,500	67,095	54,600	47,250	42,240	36,850	29,860

TABLE 38. CAPACITIES OF RETURN MAINS IN SQ. FT.

SIZE OF PIPE	1"	1 1/4"	1 1/2"	2"	2 1/2"	3"	3 1/2"
*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

TABLE 39. CAPACITIES OF SUPPLY RISERS IN SQ. FT.

SIZE OF PIPE	1"	1 1/4"	1 1/2"	2"	2 1/2"	3"	3 1/2"
**Length 200'	73	160	248	500	830	1,500	4,750
" 400'	52	114	177	357	592	1,040	3,240
" 600'	42	92	145	290	480	845	2,630
" 1,000'	33	72	112	225	374	657	2,045
" 2,000'	23	51	80	160	264	463	1,450

Horizontal branches to risers to be one size larger than riser.

TABLE 40. CAPACITIES OF RETURN RISERS IN SQ. FT.

SIZE OF PIPE	3/4"	1"	1 1/4"				
*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 vacuum pump to end of riser.

**Length equals measured distance from boiler or pressure reducing valve to end of riser.
Capacities as given in Tables 38, 39, 40, include allowances for elbows, tees, etc.

TABLE 41. 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 100	3/4"	3/4"	1"	1/2"	1/2"	3/4"
101 to 200	1"	1"	1 1/4"	1/2"	1/2"	3/4"
201 to 300	1 1/4"	1 1/4"	1 1/2"	3/4"	3/4"	3/4"

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.

CHAPTER IV

PIPE SIZES FOR STEAM WITH COUNTER FLOW OF CONDENSATE

THE Research Laboratory of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS is making an investigation of the Flow of Steam in Pipes with the Counter Flow of Condensate. The object

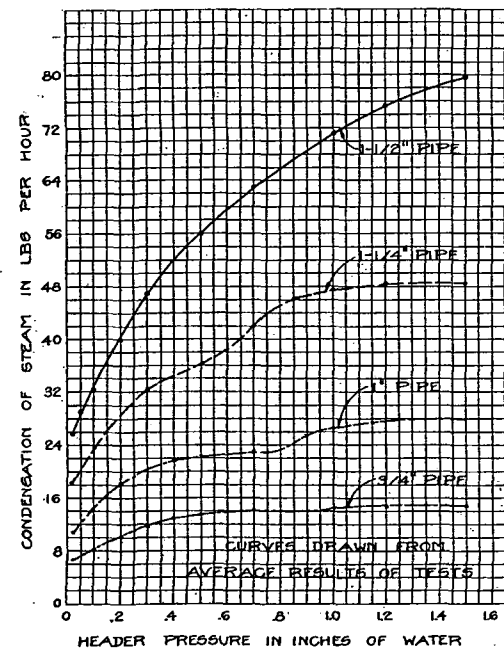


FIG. 14. CAPACITIES OF STEAM PIPES AS AFFECTED BY CRITICAL VELOCITY OF STEAM AND CONDENSATE MIXTURES

of the investigation is, first, to determine the fundamental phenomena taking place in such a pipe, and, second, to determine the capacity of various connections found in heating practice. In connection with this

This section especially compiled by F. C. Houghton, New York.

investigation the following problems have thus far been studied, at the Research Laboratory and complete reports will be found in the Society's JOURNAL:

1. Critical velocity of risers—one and two-pipe systems;
2. Effect of rounded, reamed and unreamed entrances, to pipe upon the critical velocity;
3. Effect of entrances of pipe cut with single and three-wheel cutters upon the critical velocity;
4. Effect of unions and couplings upon the critical velocity;
5. Critical velocity in horizontal, vertical and inclined pipes;
6. Effect of high pressures, horizontal offsets and valves.

Fig. 14 shows the relation between the pressure drop through a 10 ft. vertical pipe and its capacity.

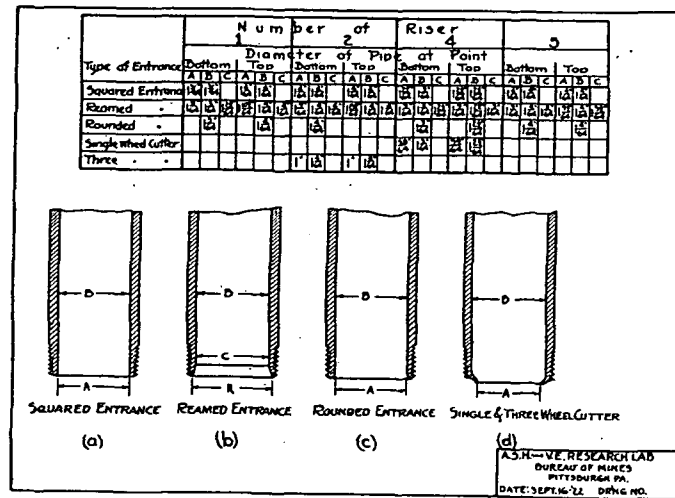


FIG. 15: DETAILS OF FOUR TYPES OF ENTRANCES TESTED

The capacity of a vertical pipe is greatly affected by the shape of its entrance. By gently flaring the entrance of the pipe its capacity may be greatly increased.

A series of tests were made on 1-in. risers with various shaped entrances as shown in Fig. 15. The maximum capacities obtained in these tests were as follows:

		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 42. EFFECT OF VARIATION OF SIZE AND SMOOTHNESS OF PIPE

Per Cent Difference due to Variation of Pipe

	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

Table 42 shows the 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.

The capacity of risers based upon 18 and 22 ft. velocity is given in Table 43.

TABLE 43. CAPACITIES OF ONE PIPE RISERS

Allowable Velocity in Feet per Second

DIA. OF PIPE IN.	18			22		
	COND. LB. HR.	B.T.U. LOSS HR.	SQ. FT. RAD. BASED ON 240 B.T.U.	COND. LB. HR.	B.T.U. LOSS HR.	SQ. FT. RAD. BASED ON 240 B.T.U.
¾	8.9	8,640	36.0	10.9	10,580	44.1
1	14.5	14,070	58.6	17.8	17,270	72.0
1¼	25.2	24,460	101.9	30.8	29,890	124.5
1½	34.2	33,190	138.1	41.8	40,560	169.0
2	56.5	54,830	228.4	69.0	66,960	279.0

TABLE 44. PITCH REQUIRED IN HORIZONTAL PIPES TO GIVE SAME CAPACITY AND VELOCITY AS GIVEN IN TABLE 43 FOR RISERS OF LIKE SIZE

Allowable Velocity in Feet per Second

NOMINAL DIA. OF PIPE IN.	18				22			
	COND. IN LB. PER HR.	B.T.U. LOSS PER HR.	SQ. FT. RAD. BASED ON 240 B.T.U.	PITCH OF PIPE IN. PER 10 FT.	COND. IN LB. PER HR.	B.T.U. LOSS PER HR.	SQ. FT. RAD. BASED ON 240 B.T.U.	PITCH OF PIPE IN. PER 10 FT.
¾	8.9	8,640	36.0	1.00	10.9	10,580	44.1	2.6 to 3.0
1	14.5	14,070	58.6	0.75	17.8	17,270	72.0	1.7 to 2.0
1¼	25.2	24,460	101.9	0.50	30.8	29,890	124.5	1.00
1½	34.2	33,190	138.1	0.50	41.8	40,560	169.0	1.00
2	56.5	54,830	228.4	0.50	69.0	66,960	279.0	1.00

TABLE 45. MAXIMUM CAPACITY OF ONE PIPE LINES AT VARIOUS PITCHES

Pitch of Pipe in Inches per 10 Ft.

NOMINAL DIAM. OF PIPE IN. IN.	$\frac{1}{4}$ "			$\frac{1}{2}$ "		
	COND. LB. PER HR.	B.T.U. LOSS PER HR.	SQ. FT. RAD. BASED ON 240 B.T.U.	COND. LB. PER HR.	B.T.U. LOSS PER HR.	SQ. FT. RAD. BASED ON 240 B.T.U.
$\frac{3}{4}$	6.19	6,010	25.0	7.48	7,260	30.3
1	11.32	10,990	45.8	13.02	12,630	52.6
$1\frac{1}{4}$	25.95	25,180	104.9	29.00	28,140	117.2
$1\frac{1}{2}$	35.25	34,210	142.6	39.30	38,140	159.0
2	58.40	56,670	236.0	65.20	63,270	263.5
1"						
$\frac{3}{4}$	9.22	8,950	37.3	10.00	9,700	40.4
1	15.58	15,110	63.0	17.30	16,790	70.0
$1\frac{1}{4}$	32.93	31,950	133.0	35.75	34,690	144.5
$1\frac{1}{2}$	44.80	43,470	181.0	48.60	47,160	196.5
2	74.10	71,910	299.5	80.50	78,120	325.5
2"						
$\frac{3}{4}$	10.50	10,190	42.5	11.40	11,060	46.1
1	18.60	18,050	75.2	20.55	19,940	83.0
$1\frac{1}{4}$	38.10	36,970	154.0	40.80	39,500	165.0
$1\frac{1}{2}$	51.80	50,270	209.3	55.50	53,860	224.0
2	85.70	83,160	346.5	91.90	89,180	371.5
3"						
$\frac{3}{4}$	11.74	11,390	47.5	12.19	11,830	49.3
1	21.75	21,110	87.9	22.31	21,650	90.2
$1\frac{1}{4}$	42.68	41,420	172.6	44.07	42,760	178.2
$1\frac{1}{2}$	58.10	56,350	234.8	60.00	58,220	242.6
2	96.80	93,240	388.4	99.21	96,270	401.1

The accompanying tables are all for low pressure steam, that is, with the radiator at atmospheric pressure.

Table 46 gives the maximum capacity of various sized pipes for steam pressures up to 1 lb., and also the velocity for the same pipe with the radiator at atmospheric pressure.

TABLE 46. RESULTS OF TESTS USING HIGH PRESSURE STEAM

NOMINAL SIZE OF PIPE IN.	PITCH OF PIPE IN DEGREES	HEADER PRESSURE LB. PER SQ. IN.	RADIATOR PRESSURE LB. PER SQ. IN.	MAXIMUM CONDENSATE LB. PER HR.	MAXIMUM VELOCITY FT. PER SEC.	MAXIMUM VELOCITY WITH RADIATOR OPEN TO ATMOSPHERE	PER CENT CHANGE FROM MAXIMUM
1	90	0.25	0.25—	24.49	30.1	30.1	00.0
1	90	0.50	0.50—	26.35	31.8	30.1	+5.8
$1\frac{1}{4}$	90	0.50	0.50—	49.90	34.2	35.2	-2.8
$1\frac{1}{2}$	90	1.00	1.00—	72.58	36.4	38.5	-5.4
$1\frac{1}{2}$	-0.05	1.00	1.00—	27.27	13.7	14.6	-6.2
$1\frac{1}{4}$	0.0833	1.00	1.00—	21.30	14.2	15.8	-10.1
1	18.0833	1.00	1.00—	31.63	37.2	36.5	+1.9

Table 47 gives the capacity of various sized lines with and without an angle valve. It will be noted that the valves used in these tests had a seat opening smaller than the internal area of the pipe. The capacity of such lines containing a valve varies from 63 to 95 per cent of the same line without the valve.

TABLE 47. RESULTS OF TESTS ON ANGLE 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
$\frac{3}{4}$	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
$1\frac{1}{4}$	1.459	1.258	86.2	30.00	47.5	63.1
$1\frac{1}{2}$	1.927	1.773	92.2	46.13	68.5	67.4

The capacity of various sized lines with a globe valve is given in Table 48, with the valve stem both in a vertical and horizontal position. It will be noted that with the stem in the vertical position the capacity of such a line varies from 11 to 35 per cent of the capacity of the same line without such a valve. With the valve stem in the horizontal position the capacity of the line varies from 54 to 76 per cent of the capacity of the same line without the valve. In other words, the capacity of a globe valve is somewhat less than the capacity of a pipe of the same nominal

TABLE 48. RESULTS OF TESTS ON GLOBE VALVES

PITCH = 0.4 IN. PER FT.

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
$\frac{3}{4}$	1.38	11.8	8.83	76.3
1	7.73	35.7	14.06	66.1
$1\frac{1}{4}$	13.20	31.2	22.88	54.3
$1\frac{1}{2}$	18.81	33.0	32.00	56.7

TABLE 49. RESULTS OF TESTS ON GATE VALVES

NOMINAL SIZE OF PIPE AND VALVE IN.	AREA OF PIPE SQ. IN.	AREA OF VALVE SQ. IN.	PITCH = 0.4 IN. PER FT.		PITCH = 90 DEG. FAHR.	
			Capacity of Pipe and Valve Lb. per Hr.	Per Cent of Capacity of Same Pipe Without Valve	Capacity of Pipe and Valve Lb. per Hr.	Per Cent of Capacity of Same Pipe Without Valve
$\frac{3}{4}$	0.5373	0.4418	10.15	85.9	10.55	78.0
1	0.860	0.809	22.50	94.0	18.78	78.0
$1\frac{1}{4}$	1.459	1.208	33.13	100.	32.50	68.6
$1\frac{1}{2}$	1.927	1.743	50.93	90.4	52.00	75.9

size when the stem is horizontal. When the stem is in the vertical position the capacity is reduced very much further.

The capacity of various sized lines containing a gate valve is given in Table 49.

In a number of the tables listed the word *maximum capacity* is used. This is the maximum value obtained at the Research Laboratory with smooth operation. In actual practice the system should be so designed as to allow a reasonable factor of safety.

CHAPTER V

THE BOILER

FUNCTIONS OF THE MAJOR PARTS OF THE HEATING SYSTEM

A STEAM heating plant consists of three major parts, the *boiler*, the *pip*ing and the *radiation*, each of which has certain functions to perform in offsetting the heat loss from the building. It is the function of the *boiler* to deliver at its outlet the necessary amount of dry steam to the piping system. It is the function of the *pip*ing system, including valves, to distribute this dry steam to the various radiators and to return the condensate to the boiler at the same rate as it leaves the boiler in the form of steam. It is the function of the *radiators* to transmit the heat contained in the steam to the various rooms to be heated. It is understood that before the piping and valves can distribute the steam, they must first eliminate the air from the system. By dry steam is meant steam containing less than 2 per cent moisture.

RATED VS. OPERATING CAPACITY OF A BOILER

Commercial ratings of boilers are generally computed on the following basis: Number of pounds of dry steam (or its equivalent, as stated, in square feet of direct radiation) that the boiler can deliver at its outlet per hour, when operating under certain specified conditions, as to: Condition of boiler, draft intensity, kind and quality of coal burned per hour, and period of firing and method of operation as indicated by the CO₂ recorder and temperature of flue gases. No rating is reliable unless definite operating conditions are specified. The operating capacity of a boiler may range anywhere from 20 per cent of its rated capacity to 150 per cent of its rating in modern heating boilers. To expect a boiler to develop its rated capacity with oil in the boiler, air leaks between the sections or through the setting, fouled heating surface, dirty grade of coal, weak draft, and incompetent firing and operating conditions, is about on a par to expect a racing automobile to win a race with water in the oil, leaky set of tires, fouled spark plugs, poor grade of gas, improper carburetor adjustment, and a novice at the wheel.

The operating capacity or efficiency of any heating boiler, high or low pressure, depends more upon the operating conditions than upon the design of the boiler—important as proper design may be. This point cannot be emphasized too strongly as it is one that is frequently lost sight of.

DETERMINING BOILER CAPACITY REQUIRED FOR A PARTICULAR INSTALLATION

First determine from the boiler manufacturer whether his complete line of boilers has been tested according to the A. S. H. & V. E. Boiler Testing Code Revision of 1923 (See p. 65). Look for the evidence of such testing in his catalog also facts as to fuel capacity, evaporative power and on the smaller boilers, length of firing period, efficiency and draft requirements. The net amount of radiation should be increased by about 20 per cent for line losses to determine the total heating load on the boiler. The smaller the boiler, the greater the handicaps it usually must operate under, such as poor draft, dirty coal, sooty heating surface, incompetent attention, etc. To offset those handicaps on boilers used for residence heating, a factor of safety of 50 to 100 per cent should be figured above the total load in determining boiler capacity. In larger size installations the operating conditions are more favorable where a factor of safety of 25 to 75 per cent is ample. Under ordinary operating conditions any boiler should be able to develop at least its full rated capacity.

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 50:

TABLE 50. CHIMNEY SIZES

WARM AIR FURNACE CAPACITY IN LEADER PIPE SQ. IN.	STEAM BOILER CAPACITY SQ. FT. OF RADI- TION	HOT WATER HEATER CAPACITY SQ. FT. OF RADI- TION	NOMINAL DIMEN- SIONS OF FIRE CLAY LINING IN.	RECTANGULAR FLUE			ROUND FLUE		
				Actual Inside Dimensions of Fire Clay Lining In.	Actual Area Sq. In.	Effective Area Sq. In.	Inside Diameter of Lining In.	Effective Area Sq. In.	Height in Ft. from Grate
790	590	973	8½x13	7x11½	81	70	10	79	35
1000	690	1140							
	900	1490	13x13	11¼x11¼	127	99			
	900	1490	8½x18	6¼x16¼	110	100			
	1100	1820					12	113	40
	1700	2800	13x18	11¼x16¼	183	156	15	177	
	1940	3200							
	2130	3520	18x18	15¼x15¼	248	195			45
	2480	4090	20x20	17¼x17¼	298	234			50
	3150	5200					18	254	
	4300	7100					20	314	
	5000	8250	24x24	21x21	441				55
	4600	7590		20x24*	480	326			60
	5570	9190		24x24	576	380			
	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 51.

TABLE 51. 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

AMERICAN SOCIETY OF HEATING and VENTILATING ENGINEERS GUIDE, 1924-25

TABLE 51. HEIGHT OF STACK FOR AVERAGE INSTALLATIONS (SEA LEVEL)—Continued

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,	450	500
Efficiency.....	65%	65%	63%	deg. fahr.....	550	550
CO ₂	8%	9%	10%	Lbs. of Gas.....	85	77

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 Breaching 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

AMERICAN SOCIETY OF HEATING and VENTILATING ENGINEERS GUIDE, 1924-25

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

An approximate rule often applied to chimneys over 64 ft. high, as regards rate of combustion is:

$$\text{Rate Combustion for Hard Coal} = 1\frac{1}{2} \sqrt{H} \text{ to } 2 \sqrt{H};$$

$$\text{Rate Combustion for Soft Coal} = 2 \sqrt{H} \text{ to } 3 \sqrt{H};$$

Where H = height of chimney in feet.

In the absence of a chimney size formula based on research data, the formula given in *Kent's Hand Book* is about the best available.

$$R = 333 E \sqrt{H}$$

where

R = steam rated capacity of boiler in square feet.
 E = effective area of stack in square feet which should not extend within 2 in. of stack walls.

$\sqrt{H}$ = square root of height in feet measured from center of breeching connection to stack. The height of stacks less than 65 ft. should not be less than 30 times the diameter or width of stack.

The rate of combustion in heating boilers ranges from 5 lb. to over 20 lb. of coal per square foot of grate per hour, according to the height of the stack. Large heating boilers are being attached to stacks 100 to 300 ft. high. Small round boilers require from 0.1 to 0.2 in. of draft at the smoke outlet, according to the number of intermediate sections placed between the firepot and dome sections. Medium size boilers require from 0.15 to about 0.5 in. of draft. Smokeless boilers require from 0.4 to 1.0 in. of draft to develop their rated capacity. Such conditions as nature of fuel condition of firebed, amount of excess air used and condition of the flue travel very materially increase or decrease the draft required to develop the rated capacity of any boiler.

Small house heating boilers should be rated on a 10-hr. hard coal basis. The larger size boilers using hard coal and having a grate over 40 in. wide are rated on a 4 to 6-hr. hard coal basis. All boilers burning soft coal are rated on an hourly basis because of the tendency of soft coal to burn holes through the firebed in a relatively short time after firing. The largest size of boilers are rated on an hourly basis since a fireman is in constant attendance.



HOW TO CLEAN WATER-GAGE GLASS ON STEAM BOILER WITHOUT REMOVING IT

1. Draw a cupful of hot water from the boiler, into which pour at least a tablespoon of raw muriatic or other acid.
2. Close both water-gage valves.
3. Open top water-gage valve and also pet cock at bottom, and blow water out of glass. Then immediately close the top valve and submerge the end of the pet cock in cup of hot-water solution. A vacuum is at once created in the gage glass which causes the solution in the cup to rush in.
4. Keep the pet cock immersed and operate the top valve, slightly opening and closing, alternately expelling and drawing in the solution until all grease, oil, or other matter adhering to the inside of the glass is cut out. Then close pet cock and open both water-gage valves.

It is necessary to have 1 lb. pressure of steam or more on the boiler before commencing this operation, which need not occupy more than 10 min. The result is a clean glass without the risk of breakage and probable renewal of gaskets, which is frequently the case when removing the glass for cleaning.

CLEANING STEAM BOILERS

After a steam or vapor boiler has been in operation for a short time, grease, oil, scale, core sand and other foreign matter will accumulate in the boiler, which will invite various kinds of trouble and can only be eliminated by thorough cleaning.

The following method of cleaning a steam boiler has been successfully used and is recommended by many boiler manufacturers.

1. Close all radiator supply valves and where used remove the thermostatic member of all return line valves, or if boiler is valved close both supply and return. Blow down the boiler through bottom blowoff under a pressure of at least 5 lb. Where a skimming opening is tapped in boiler near water line connect a pipe with gate valve to skimmer opening and skim oil and grease from boiler.
2. Remove the safety valve and put acid vinegar (Acetic acid) in the boiler as follows:

Boilers up to 1000 sq. ft., capacity—3 gallons
“ “ “ 2000 “ “ “ 4 “
“ “ “ 4000 “ “ “ 5 “
“ “ “ 6000 “ “ “ 7 “

Replace the safety valve and operate the entire plant for at least 30 hr.

3. Again remove the safety valve in the absence of a skimmer opening and connect a pipe with gate valve to the outside on convenient drain. This pipe to be not less than size of safety valve.

With water in boiler at proper level and valve in top blow-off pipe closed, build a very hot coal fire creating a pressure of 5 to 10 lb. Open top blow-off valve and let water and steam pass through the blow-off line to drain—keep up a pressure between 5 and 10 lb.—and carefully supply water constantly into boiler so as to keep gage glass filled to top—keep this up without interruption for 6 to 8 hr. During the last 2 hr. fill boiler full of water allowing the hot water to flow through, and out of top blow-off pipe to drain.

4. Close the water-feed valve and let steam and water flow through top blow-off line until water level in boiler is at top of gage glass—close the gate valve in top blow-off line and with at least 10 lb. steam pressure—draw fire quickly and open the bottom blow-off valve, and entirely drain the boiler. Allow the boiler to cool—replace if any thermostatic-members in return line valves—replace safety valve—close bottom blow-off valve and fill boiler with fresh water to proper level.

Sometimes one blowing off will not give the desired results in which case the operation must be repeated or continued until the boiler is thoroughly free from all foreign matter.

With plants using vacuum and boiler feed pump the return to pump should be closed off and all condensation passed to drain for at least a week and then the boiler should be cleaned as above.

To avoid all this expense and trouble, some heating contractors do not allow any return water from a new system to enter the boiler during the time temporary heat is on and while the men are working on the job. The valve on the return main is closed, a plug removed from a tee just outside the return valve and the feed-water valve cracked open enough to maintain the water in the boiler up to the water line under close watching by one of the steam fitters. At night the fire is banked, the plug in the return replaced and the return valve opened. With a banked fire practically no grease enters the boiler from the system during the night.

TABLE 52. SAFETY VALVE SIZES FOR STEAM HEATING BOILERS

SAFETY VALVE			RATED CAPACITY OF BOILER	
Diameter, In.	Area, Sq. In.	Discharge Capacity, Lb. per Hr.*	Steam Radiation, Sq. Ft.	Steam, Lb. per Hr.
3/4	0.4418	130	520	130
1	0.7854	230	920	230
1 1/4	1.2272	360	1,440	360
1 1/2	1.7671	515	2,065	515
2	3.1416	920	3,680	920
2 1/2	4.9087	1,435	5,740	1,435
3	7.0686	2,070	8,280	2,070
3 1/2	9.6211	2,810	11,250	2,810
4	12.5660	3,675	14,700	3,675
4 1/2	15.9040	4,650	18,600	4,650

*Capacity of safety valve based on 33 1/3 per cent over-pressure, valve set to relieve at 15 lb. per sq. in. Note.—For the purpose of these computations 240 heat units or 0.25 lb. of steam per hr. shall be considered as the equivalent of a square foot of steam radiation.

Grease in a boiler, not only prevents proper steam generation but it is liable to cause burning out of the boiler. A practical method of determining when the water in a boiler is free from oil, is to draw a sample of the water from the gage cock into a vessel, say about 3 in. in diameter, and at least 8 to 12 in. deep. Have about 2 or 3 in. of water in the vessel and boil it over a gas plate or other hot fire. If there is oil in the water the boiling will cause it to foam and overflow the vessel; while if the water is clear and free from oil and alkali, one can always see the top of the boiling water emitting bubbles of steam but not foaming.

PREVENTING WATER HAMMER CAUSED BY BOILER PRIMING

Where the velocity of steam in a steam pipe is so great that it banks the condensate up in waves, similar to a high wind on a body of water, steam pockets are formed between solid lugs of water—similar to A, Fig. 16. The steam in those pockets is condensed rapidly by the condensate and cool air around the pipe which produces a vacuum and as a result the slugs of water B-B are forced together with a sharp impact and often with sufficient force to crack large ells at the end of a straight run of pipe.



FIG. 16. EXAMPLE OF WATER HAMMER

If the pipe is properly graded, and large enough to permit the steam to travel at a relatively low velocity, it will not form such waves of water and produce water hammer. A steam separator placed in the main near the boiler will prevent water hammer due to the boiler priming. Quickly heating up a cold radiator or partly opening a valve on a one-pipe radiator will cause water hammer and gurgling in the radiator.

CHAPTER VI

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:

- The total heat input.
(The total heat input is the total heat value of the fuel charged.)
- 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 Revisions made 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 $\frac{3}{4}$ 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.

¹As 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 AMERICAN 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 $\times$ 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. radiation¹
9. Grate Area²..... 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 ^a | lb. |
| 16. | Depth on Grate at Start of Test | in. |
| | (After Firing) | in. |
| 17. | Depth on Grate at Finish of Test | in. |
| 18. | Weight as Fired during Test ^a | lb. |
| 19. | Weight as Fired per Hour ^a | lb. |
| 20. | Moisture in Fuel | per cent |
| 21. | Weight Fired per Hour less Moisture: ^a | |
| | $\frac{100 - \text{item 20}}{100} \times \text{item 19}$ | 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*
(item 22 + item 23)..... | lb. |

¹One sq. ft. radiation to be assumed equal to 240 B.t.u. per hr.
²If the grate have an unusual shape, method of computing area must be stated under "Remarks."
³When 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.
⁴To include ash content of residual fire when New Fire Method is used.

AMERICAN SOCIETY of HEATING and VENTILATING ENGINEERS GUIDE, 1924-25

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 $\times$ 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 (item 49 $\times$ $\frac{\text{item 50}}{\text{item 11}}$).....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 (item 51 $\times$ $\frac{\text{item 52}}{\text{item 11}}$).....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:
 (item 51 $\times$ $\frac{\text{item 58}}{100}$).....lb.

⁵Item 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.

AMERICAN SOCIETY of HEATING and VENTILATING ENGINEERS GUIDE, 1924-25

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.)

AMERICAN SOCIETY of HEATING and VENTILATING ENGINEERS GUIDE, 1924-25

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.

72

AMERICAN SOCIETY of HEATING and VENTILATING ENGINEERS GUIDE, 1924-25

LOG SHEET NO. 3

Date.....

Test No.

Observations of Feed Water, Pressures, and Temperatures

[illegible][illegible]

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

At finish

73

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

[illegible]

CHAPTER VII

PUMPS FOR HEATING AND VENTILATING EQUIPMENT

INTRODUCTION

1. The great increase in the number of large buildings.
2. The increasing use of electricity for industrial purposes together with the development of reliable motor driven pumps, and
3. The desire to eliminate high pressure boiler plants where steam is used only for heating purposes.

It is as an aid to the proper determination of pump ratings and capacities, therefore, that the following information is given.

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.

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

Material for this section especially prepared for THE GUIDE by Perry West, Newark, N. J., and R. H. Carpenter, New York.

Piston speeds in feet per minute for reciprocating boiler feed pump ought 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

TABLE 53. SIZES, REVOLUTIONS PER MINUTE, 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

TABLE 54. 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	PIPE STEAM INCHES	SIZE EXHAUST INCHES	SUCTION INCHES	DISCHARGE INCHES
				Per Stroke	Per Min.						
3	2	3	70	0.04	5.6	2½	80	½	¾	1½	1
4½	2½	4	60	0.10	12.0	4	180	¾	1½	1½	1½
5½	3½	5	50	0.20	20.0	5	300	¾	1½	2	1½
6	4	6	50	0.33	33.0	5½	480	1	1½	2½	2
7½	4½	6	50	0.42	42.0	6½	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	9½	2000	2½	3	5	4

TABLE 55. 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	1½
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 56. 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

TABLE 57. 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% to 70%.

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
3½	40-60	1600	3	2½
3½	55-100	1500	4	3
4	85-200	1400	4	4
5	175-275	1200	5	4
5½	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

especially with widely fluctuating loads as the efficiencies of centrifugal 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 usually employed for installations of less than 1000 b.hp.

For small capacities screw pumps may be successfully used for greater economy.

CONDENSATION RETURN PUMPS

Condensation return pumps are generally of two classes:

1. Automatic pumps and receivers.
2. Continuous operation non-automatic return pumps.

AUTOMATIC PUMPS AND RECEIVERS

The volumetric capacities of receivers should be from 2 to 5 times the maximum minute volumetric flow of condensation to be handled, measured between the high and low water lines in the receivers for electric driven pumps and much smaller for steam driven pumps.

The piston speeds in feet per minute should not be more than 10 times the square root of the number of inches in the length of stroke.

The volumetric displacement rate of water pistons should be 3 or more times the maximum volumetric rate of the flow of condensate to be handled.

The normal capacities for centrifugal pumps should be 2 or more times the maximum rate of flow of the condensation to be handled.

CONTINUOUS OPERATION NON-AUTOMATIC RETURN PUMP

The volumetric displacement rate of water pistons should be not less than 2 times the maximum rate of flow of the condensation to be handled.

Piston speeds in feet per minute should not be more than 10 times the square root of the number of inches in the length of stroke.

The quantities of condensate to be handled from direct radiation, direct-indirect radiation and indirect or fan blast radiation can be estimated as follows:

The normal capacity of pumps should 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 Table 58.

TABLE 58. TEMPERATURE OF CONDENSATE AT PUMP SUCTION

Deg. fahr.	Factor
190	1.15
200	1.56
204	2.00

TABLE 59. 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 60. 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" x 3' 8"	700
102	16,000	22	1725	0.6	¾	5' 3" x 3' 8"	700
103	26,000	35	1725	0.8	1	6' 5" x 3' 8"	750
104	40,000	60	1140	1.0	1½	7' 6" x 4' 2"	1050
105	65,000	90	1140	1.4	2	7' 6" x 4' 2"	1100

TABLE 61. SIZES, SPEEDS, HORSE-POWERS AND CAPACITIES 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	¾ ¾	¾ ¾	¾ ¾	¾ ¾
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

TABLE 62. 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	¾	1	15,000	25-30	10	¾	2
4000	6-8	15-40	1½	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	¾	1½	20,000	30-40	10	¾	2
6000	9-12	15-40	¾	1½	20,000	30-40	15	1	2
6000	9-12	50-60	1	1½	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	¾	1½	25,000	40-50	10	1	2½
8000	12-16	15	¾	1½	25,000	40-50	15	1½	2½
8000	12-16	20	1	1½	25,000	40-50	20	2	2½
8000	12-16	30-60	1½	1½	25,000	40-50	30-40	3	2½
					25,000	40-50	50-60	5	2½
10,000	15-20	10	¾	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					

To use Table 58, 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 lb. 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, where condensate is to be returned direct to a boiler from the pump.

TABLE 63. 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 × 2½ × 4	20	10,500	3500	40
5½ × 3½ × 5	40	19,500	6500	35
6 × 4 × 6	60	30,000	11,000	35
7½ × 5 × 6	100	45,000	15,000	30

Low Pressure

SIZE OF PUMP	RECEIVER CAPACITY GALLONS	SQ. FT. DIRECT RADIATION	LB. CONDENSATE PER HOUR	MINIMUM STEAM PRESSURE
4½ × 2 × 4	12	6000	2000	25
5½ × 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

Return line vacuum heating pumps may be divided into three classes as follows:

1. Direct acting reciprocating steam driven vacuum return line pumps.
2. Reciprocating power driven return line vacuum pumps.
3. Motor driven return line vacuum pumps.

In estimating the size of the vacuum pump, it is not sufficient to know merely the square feet of equivalent direct radiation. There are other variables which enter into the problem such as the following:

1. The degree of tightness of the system.
2. The efficiency of the radiator traps.
3. The temperature of the condensate at the pump.
4. The probable cooling effect of the return piping.
5. Are lift points required in the return?
6. What vacuum must be maintained at the pump?
7. Do large volumes of high temperature water enter the return piping near the pump?
8. Are the runs of piping long from the source of steam supply to the farthest radiator?

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. 17 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.

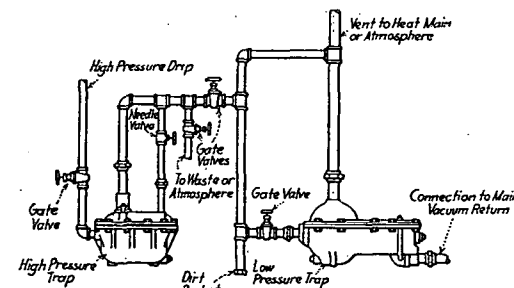


FIG. 17. METHOD OF DISCHARGING HIGH-PRESSURE APPARATUS INTO LOW-PRESSURE HEATING MAINS AND VACUUM RETURN MAINS THROUGH A LOW-PRESSURE TRAP

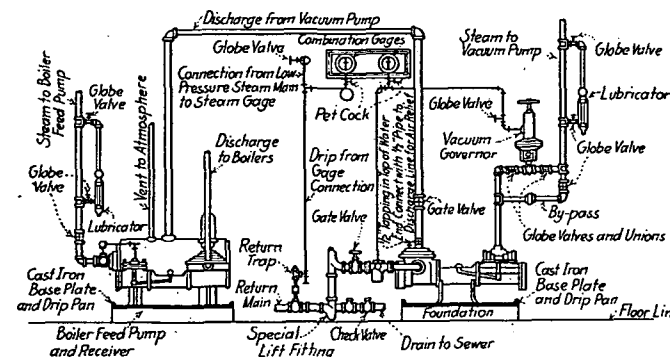


FIG. 18. METHOD OF CONNECTING VACUUM PUMP AND AUTOMATIC BOILER-FEED PUMP AND RECEIVER

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 so that some 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 water flow downward while the entrained air is escaping to the surface against the

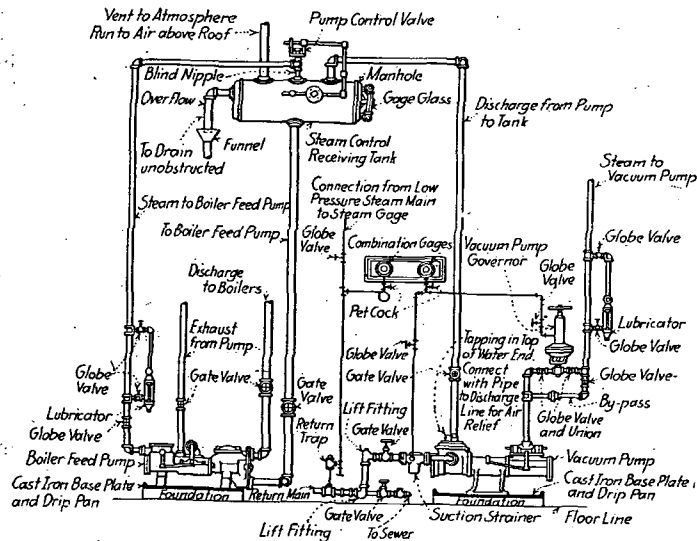


FIG. 19. METHOD OF CONNECTING VACUUM PUMP, BOILER-FEED PUMP AND STEAM-CONTROL RECEIVING TANK

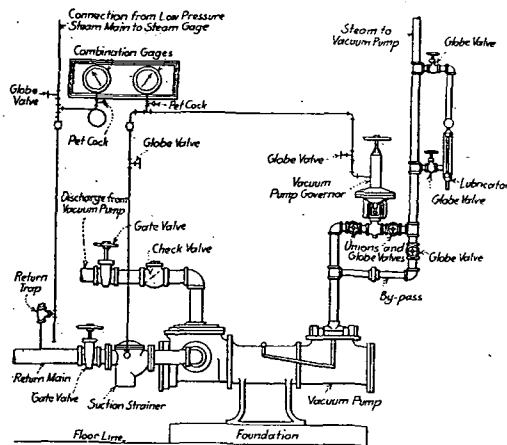


FIG. 20. METHOD OF MAKING CONNECTION TO STEAM-OPERATED VACUUM PUMP

water current. For removal of air, allowance of 1 sq. ft. of horizontal cross section for each 2100 lb. of water per hr. should be made. 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.

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 can be 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. Figs. 18, 19 and 20 show vacuum pump connections for several different conditions of service.

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.

Table 64 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.

TABLE 64. 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

Receivers.—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 are as follows:

TABLE 65. 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 LEVELS 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

Air Capacities.—The air capacities recommended, refer 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 Table 66. It should be noted that while water capacities of pumps to be added for fan blast 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 66. AIR CAPACITIES

SQ. FT. DIRECT EQUIVALENT RADIATION SURFACE	DIAMETER ORIFICE VAC. 10"	AIR CAPACITY CU. FT. PER MIN.
8,000	$\frac{3}{8}$ "	5
16,000	$\frac{1}{8}$ "	9
26,000	$\frac{1}{4}$ "	15
40,000	$\frac{3}{8}$ "	19
65,000	$\frac{1}{2}$ "	34
100,000	$\frac{5}{8}$ "	60
150,000	$\frac{3}{4}$ "	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 $\frac{1}{8}$ in. thick with a reamed hole having sharp edges and of a diameter corresponding to the capacity of the pump.

* Fig. 21 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.

TABLE 67. 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. PRES- SURE 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

Water Capacity.—The water capacity of the pump when operating against 8 in. of mercury vacuum should be not less than two-thirds 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

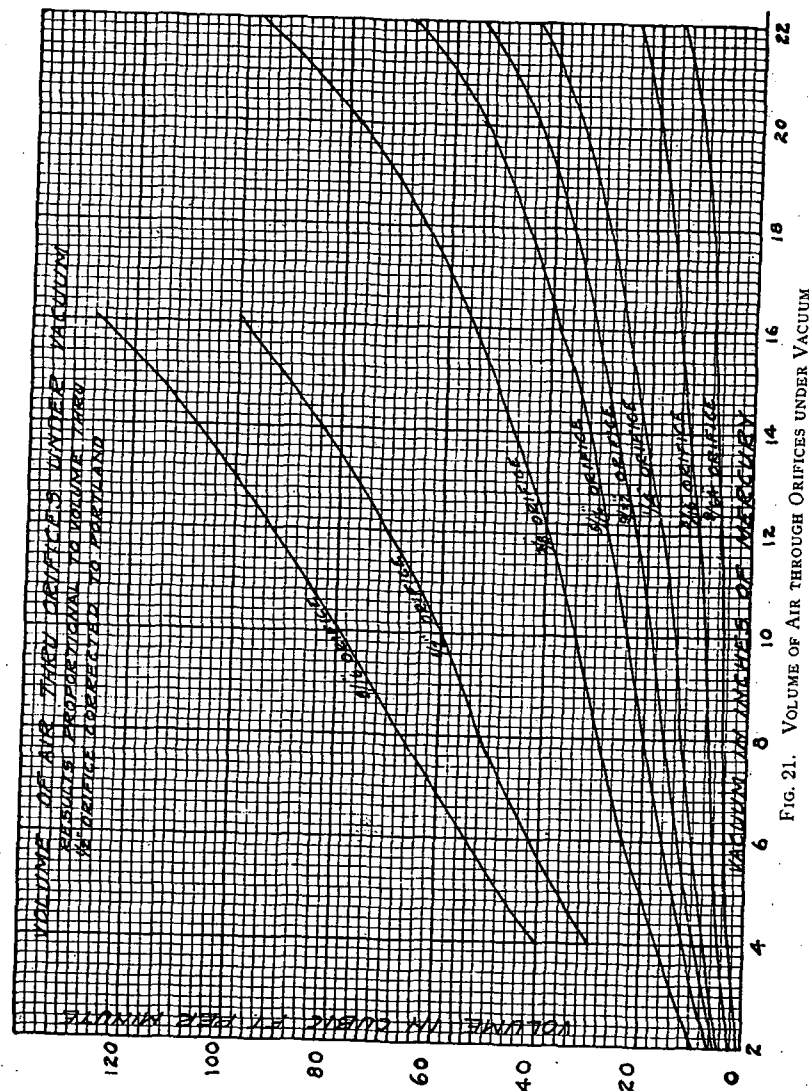


FIG. 21. VOLUME OF AIR THROUGH ORIFICES UNDER VACUUM

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 previously mentioned.

TABLE 68. 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	3/4
6000	9	15	1
8000	12	10	1 1/2
8000	12	15	2
12,000	18	10	2 1/2
12,000	18	15	3
18,000	27	10	4
18,000	27	15	5
30,000	45	10	7 1/2
30,000	45	15	10

TABLE 69. TWO PUMP TWO MOTOR RETURN LINE SYSTEM VACUUM PUMPS

CAPACITY SQ. FT. OF DIRECT RADIATION	CAPACITY G. P. M.	PRESSURE AT PUMP	MOTOR H. P.	
			Air	Water
6000	9	10	1/2	3/4
6000	9	15	1/2	3/4
8000	12	10	1/2	3/4
8000	12	15	1/2	3/4
12,000	18	10	3/4	1
12,000	18	15	3/4	1 1/2
18,000	27	10	3/4	2
18,000	27	15	3/4	2 1/2
25,000	38	10	1	3
25,000	38	15	1	4
30,000	45	10	1	5
30,000	45	15	1	6

The capacities given in Table 70 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.

$$A_s \times \frac{P_b}{3} = A_w \times \left(\frac{V}{2} + P_d \right)$$

TABLE 70. 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	1/2	1 1/4	3/4	2.50	1.58
4	1047	3490	1/2	1 1/2	1	2.25	1.48
5	1830	6100	1/2	2	1 1/4	2.00	1.38
6	2890	9633	1/2	2 1/2	1 1/2	1.90	1.34
7	4250	14,166	3/4	2 1/2-3 1/2	1 1/2-2	1.80	1.31
8	5920	19,733	3/4	3-3 1/2	2	1.75	1.29
9	7980	26,600	3/4	3 1/2-4	2	1.70	1.27
10	10,350	34,500	1	4-4 1/2	2 1/2	1.67	1.25
12	16,300	54,333	1	4 1/2-5	2 1/2	1.60	1.23
14	24,000	80,000	1 1/4	5-6	3	1.50	1.10
16	33,500	111,666	1 1/4	6-7	3 1/2	1.40	1.15
18	45,000	150,000	1 1/2	7	4	1.33	1.13
20	58,500	195,000	1 1/2	7-8	4 1/2	1.30	1.12
22	74,300	247,666	2	8	4 1/2	1.25	1.10
24	92,300	317,666	2	8-10	5	1.20	1.08
26	112,800	376,000	2 1/2	10	6	1.10	1.04
28	135,800	452,666	2 1/2	12	6	1.00	1.00
30	161,300	537,666	2 1/2	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

TABLE 71. CENTRIFUGAL TYPE SUMP PUMPS

SIZE OF PUMP IN.	SIZE OF DISCHARGE IN.	CAPACITY GAL. PER MIN.	TOTAL HEAD FT.	SPEED, LIMITS REVOLUTIONS PER MIN.		SIZE OF MOTOR H. P.
				Minimum	Maximum	
1 1/2	1 1/2	60	10	850	1450	1
1 1/2	1 1/2	60	15	980	1800	1 1/2
1 1/2	1 1/2	60	20	1120	1800	1 1/2
1 1/2	1 1/2	60	25	1250	1800	1 1/2
1 1/2	1 1/2	60	30	1400	1800	2
2	2	125	10	750	1200	1 1/2
2	2	125	15	900	1450	2
2	2	125	20	1000	1650	3
2	2	125	25	1120	1800	3
2	2	125	30	1200	1800	3
2 1/2	2 1/2	200	10	650	1120	2
2 1/2	2 1/2	200	15	800	1300	3
2 1/2	2 1/2	200	20	900	1500	5
2 1/2	2 1/2	200	25	1000	1750	5
2 1/2	2 1/2	200	30	1100	1800	7 1/2
3	3	275	10	550	1120	3
3	3	275	15	600	1300	3
3	3	275	20	700	1500	5
3	3	275	25	750	1750	5
3	3	275	30	800	1800	7 1/2
4	4	500	10	1000	1120	5
4	4	500	15	1050	1250	5
4	4	500	20	1120	1450	7 1/2
4	4	500	25	1250	1600	10
4	4	500	30	1350	1750	10

From which we have

$$A_s = A_w \times \left(\frac{V}{2} + P_d \right) \times 3$$

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.

SUMP PUMPS

Sump pumps are usually of the vertical shaft centrifugal type and the following Table 71 will give the size capacity, horse-power and other essential data covering several commercial sizes of this type pump.

The *Hydraulic Society* has published a list of trade standards used in the pump industry which it recommends and this publication may be obtained by engineers from the *Hydraulic Society*.

TABLE 72. RECIPROCATING VACUUM PUMPS

Maximum Speed for Steam Driven Pumps

LENGTH OF STROKE IN.	NUMBER OF SINGLE STROKES PER MIN.	PISTON SPEED FT. PER MIN. S.	LENGTH OF STROKE IN.	NUMBER OF SINGLE STROKES PER MIN.	PISTON SPEED FT. PER MIN. S.
3	100	25	12	60	60
4	90	30	14	57	66 1/2
5	84	35	15	56	70
6	80	40	16	55	73
7	69	40	18	53	80
8	67 1/2	45	20	51	85
10	60	50	22	49	90

Maximum Speed for Power Driven Pumps

LENGTH OF STROKE IN.	REV. PER MIN. CRANK SHAFT	SINGLE STROKES PER MIN.	PISTON SPEED, FT. PER MIN. S.	LENGTH OF STROKE IN.	REV. PER MIN. CRANK SHAFT	SINGLE STROKES PER MIN.	PISTON SPEED, FT. PER MIN. S.
3	80	160	40	10	40	80	67
5	50	100	42	12	40	80	80
6	50	100	50	16	30	60	80
8	50	100	67	20	25	50	83

Use Mfg. Speed when equal or less than above.

TABLE 72. RECIPROCATING VACUUM PUMPS—Continued
Gross Capacity in Gallons of Pump Cylinders per Foot Piston Speed

DIA. CYLINDER IN.	GAL. PER FOOT G	DIA. CYLINDER IN.	GAL. PER FOOT G	DIA. CYLINDER IN.	GAL. PER FOOT G
2	.1632	6½	1.724	13	6.895
2½	.2550	6¾	1.859	13½	7.436
3	.3672	7	1.999	14	7.996
3¼	.4309	7¼	2.145	14½	8.578
3½	.4998	7½	2.295	15	9.180
3¾	.5738	7¾	2.450	15½	9.801
4	.6528	8	2.611	16	10.44
4¼	.7369	8½	2.948	17	11.79
4½	.8263	9	3.305	18	13.32
4¾	.9206	9½	3.682	19	14.73
5	1.020	10	4.080	20	16.32
5¼	1.125	10½	4.498	21	17.99
5½	1.234	11	4.937	22	19.75
5¾	1.349	11½	5.396	23	21.58
6	1.469	12	5.875	24	23.50
6¼	1.594	12½	6.375	25	25.50

Empirical Formula

$$G \times S \times W = \text{capacity sq. ft. direct radiation}$$

G = capacity water cylinder in gal. per ft. length.

S = piston speed in ft. per min.

W = constant—105 for 6 in. and less—120 for over 6-in. cylinder

TABLE 73. PUMP DATA

ALTITUDE	BAROMETRIC PRESSURE	EQUIVALENT HEAD OF WATER IN FT.	PRACTICAL SUCTION LIFT
Sea level	14.70 lb. to sq. in.	33.95	22'
¼ mile above	14.02 " " "	32.38	21'
½ " " "	33.33 " " "	30.79	20'
¾ " " "	12.66 " " "	29.24	18'
1 " " "	12.02 " " "	27.76	17'
1¼ " " "	11.42 " " "	26.38	16'
1½ " " "	10.88 " " "	25.13	15'
2 " " "	9.88 " " "	22.82	14'

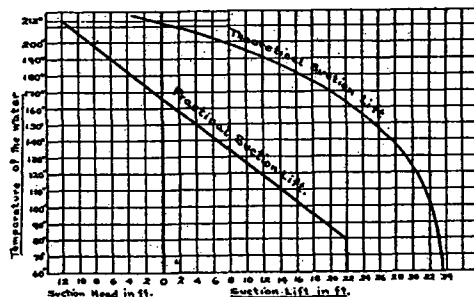
SUCTION LIFT OF PUMPS
WITH BAROMETRIC PRES-
SURE AT DIFFERENT ALTI-
TUDES AND EQUIVALENT
HEAD OF WATER IN FEET.

TABLE 74. PROPERTIES OF SATURATED STEAM

VACUUM IN IN. OF MERCURY OR GAGE PRESSURE IN LB.	ABSOLUTE PRESSURE IN LB. PER SQ. IN.	TEMPERATURE IN DEG. FAHR.	TOTAL HEAT ABOVE 32 DEG. FAHR.		LATENT HEAT OF THE STEAM IN B.T.U.	VOLUME IN CU. FT. OF 1 LB. OF STEAM
			B.t.u. in the Water	B.t.u. in the Steam		
27.88	1.	101.83	69.8	1104.4	1034.6	33.0
25.85	2.	126.15	94.0	1115.0	1021.0	173.5
23.81	3.	141.52	109.4	1121.6	1012.3	118.5
21.78	4.	153.01	120.9	1126.5	1005.7	90.5
19.74	5.	162.28	130.1	1130.5	1000.3	73.33
17.70	6.	170.06	137.9	1133.7	995.8	61.89
15.67	7.	176.85	144.7	1136.5	991.8	53.56
13.63	8.	182.86	150.8	1139.0	988.2	47.27
11.60	9.	188.27	156.2	1141.1	985.0	42.36
9.56	10.	193.22	161.1	1143.1	982.0	38.38
7.52	11.	197.75	165.7	1144.9	979.2	35.10
5.49	12.	201.96	169.9	1146.5	976.6	32.36
3.45	13.	205.87	173.8	1148.0	974.2	30.03
1.42	14.	209.55	177.5	1149.4	971.9	28.02
0.00	14.70	212.00	180.0	1150.4	970.4	26.79
0.3	15.	213.00	181.0	1150.7	969.7	26.27
1.3	16.	216.3	184.4	1152.0	967.6	24.79
2.3	17.	219.4	187.5	1153.1	965.6	23.38
3.3	18.	222.4	190.5	1154.2	963.7	22.16
4.3	19.	225.2	193.4	1155.2	961.8	21.07
5.3	20.	228.0	196.1	1156.2	960.0	20.08
6.3	21.	230.6	198.8	1157.1	958.3	19.18
7.3	22.	233.1	201.3	1158.0	956.7	18.37
8.3	23.	235.5	203.8	1158.8	955.1	17.62
9.3	24.	237.8	206.1	1159.6	953.5	16.93
10.3	25.	240.1	208.4	1160.4	952.0	16.30
15.3	30.	250.3	218.8	1163.9	945.1	13.74
20.3	35.	259.3	227.3	1166.8	938.9	11.89
25.3	40.	267.3	236.1	1169.4	933.3	10.49
31.3	46.	275.8	244.8	1172.0	927.2	9.20
35.3	50.	281.0	250.1	1173.6	923.5	8.51
41.3	56.	288.2	257.5	1175.7	918.2	7.65
45.3	60.	292.7	262.1	1177.0	914.9	7.17
51.3	66.	299.0	268.5	1178.8	910.2	6.56
61.3	76.	308.5	278.3	1181.4	903.0	5.74
71.3	86.	317.1	287.2	1183.6	896.4	5.10
81.3	96.	324.9	295.3	1185.6	890.3	4.60
90.3	105.	331.4	302.0	1187.2	885.2	4.23
100.3	115.	338.1	309.0	1188.8	879.8	3.88
125.3	140.	353.1	324.6	1192.2	867.6	3.219
140.3	155.	361.1	332.9	1194.0	861.0	2.920
150.3	165.	366.1	338.2	1195.0	856.8	2.753
165.3	180.	373.1	345.6	1196.4	850.8	2.533
175.3	190.	377.6	350.4	1197.3	846.9	2.406
200.3	215.	388.0	361.4	1199.2	837.9	2.138

TYPICAL CONNECTIONS

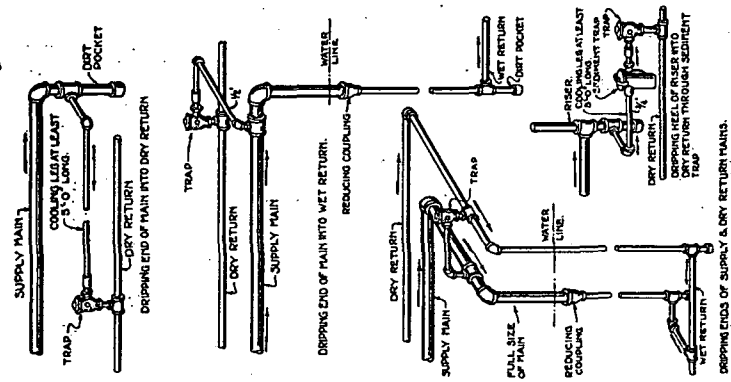


FIG. 24. TYPICAL VAPOR PIPE CONNECTIONS

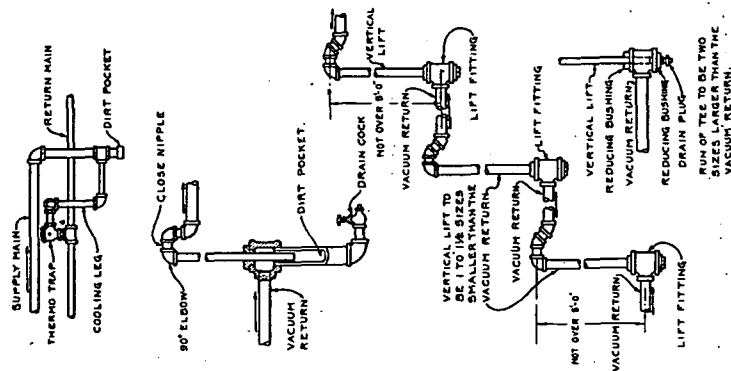


FIG. 23. TYPICAL VACUUM CONNECTIONS

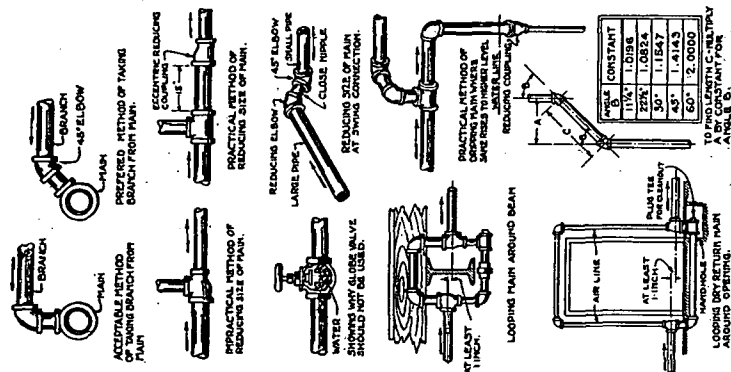
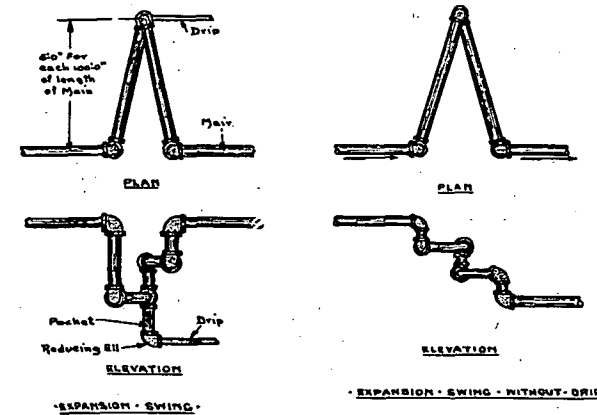


FIG. 22. TYPICAL STEAM PIPE CONNECTIONS



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.

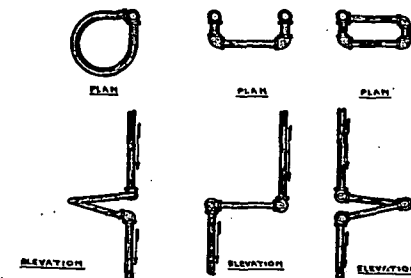


FIG. 25. TYPICAL EXPANSION CONNECTIONS

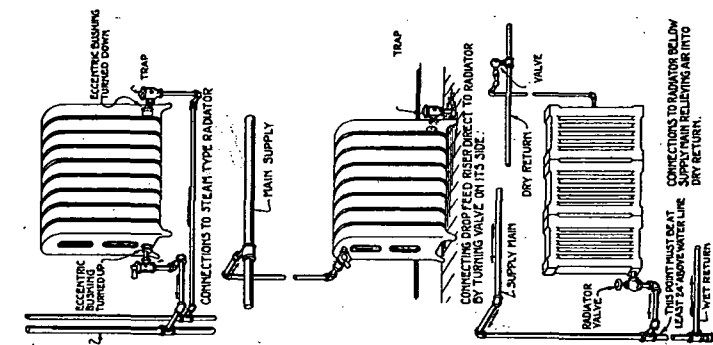


FIG. 28. TYPICAL RADIATOR CONNECTIONS

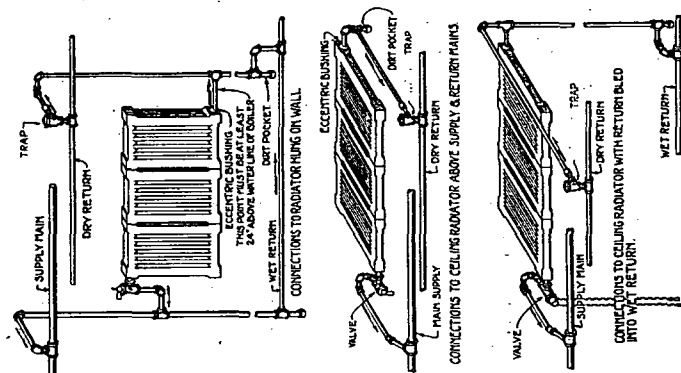


FIG. 27. TYPICAL RADIATOR CONNECTIONS

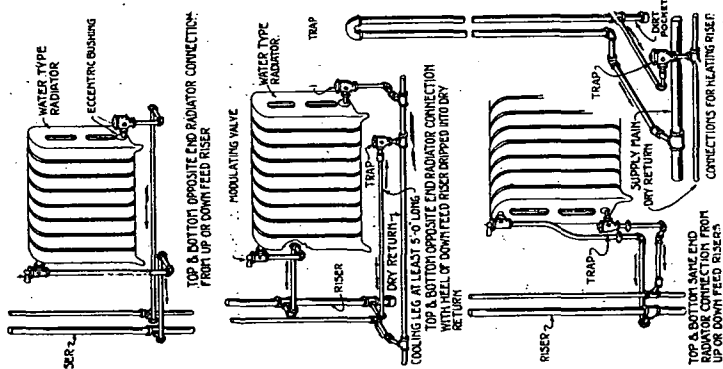


FIG. 26. TYPICAL RADIATOR CONNECTIONS

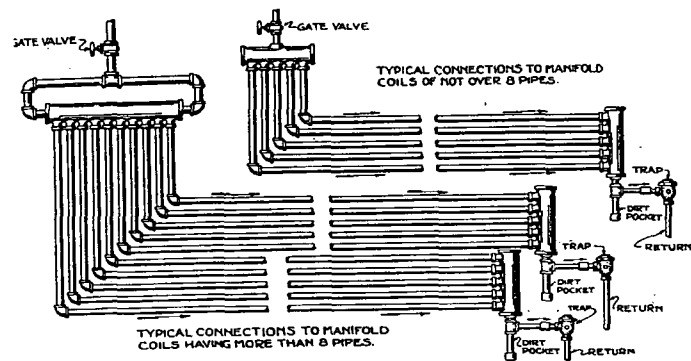


FIG. 29. TYPICAL CONNECTIONS TO MANIFOLD COILS HAVING MORE THAN 8 PIPES

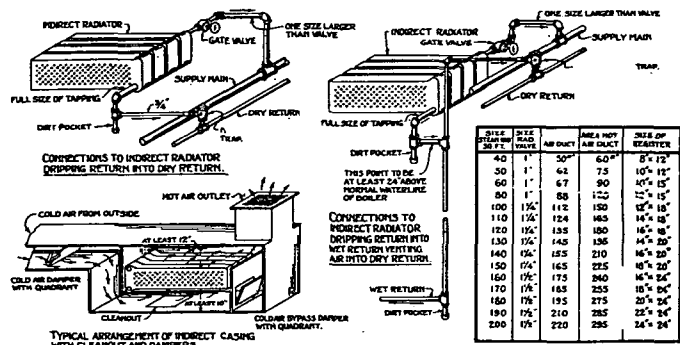


FIG. 30. INDIRECT RADIATOR CONNECTIONS

SIZE OF RADIATOR	SIZE OF RADIATOR	SIZE OF RADIATOR	SIZE OF RADIATOR	SIZE OF RADIATOR	SIZE OF RADIATOR
40	1"	62	75	10"	12"
50	1"	67	90	10"	15"
60	1"	88	120	12"	15"
80	1 1/2"	112	150	12"	18"
100	1 1/2"	124	165	14"	18"
120	1 1/2"	135	180	14"	20"
130	1 1/2"	145	195	16"	20"
140	1 1/2"	155	210	16"	22"
150	1 1/2"	165	225	18"	22"
160	1 1/2"	175	240	18"	24"
170	1 1/2"	185	255	18"	26"
180	1 1/2"	195	270	20"	26"
190	1 1/2"	210	285	22"	26"
200	1 1/2"	220	295	24"	26"

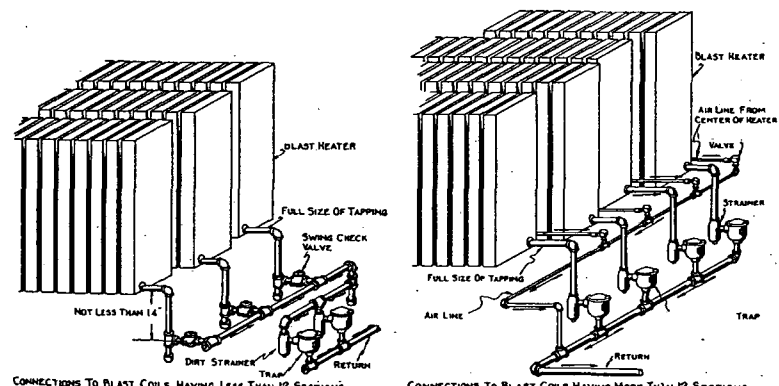


FIG. 31. RETURN CONNECTIONS TO BLAST COILS

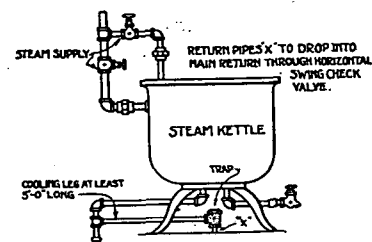
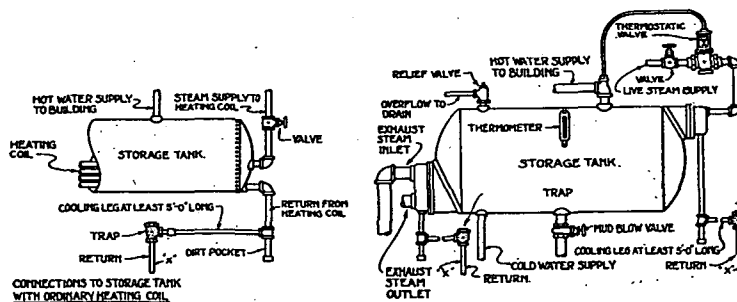


FIG. 32. CONNECTIONS TO COILS IN TANKS

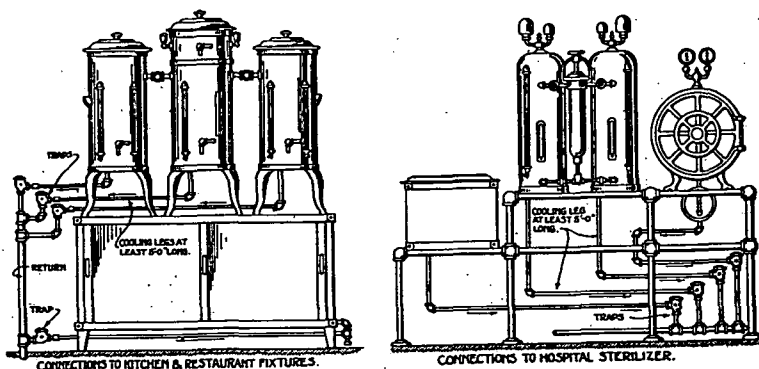


FIG. 33. TYPICAL CONNECTIONS TO KITCHEN AND HOSPITAL EQUIPMENT

CHAPTER VIII

HOT WATER HEATING

HOT water heating may be divided into two classes, forced and gravity circulation. The first is used on large units and other installations where it would be difficult to obtain uniform heating by gravity circulation. In many cases, approaching the natural dividing line between the two systems, a combination of forced and gravity circulation is installed, in which a pump is used as an auxiliary to circulate the water during periods of heavy firing.

GRAVITY HOT WATER SYSTEMS

Gravity hot-water heating may be divided into several classes, depending on the method of running the flow and return mains. For residences, the two-pipe, up-feed system generally is used. This means that the flow and return mains are run on the ceiling of the basement, with branches and risers feeding the several radiators from below. Where attic space is available, and in shops and factories the down-feed system often is used. This may have either single or double drops, although the single drop is preferable. The chief advantage of the down-feed system is that it raises the mean effective circulating head, and obviates many of the fine adjustments that are required with the up-feed system. Sometimes, when there is plenty of circulating head available, a two-pipe up-feed system with a single-pipe basement circuit is installed. This system, while it cuts down the amount of piping in the basement, increases the size of the mains because it divides the available circulating head into two circuits.

The basic principle of gravity circulation is shown in Fig. 34. As the water in column *A* is heated, and its density decreases it is overbalanced by the cold water in *B*. The water in column *B*, being colder, always outweighs the water in column *A*, and thus circulation is established. As the temperature difference between these two columns is increased, the difference in weight increases, with a consequent increase in the velocity of circulation. The velocity of circulation also varies with the difference in elevation between the heater and the radiators.

A circuit similar to that shown in Fig. 35 will not circulate, because the hot water is not overbalanced by the cold. Adding pressure to the water will not increase the velocity of circulation in any way, except that it may allow greater temperature differences to exist between the flow and return columns. The velocity of circulation cannot be increased or decreased by changing the pitch of the mains.

Material for this section was prepared especially for THE GUIDE by William Hutton, Winsted, Conn., in collaboration with Philip Parker, Woburn, Mass., W. P. Elder, Sherman Parker and A. F. Karlson, Fitchburg, Mass. Greenhouse heating by F. P. Elder, Irvington-on-Hudson, N. Y.

In actual practice, the circulation of water in a hot-water heating system is much more complicated than that shown in a simple circuit like Fig. 34. Every radiator then has a separate circuit of its own which must have approximately the same resistance as every other circuit. Each of these circuits has an individual length, height and amount of heat to be delivered. If any one circuit has a great advantage over the others, it will increase this advantage by heating the main return, which subtracts from the effective height of all the other radiators involved.

If the risers to radiator *B*, Fig. 37, were changed to $1\frac{1}{2}$ in. and all other connections remained as shown, the hot water would pass through this radiator with a very small temperature drop and back into the return main. This would subtract 3 ft. of effective height from radiators *C* and *D* and might even cause reverse circulation.

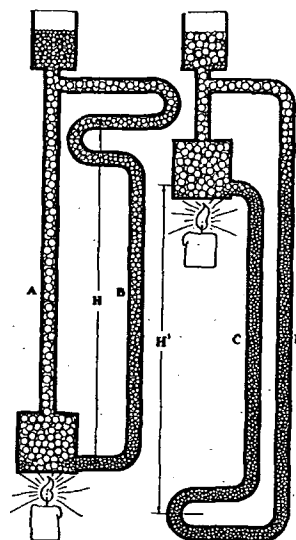


FIG. 34. ILLUSTRATES PRINCIPLE OF GRAVITY CIRCULATION

FIG. 35. CIRCULATION IMPOSSIBLE WITH THIS ARRANGEMENT

it should be based on a weight difference between the flow and return risers as weight difference and temperature drop do not correspond at different water temperatures. It is usual to assume an average water temperature of 180 deg. fahr.

A low-temperature drop requires larger piping, and is not so responsive to the fire because there is more water in circulation, but due to the low-water velocity it is much easier to balance. A low-temperature drop is better where several radiators are taken from a single main as in the one-pipe system.

With gravity hot-water heating the force tending to cause circulation is very small. For 40 deg. drop, it only amounts to $\frac{1}{16}$ in. of water pressure for each foot of effective height. There is very little data available on the flow of hot water in pipes under conditions such as are found in gravity work. The pioneers in this field adapted their formulae from tests made on large cast iron pipes such as are used in city water works. These formulae were not adapted to conditions such as are found in gravity hot-water heating, but they were the only ones available at the time. All modern formulae are based on the experiments of German engineers with pipes and fittings, such as are found in that country. How these compare with ours is a matter of conjecture.

DESIGNING A GRAVITY SYSTEM

To make all the radiators in a gravity circulating system correspond with one another, it is necessary to assume a temperature drop for the circuit, and then equalize all the individual circuits to this temperature drop. To be correct

SELECTING THE RIGHT PIPE SIZE

The charts, Fig. 36, show the pipe sizes required for temperature drops of 20, 30 and 40 deg. The vertical lines represent the total length of the circuit, divided by the effective height. The length of the circuit should be figured as if a separate pipe were carried from the heater to each individual radiator and back to the heater again, as is indicated in the diagram, Fig. 37. The effective height in simple circuits should be the distance between the center of the heater and the center of the radiator. In compound circuits such as is shown at *AA*, Fig. 37, the mean effective height would be the B.t.u. delivered by each separate heat emitting unit, multiplied by its effective height, the sum being divided by the total B.t.u. of the circuit. The horizontal lines in the charts represent the capacity of the circuit in B.t.u. per hour and in square feet of radiation. It is better to work from the B.t.u. side of the chart, as a square foot of radiation is a meaningless term. The chart for a 30 deg. drop has been made opposite hand from the 20 deg. and 40 deg. charts to save space.

Knowing the number of B.t.u., or the square feet of radiation, follow the line horizontally to the vertical line representing the ratio of the effective height to the length of the circuit. The next lower diagonal line, representing the size of pipe, gives the answer required.

For example, 10,000 B.t.u. would be supplied to a circuit 100 ft. long with 10 ft. of effective height by an $1\frac{1}{4}$ -in. pipe with a 20 deg. drop, by a 1 in. pipe with a 30 deg. drop and a 1 in. pipe with a 40 deg. drop, but the total capacity in the case of the 40 deg. drop would be about 17,000 heat units.

The pipe sizes, as given above would be correct if a separate pipe were taken from the heater to each radiator, with a separate return from each radiator back to the heater. From 10 to 30 per cent would have to be added to the actual length of the circuit to allow for the additional resistance of fittings. It is customary to run all these different circuits as far as possible in a single main. This decreases the frictional resistance because of the additional capacity of the larger pipes.

RESISTANCE IN PIPES AND FITTINGS

The chart in Fig. 38 gives the proportional resistance of pipes in terms of a smaller size. For example, the 2-in. line crosses $2\frac{1}{2}$ -in. at 0.3, the 3-in. at 0.13, the $3\frac{1}{2}$ -in. at 0.05 and the 4-in. at 0.025. A circuit made up of 10 ft. of each of the above sizes, while having a total length of 40 ft. would only have a resistance equal to 15 ft. of 2-in. pipe. In many cases the proportional resistance of the larger pipes will balance the additional resistance of the fittings. A chart showing the resistance of fittings is given under the section on Forced Hot-Water Heating.

The size of the mains must be proportioned to the greatest ratio between length of circuit and effective height.

These charts may be used for any type or form of gravity hot-water heating having from 6 to 60,000 sq. ft. of radiation. The principle involved is the same for residences, greenhouses, or industrial buildings. Hot-water circulation is positive and certain, provided that none of its basic principles are violated.

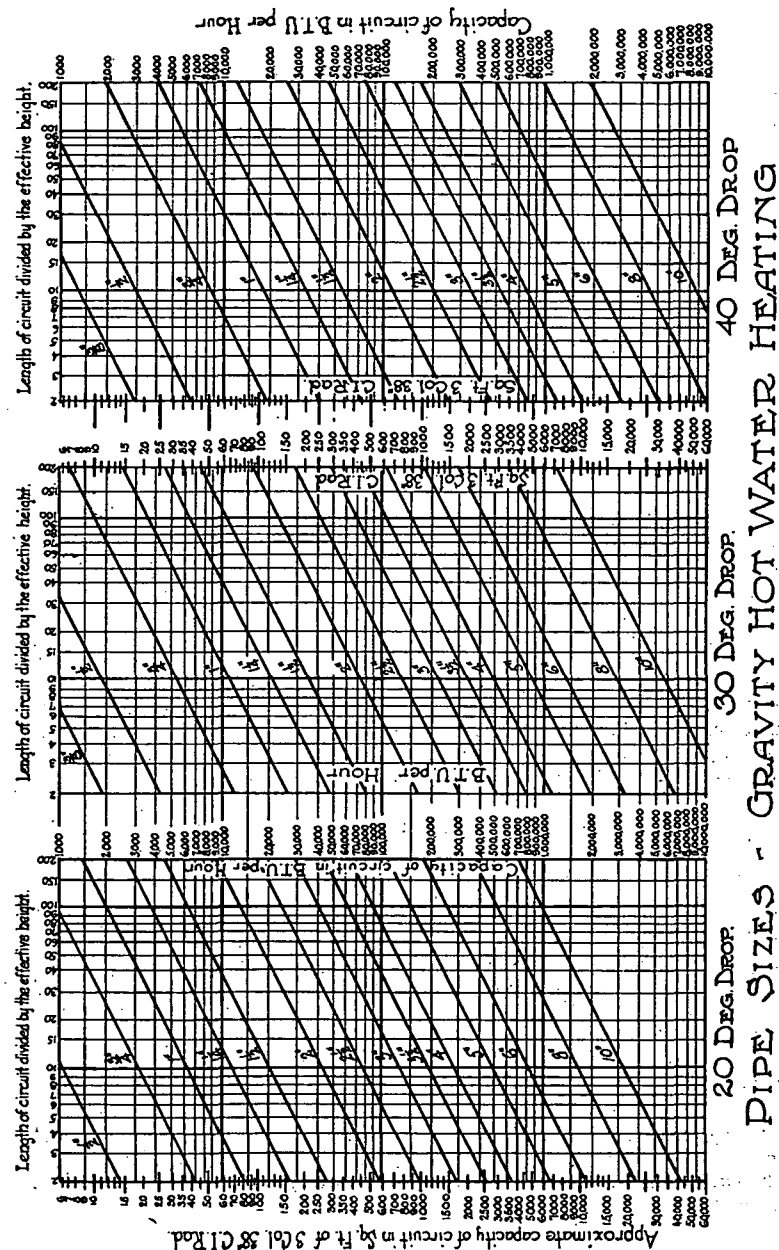


FIG. 36. PIPE SIZES REQUIRED FOR VARIOUS TEMPERATURE DROPS

EQUALIZING RISER TEMPERATURE DROPS

No matter how carefully riser or circuit sizes may be calculated, the limitations imposed by the necessity of using standard sizes of pipe and fittings will affect the results sought for in a heating system. This may be instanced by using the diagram in Fig. 37 as a means of illustration.

Suppose the radiator in the circuit *C* to be 90 sq. ft. instead of 100 sq. ft. Reference to the charts indicates that a $\frac{3}{4}$ in. pipe would supply 80 sq. ft. and maintain a temperature drop of 40 deg. and that the next size, 1 in., would supply 170 sq. ft. with the same temperature drop and that, if the radiator were 90 sq. ft., the drop would be less than 40 deg.

If then, the 40 deg. drop were maintained at the radiators in circuits *B* and *D*, some interference would be experienced in the return from these

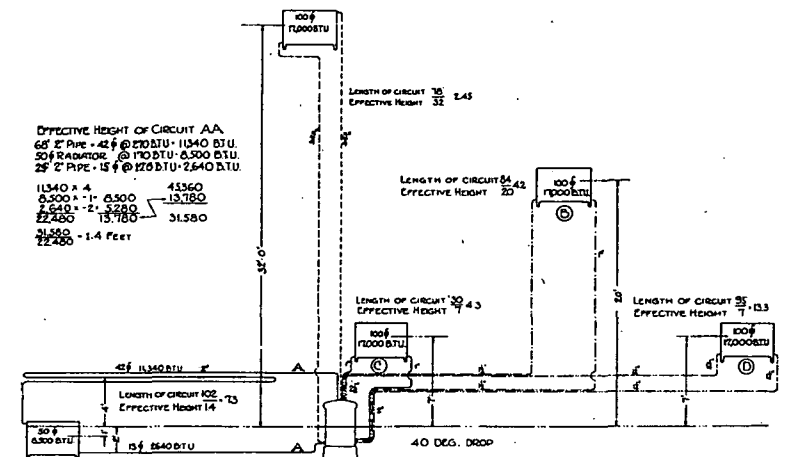


FIG. 37. DIAGRAM SHOWING EFFECTIVE CIRCUIT HEIGHTS WITH RADIATORS ABOVE AND AT BOILER LEVEL AND METHOD OF CALCULATING CAPACITY OF CIRCUITS FROM CHARTS IN FIG. 36.

radiators. The choice would then lie between using a $\frac{3}{4}$ in. connection to radiator *C* and having the drop more than 40 deg., or using a 1 in. pipe and retarding the flow by some means so as to secure the equal drop.

Several methods may be suggested to secure this. The radiator valve and union ell may be made $\frac{3}{4}$ in. to add a little friction, a special fitting may be inserted in the tee on the main to divert the flow to some extent, or the riser may be trapped to increase the frictional resistance. This resistance may be varied to some extent by varying the depth of the trap.

Again, there may be some advantage in making the temperature drops at various branch circuits unequal. It would seem that ideal conditions would be obtained if the greater drop were at the return connection

nearest the boiler as at *C*, in Fig. 37, with a slightly lower drop at *B* and the lowest at *D*. Then the water would have a gradually falling temperature throughout the main circuit, from the boiler back to the boiler. These conditions would favor a steady circulation at any boiler temperature without interference or retarding of the return flow from any of the various radiators.

Therefore, if the radiators at *C* were 90 sq. ft. and connected with $\frac{3}{4}$ in. pipe, the temperature drop might be greater than 40 deg., but the result would be better than if 1 in. were used and resistances introduced to equalize the drop to 40 deg.

PIPE SIZES FOR FORCED CIRCULATION

A basic rule to be followed in computing pipe sizes for systems of hot-water heating using forced circulation is that the pressure drop at each radiator, due to friction in the mains, risers and branches, must be uniform throughout.

Selection of pipe sizes from charts or tables stating the maximum duty performed does not afford a close enough distribution of the load on the system to insure perfect operation. The pump in a forced circulation system delivers a fixed volume of water and a gain for one radiator must be a loss for another.

A convenient means of determining the pressure drop due to friction is found in two charts which originally appeared in the May 28, 1920, issue of the *Metal Worker, Plumber & Steam Fitter*, and are reproduced herewith. Fig. 39 gives the friction pressure drop in straight lines of pipe and is based upon the formulae of A. V. Serginsky. These formulae take into consideration the greatly decreased viscosity of liquids at increased temperatures as found by the experiments of Biel and give much smaller pipe sizes for this class of work than those obtained by the formulae of Weisbach. The chart shown in Fig. 40 gives the length of pipe for which the resistance is equivalent to that of a given fitting of the same size.

The chart is read by laying a straight-edge across the given pipe size and the given capacity, and reading the result for short-radius elbows. The equivalent length of pipe for other fittings may be found by multiplying by the constants given.

An average pressure drop per foot for the mains, due to friction, must first be obtained by dividing the pressure against which the pump will deliver the necessary quantity of water by the actual piping distance to and from the farthest radiator, plus the allowance for fittings. Using this figure for the loss-in-pressure factor on the chart, preliminary pipe sizes may be obtained. To make the sizes of the branches more nearly equal throughout the system, the size of the main near the pump should be less than that read on the chart, and the size of the main at the far end greater than that given.

The total friction drop for the circuit should now be checked and such corrections made as may be necessary.

To obtain the pipe sizes for the branches compute the friction drop for the supply and return main from the pump to each supply and return

branch. The working pressure of the pump less the sum of the friction loss in the supply and return mains to any pair of branch lines will give the pressure loss due to friction, that may be used in those branches. From the charts the size of each branch may be computed in the same way as the sizes of the mains were obtained.

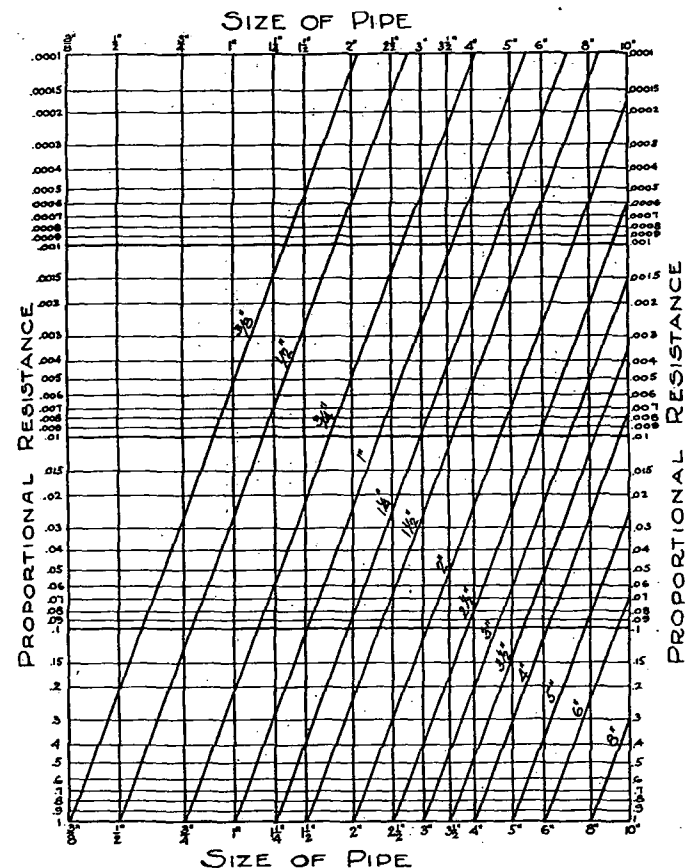


FIG. 38. CHART SHOWING PROPORTIONAL RESISTANCE OF PIPES

As much of the pressure drop as possible should be confined to the branches so that they will be as small as possible. At the same time it must be borne in mind that if this is carried too far the size of the branches near the pump may be smaller than is desirable in practice.

Theoretically, the pipe sizes calculated by this method will be so nearly correct that the friction loss and, therefore, the flow, will be equal at all

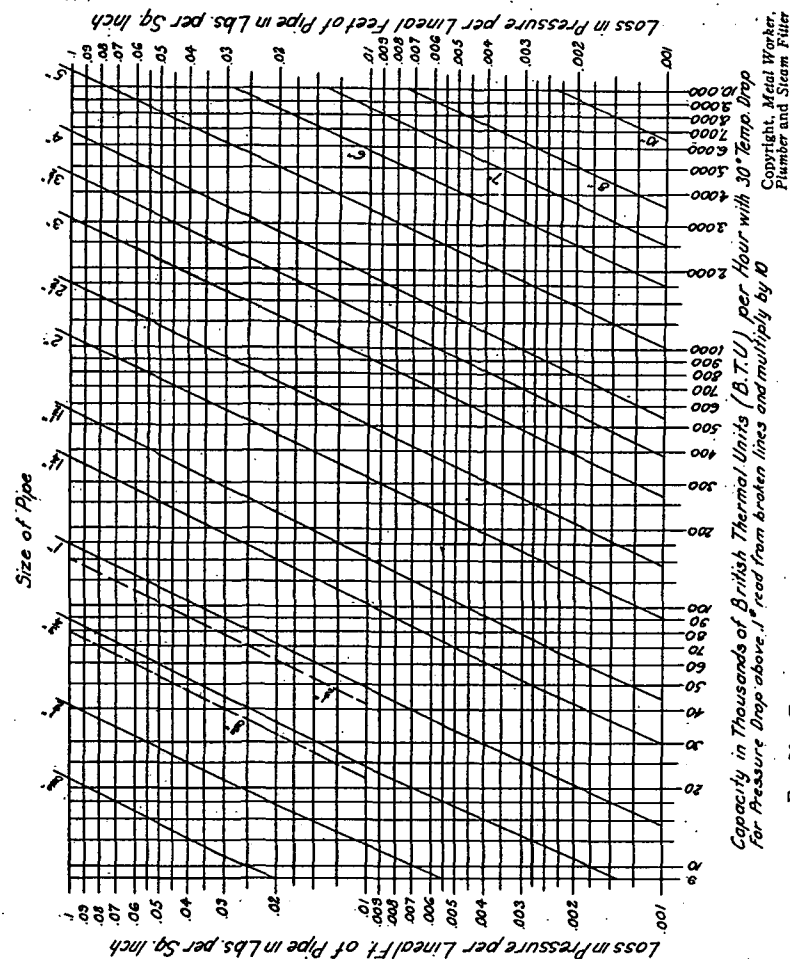


FIG. 39. FRICTION PRESSURE DROP IN STRAIGHT LINES OF PIPE

radiators. In practice, however, this is impossible because of the gaps in pipe sizes and many engineers specify the use of lock shield valves on one connection to each radiator so that the system may be adjusted to work evenly after it is in operation.

A typical arrangement of pumps and heaters such as are used in forced-circulation systems is shown in Fig. 41.

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

TABLE 75. 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

radiating surface giving a higher rate of heat emission, special care must be given to the selection of the boiler.

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

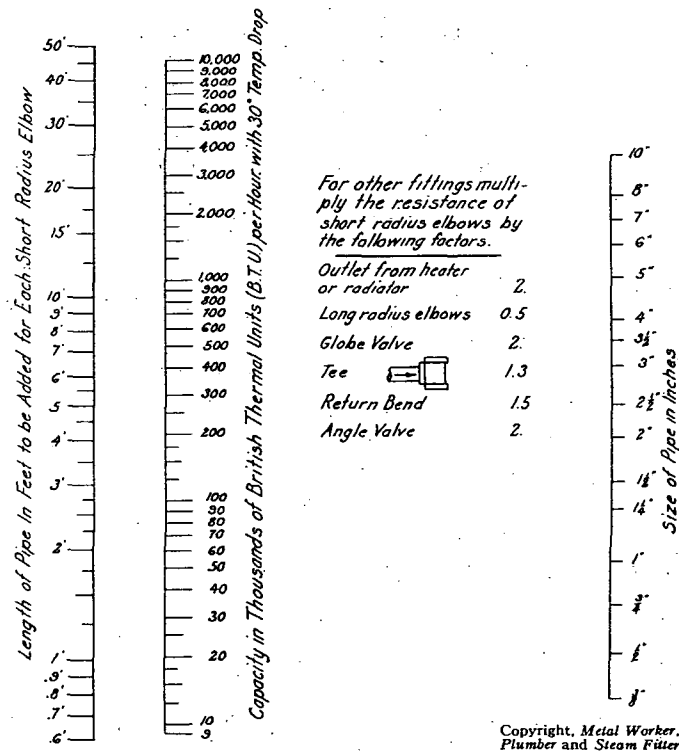


FIG. 40. CHART FOR FINDING FRICTION LOSS THROUGH FITTINGS

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 75.

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 ¾ 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 76. 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

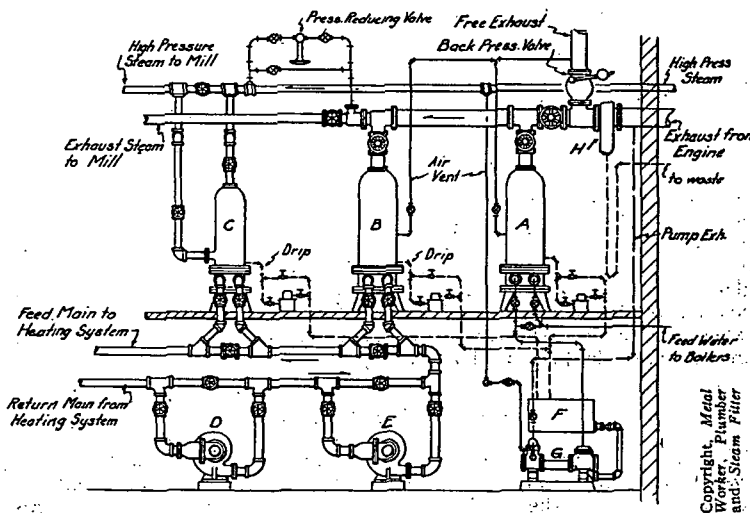


FIG. 41. TYPICAL ARRANGEMENT OF PUMPS AND HEATERS FOR FORCED CIRCULATION SYSTEM

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. 42 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 $3\frac{1}{2}$ -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 76 for the temperature desired, and accepts the result obtained as the required number of lines of $3\frac{1}{2}$ -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 $3\frac{1}{2}$ 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 $4\frac{1}{2}$ 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 $\frac{3}{8}$ th 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, $1\frac{1}{4}$ -in. pipe is used almost exclusively, and the greenhouse man has found that where one line of $3\frac{1}{2}$ -in. pipe is required to produce a certain specified temperature with hot water as the heating medium, one line of $1\frac{1}{4}$ -in. steam pipe at 0.5 lb. pressure will do the same work. This fact is inconsistent with the application of the divisors given

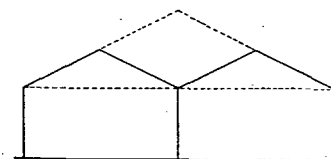


FIG. 42. SKETCH SHOWS RELATION OF CUBIC CONTENTS AND ROOF GLASS SURFACES

for quantities of radiation, but the difference is probably accounted for by the fact that $1\frac{1}{4}$ -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 IX

WARM-AIR FURNACE HEATING

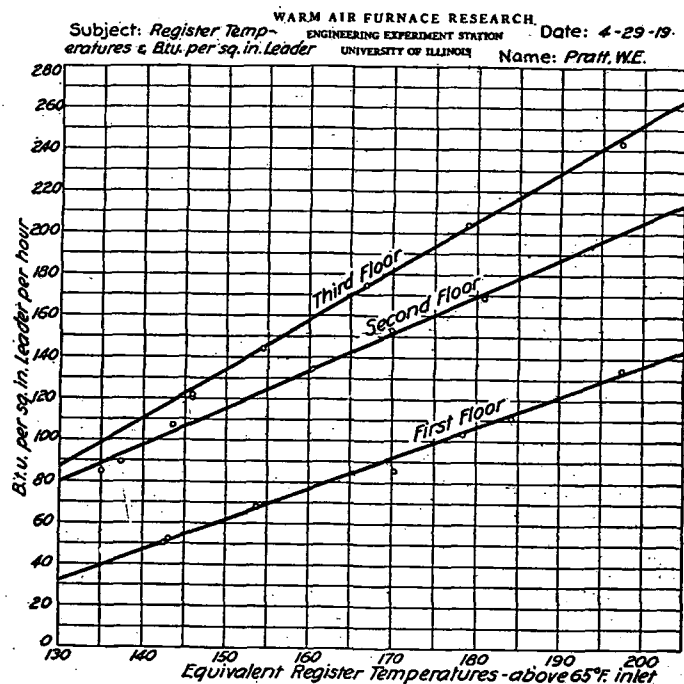
GENERAL PRINCIPLES OF DESIGN

IT is assumed in the following discussion that a recirculating system is to be installed, with a maximum air temperature at the registers ranging between 175 and 185 deg. fahr., maintaining 70 deg. inside in the coldest weather.

Under the conditions just indicated the procedure to be followed in designing a gravity warm-air furnace heating system may be summarized as follows:

1. Determine the hourly heat loss H , from each room in British thermal units when the room temperature is 70 deg. fahr., and the outside temperature is 10 deg. above the lowest on record. Include any cold floors, ceilings, and partitions in the computations, and assume unheated spaces are at 30 to 35 deg. fahr. For heat transmission factors see the chapter heat losses from buildings, as this part of the work is exactly the same as for a steam or water heating system.
2. Determine the size in square inches of the leader (basement pipe), to each room by dividing the heat loss from each room (obtained in (1) above), by the heat carrying capacity of 1 sq. in. of leader pipe for first, second or third floor runs as the case may be. Leader pipe capacities over a wide range of register temperatures, for a three-story installation, are shown in Fig. 43, and a typical example is presented in the following pages. No leader should be less than 8 in. in diameter, nor over 12 ft. in length. If leaders must be extended beyond 12 ft., or have to be run with angles of more than 45 deg., then the diameter should be increased one pipe size.
3. The wall stacks are made as near the leader size as possible, but may be reduced to 75 per cent of the area of the leaders with little effect on their capacity.
4. Registers for the warm-air inlets should have a free area exclusive of all grille work not less than the area of the basement leader pipe.
5. The recirculating duct should be made at least equal in area to the sum of the areas of the warm-air leaders and should be run with as few angles, bends, or offsets as possible. The effect of properly and improperly designed recirculating ducts on furnace capacity is discussed in a following section. This duct should enter the furnace through a shoe of full area, the top of which is not above the level of the grate (See Fig. 45).
6. The recirculating register should be placed preferably in the first floor hallway and the air should have free access to it on all sides. Registers in corners or against a wall are at a great disadvantage. The free area through the register should at least be equal to the area of the recirculating duct.
7. The furnace should be selected on the basis of grate area, and at the same time the free area through the furnace must be not less than the sum of all leader areas. It is evident that the coal burned on the grate must furnish all the heat required to keep the house at 70 deg. in coldest weather, and at the same time provide for any line losses between the furnace and the rooms, as well as radiation losses from the furnace, and the heat carried away in the smoke gases. Since the total heat loss H from the house has been determined in (1), it is first necessary to allow a reasonable factor for line losses which can be taken at 25 per cent of H . The heat lost from the furnace and in the smoke gases is approximately 40 per cent of the heat in the coal, which leaves 60 per cent for

Material for this section was prepared especially for THE GUIDE by Arthur C. Willard, Urbana, Ill.



Note. Values shown above may be increased from 10 to 15 per cent for a short and well designed recirculating duct.

FIG. 43. CURVES SHOWING EFFECT OF REGISTER TEMPERATURE ON LEADER CAPACITIES

useful heating effect put into the air leaving the bonnet. A good average chimney flue will provide for a draft sufficient to burn readily 6 lb. of coal per sq. ft. of grate per hr. The grate area (G) in sq. in. may, therefore, be computed as follows:

$$G = \frac{H \times 144 \times 1.25}{6 \times 12,000 \times 0.60} = \frac{H}{240}$$

Select a furnace having a grate area as near the calculated value as possible. In general take a grate which has a larger rather than a smaller area than that calculated.

- H = heat loss in B.t.u. from all rooms to which furnace supplies heat.
- G = grate area in sq. in. (not fire-pot area).
- 144 = sq. in. in a sq. ft.
- 1.25 = the allowance of 25 per cent for line losses in leaders and stacks.
- 6 = lb. of coal readily burned per sq. ft. of grate per hr.
- 12,000 = total heat value in B.t.u. of 1 lb. of good average coal.
- 0.60 = a decimal allowing for a furnace efficiency of 60 per cent.
- 240 = all the above numerical values combined into one number.

Now check free area of furnace selected against the sum of all leader areas. These two values should be practically equal to each other.

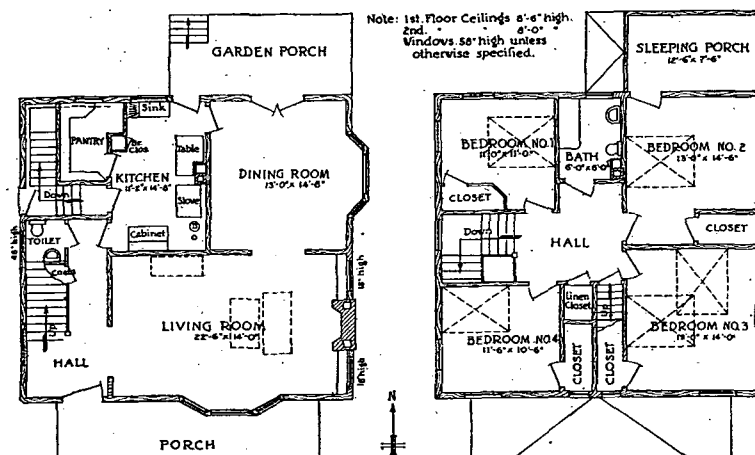


FIG. 44. FLOOR PLANS OF HOUSE USED IN TYPICAL DESIGN PROBLEM

8. The smoke connection should be not over 10 ft. in length and have not more than one 45 deg. angle, if made same size as cast-iron smoke collar on furnace. A suitable and accessible cleanout should be provided in this pipe, and both a cross damper and a check damper should be installed in the smoke connection.

9. The chimney flue should be not less than 9x12 in. clear inside and for the larger furnaces should be 12x12 in. inside. A lined flue, of the best fire clay flue lining made, is to be preferred, provided the lining is made absolutely tight at the joints and is backed up solidly with mortar so that there is no air space between lining and brick work of chimney.

10. All hot surfaces should be thoroughly covered with standard insulation not less than 1/4 in. in thickness. Asbestos paper, if applied only in a single layer, materially increases the heat loss from bright tin and galvanized iron surfaces (See Bulletin No. 117 of the Engineering Experiment Station, University of Illinois.)

TYPICAL EXAMPLE IN SELECTION OF PROPER LEADER SIZES¹

It is, of course, necessary to wait until more test data are available before making final recommendations as to the proper procedure, and the most suitable values to use in designing a furnace heating system. It may not, however, be out of place to discuss a simple application of the data so far obtained to a typical furnace heating design problem using such values as are now available. In the following discussion it has been found necessary to use register temperatures as high as 185 deg. fahr. for the first floor leaders. It is undoubtedly desirable, however, to use a lower range of register temperatures, with a maximum outlet temperature of not over 175 deg. fahr., whenever possible.

Curves, Fig. 43 have been plotted from the data obtained in seven tests on the main plant, Fig. 47 showing the relation between the register

¹From Bulletin No. 112, Engineering Experiment Station, University of Illinois.

temperatures on any floor, and the B.t.u. carried per square inch of leader pipe per hour to each of these floors. It should be noted that with a very short and well-designed recirculating duct Fig. 48, it is possible to increase the values shown in these curves by 10-15 per cent.

Knowing the B.t.u. loss per hour from any room on any floor (first, second or third), and given any register temperature, using the value of B.t.u. per square inch of leader pipe from these curves, simple division will give the square inch of leader pipe necessary to heat the room to 70 deg. Fahr., on a zero day, for which in this case the heat loss has been calculated in Table 77.

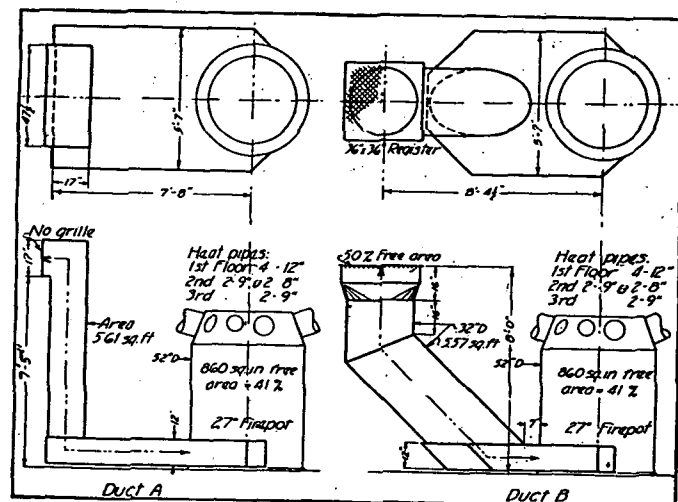


FIG. 45. TWO TYPES OF RETURN AIR DUCTS

Taking the first floor rooms of the house plan shown in Fig. 44, and assuming a register temperature for a zero day of 185 deg. Fahr. from the curve for the first floor, it is evident that 1 sq. in. of leader pipe will carry 115 B.t.u. per hour to the rooms. Then dividing the B.t.u. loss per hour from the room by 115 gives the number of square inches of leader pipe necessary to heat the room on a zero day.

From the test data obtained in the seven tests referred to above, it is apparent that the temperature at the registers on the second floor is approximately 10 deg. lower than that on the first floor, or about 175 deg. Fahr. In like manner from the second floor curve it is found that 1 sq. in. of leader pipe at this temperature will supply 160 B.t.u. per hr. Dividing the heat loss from the second floor rooms by this value gives the square inches of leader pipe necessary to offset the heat loss from the second floor rooms.

In like manner the test data show a register temperature on the third floor that is about the same as that on the first floor. From the third floor curve it will be seen that at 185 deg. Fahr. register temperature 1 sq. in. of leader pipe will carry 215 B.t.u. per hr. The square inches of leader pipe for the third floor rooms is found as before.

In plotting the curves, the average register temperature for any one floor was used in each case. It will be noted from the typical test data, that there is a considerable variation in register temperatures on any one floor. It is therefore evident that the size of the pipe as figured may not be absolutely correct in each case. It is not much in error, however, and in view of the large increase in pipe areas from one size to the next, the error is negligible for all practical purposes.

It is quite evident that the design of a furnace heating system must be based on the B.t.u. loss per hour from each room. This method of computation is quite familiar to the engineer and can be used by any well-qualified furnace man, as fairly simple formulas can be made to cover most types of installation.

It is found that the living room on the first floor of the house under consideration has a heat loss of about 16,600 B.t.u. per hr. With a register temperature of 185 deg. Fahr., each square inch of leader supplies 115 B.t.u. and the calculated area becomes $\frac{16,600}{115} \times 144$ sq. in., which requires either one 9-in. and one 10-in. leader, or a special 13½-in. leader.

Following is a table showing the heat loss in B.t.u. per hour from each room of the typical house Fig. 44 and the size of leader pipe as

TABLE 77. HEAT LOSS DATA AND LEADER SIZES FOR A TYPICAL FURNACE PROBLEM

FIRST FLOOR				
ROOM	B.T.U. LOSS PER HOUR	SIZE PIPE BY TEST DATA SQ. IN.	SIZE PIPE BY INSTALL. IN.	AREA SQ. IN.
Living Room.....	15,590	144	1-9 and 1-10	143
Dining Room.....	14,040	121	12	113
Kitchen.....	8980	78	10	78
Hall.....	11,810	103	12	113
Toilet.....	2287	19	8*	50
SECOND FLOOR				
Bedroom No. 1.....	6990	44	8	50
Bedroom No. 2.....	8670	54	9	64
Bedroom No. 3.....	8335	52	9	64
Bedroom No. 4.....	7245	45	8	50
Bath.....	3254	20	8*	50
THIRD FLOOR (assuming same rooms as second floor)				
Rooms same as second floor with	8400	40	8	50
20 per cent greater heat loss.....	10,404	48	8	50
	10,000	47	8	50
	8700	40	8	50
	3900	18	8*	50

*No size used commercially less than 8-in. diameter pipe.

previously figured. The size leader that would be installed based on the results as figured and the actual areas of same are also given. Stacks are assumed of common commercial sizes as the plant from which the data were secured has the common commercial size stacks. These are approximately 0.7 of the leader area for the second floor, and 0.6 of the leader area for the third floor.

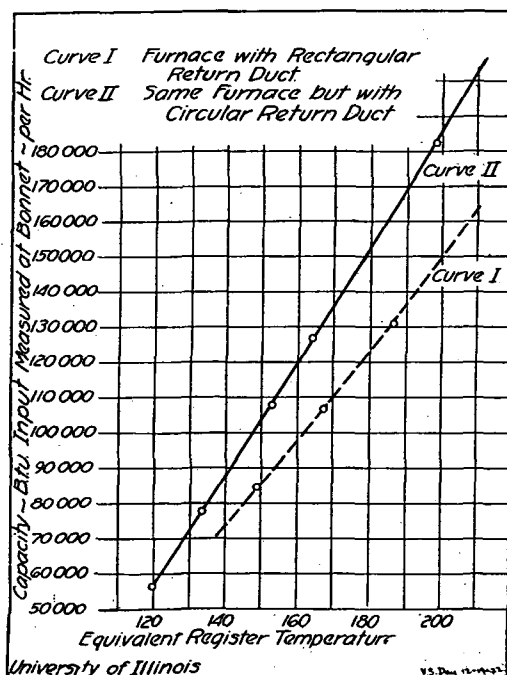


FIG. 46. CURVES SHOWING RELATION OF CAPACITY TO SHAPE OF RETURN DUCT

As test data are not yet available on stacks and registers no attempt has been made to discuss the design of this part of the system. It is also assumed that all the preceding leaders are short and straight. The effects of long runs and elbows in leaders is being investigated in tests run on the auxiliary plant.

EFFECT OF RECIRCULATING DUCT DESIGN ON FURNACE CAPACITY²

The following discussion is a typical illustration of the kind of information which the University of Illinois and the *National Warm Air Heating*

²Abstract of article by A. C. Willard, A. P. Kratz and V. S. Day in *Sheet Metal Worker*, January 19, 1923, based on tests made at University of Illinois and apply only where gravity circulation is used.

and Ventilating Association are developing in the warm air furnace research work which is being carried on jointly by these two agencies at Urbana, Illinois.

GENERAL STATEMENT

One of the most interesting series of comparative tests which has been carried on in the warm air furnace research work at the University of Illinois was the investigation of the effect of the recirculating duct on the capacity of a gravity warm air furnace. The results are of special interest to the installer and house owner, and since these ducts may materially increase or decrease the heating capacity of any given furnace the furnace manufacturer should be equally interested. When the difference in design of two common types of recirculating ducts may affect the furnace capacity by as much as 22 per cent, the details of these ducts, which account for the difference, become of vital importance to everyone connected with furnace installation.

The only change in the duct design, or in the entire plant, was to eliminate two right-angled elbows in a rectangular duct with a vertical recirculated air inlet and substitute two 45 deg. elbows with a round duct and a horizontal recirculated air inlet. In fact, the round duct with the 45 deg. elbow developed its superior air passing capacity with a register grille of only 50 per cent free area at the inlet, whereas the rectangular duct inlet was without any grille at all.

DESCRIPTION OF PLANT AND TESTS

The furnace plant Fig. 47 used in the tests was identical for both cases except for the changes necessary, Fig. 45, in the recirculating system. The tests were made as follows:

1. A group of four tests was selected from previous work, for comparison. These tests were run on the plant, Fig. 47, described under the *Main Plant* in previous reports, and on pages 18 and 19 of *Bulletin No. 120*, Engineering Experiment Station, University of Illinois. The essential features of this plant are shown in Duct A, Fig. 45.
2. A black iron inner casing was provided as in Group 1, extending from the recirculating duct connection to the top casing ring and spaced 1 in. from the outer casing.

A series of capacity tests were run over a wide range of operating temperature, for this condition. The essential features of this plant are shown in Duct B, Fig. 45.

RESULTS OF TESTS

The results of the tests are shown in the curves of Fig. 46, in which the capacities (in B.t.u. supplied to the air per hour) are plotted on a register temperature basis. A marked increase in the weight of air, and in capacity Fig. 46 was shown to exist. The round duct without the bad right-angle bends on the rectangular duct handled a much greater

quantity of air. Table 78 contains a comparison of the two ducts, on a percentage basis, for three temperatures. It is significant to note that the improved duct has a center-line length of 11 ft. as against 14 ft. for the rectangular duct. On the other hand, the improved duct was handicapped by having a register grille, whereas the rectangular duct had none. This has been found to be a considerable handicap, amounting to 4 per cent of the furnace capacity at moderate register temperatures. The failure of the rectangular duct to handle the same quantity of air as the round duct may be ascribed to sharp right angle turns, greater length, and greater frictional surface for the same cross-sectional areas.

TABLE 78. COMPARISON OF FURNACE CAPACITIES FOR TWO TYPES OF RECIRCULATING DUCT

AIR TEMPERATURE AVERAGE AT REGISTERS	CAPACITY B.T.U. PER HOUR* RECTANGULAR DUCT	CAPACITY B.T.U. PER HOUR* ROUND DUCT	PER CENT INCREASE ROUND DUCT
130 (Low)	62,500	71,000	13.6
160 (Moderate)	97,500	116,000	19.0
190 (High)	136,000	167,000	22.4

*These values were selected from the curves of Fig. 46. Capacity means B.T.U. (heat units) per hour added to the air as it passed through the furnace and measured at the furnace bonnet, just as the air enters the leaders.

SIGNIFICANCE OF THE AIR TEMPERATURE AT THE REGISTER ON THE RATING AND CAPACITY OF A WARM-AIR FURNACE³

One of the most important objects of the research work of the warm air furnace heating investigation, which is now in progress at the University of Illinois, has been the determination of the factors affecting the rating of a warm air furnace. Every manufacturer and installer is vitally concerned with the basis upon which furnace ratings are determined. Most manufacturers are agreed that the square inches of leader pipe area which a furnace can supply is a satisfactory basis for expressing the heating capacity of a furnace. Unfortunately, this is not the end of the story by any means, as such a basis of rating is still indefinite, unless the air temperature at the registers is also stated.

The real significance of this air temperature at the registers can be shown very easily by reference to any series of tests run at the University on piped furnaces. In fact, it is a very simple matter to show that a given furnace, connected to a given system of leaders, stacks, and registers as shown in Fig. 47 can be made to develop several different heating capacities when operating *with the same number of square inches of leader pipe area*. It is only necessary to increase the draft, thereby burning more coal per square foot, of grate, and as a consequence secure a higher air temperature at the register face. That the heating capacity of the furnace will be increased by such a procedure is obvious to anyone, and it should be equally obvious that any attempt to express the rating of a furnace in square inches of leader pipe area means nothing unless the register temperature is stated at the same time.

³From an article by A. C. Willard in the *American Artisan and Hardware Record*, December 30, 1922.

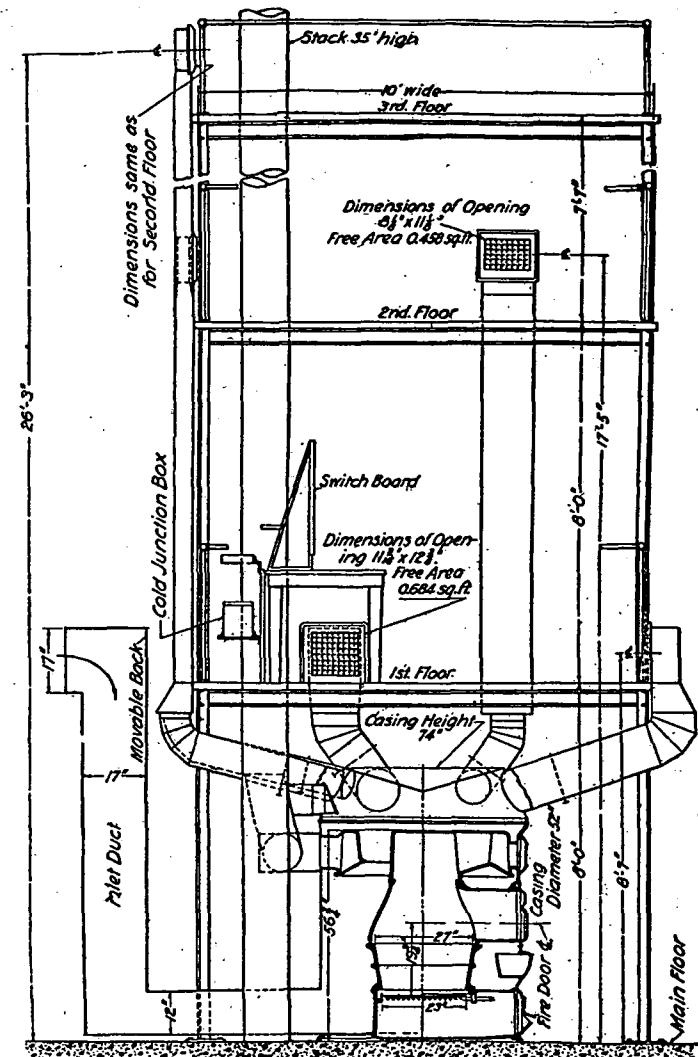


FIG. 47. ELEVATION OF PIPED FURNACE TESTING PLANT—NOTE ALTERNATIVE AND BETTER ARRANGEMENT OF RECIRCULATING DUCT IN FIG. 45

In order to illustrate just how important this item of air temperature at the registers really is, the results of three tests on the piped furnace plant Fig. 47 are presented in Fig. 49 and analyzed. Absolutely no changes were made in the furnace or plant during these tests. In the right hand half of the figure each inclined line represents one test; the lowest line

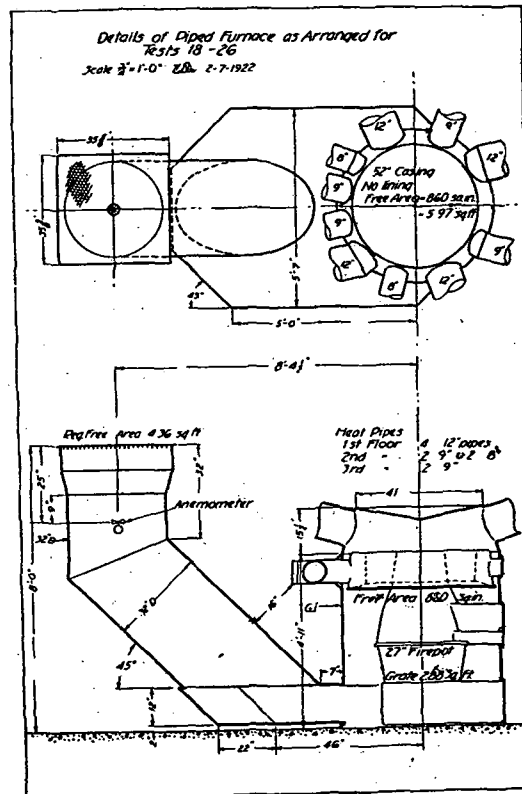


FIG. 48. AN IMPROVED RECIRCULATING DUCT WHICH INCREASED LEADER

shows the results from a test with the air temperatures at the registers for the three floors averaging 141.2 deg. fahr., the middle line is taken from a test with an average register temperature of 175.8 deg. fahr., and the upper line represents the results of a test with an average register temperature of 197.5 deg. fahr. The horizontal axis indicates the height of the register above the grate in feet, and the vertical axis gives the heating effect produced in the room per square inch of leader pipe area.

For example, during the first or low temperature test, each square inch of leader pipe to the first floor registers supplied 50 B.t.u. per hr. for useful heating effects in the rooms, each square inch of leader pipe to second floor registers supplied 89 B.t.u. per hr. for useful heating effect in the rooms, and each square inch of leader pipe to third floor registers supplied 122 B.t.u. per hr. for useful heating effect in the rooms. At this time the draft was 0.05 in. of water and the combustion rate was 3.8 lb. of coal per sq. ft. of grate.

By merely increasing the draft to 0.14 in. of water, the combustion rate in the second test increased to 5.6 lb. of coal per sq. ft. of grate and the average air temperatures at the registers became 175.8 deg. fahr. This raised the useful heat carrying capacity of each square inch of leader pipe for the first floor from 50 to 103 B.t.u. per hr., for the second floor from 89 to 153 B.t.u. per hr., and for the third floor from 122 to 204 B.t.u. per hr. A further increase of the draft to 0.16 in. of water gave a still higher combustion rate of 6.5 lb. per sq. ft. of grate and correspondingly greater heat carrying capacities for each square inch of leader as shown in the upper curve of the right-hand half of Fig. 49.

The left-hand half of Fig. 49 shows the air velocities in the leaders to each floor for each test. A glance at the curves (each curve represents one test) will show that the velocity and hence the quantity of air delivered was materially increased each time the register temperature was increased, hence an increase in register temperature not only adds more heat to each pound of air supplied at the registers, but also increases the number of pounds of the hotter air which is supplied. In all cases the leader area was the same.

It is also possible to determine exactly just what effect the changes in air temperature at the registers have had on the heating capacity of this furnace and plant. The first floor leader area is $4 \times 113 = 452$ sq. in., the second floor leader area is $2 \times 50 + 2 \times 64 = 228$ sq. in., and the third floor leader area is $2 \times 64 = 128$ sq. in., or a total of 808 sq. in. The free area of the furnace is 838.4 sq. in. Hence this furnace developed the following useful heating capacities (that is, heat supplied at registers for heating rooms to 70 deg. fahr.) in each of the three tests:

Test Number 1.

Register temperature = 141.2 deg. fahr. (Draft = 0.05 in. and combustion rate = 3.8 lb. per sq. ft. of grates.)

$$\begin{array}{r} 452 \times 50 = 22,600 \\ 228 \times 89 = 20,300 \\ 128 \times 122 = 15,600 \\ \hline 58,500 \text{ B.t.u. per hr.} \end{array}$$

Test Number 2.

Register temperature = 175.8 deg. fahr. (Draft = 0.14 in. and combustion rate = 5.6 lb. per sq. ft. of grate.)

$$\begin{array}{r} 452 \times 103 = 46,600 \\ 228 \times 153 = 34,900 \\ 128 \times 204 = 26,100 \\ \hline 107,600 \text{ B.t.u. per hr.} \end{array}$$

Test Number 3.

Register temperature = 197.5 deg. fahr. (Draft = 0.16 in. and combustion rate = 6.5 lb. per sq. ft. of grate.)

$$\begin{aligned} 452 \times 134 &= 60,500 \\ 228 \times 168 &= 38,400 \\ 128 \times 243 &= 31,000 \\ 130,000 \text{ B.t.u. per hr.} \end{aligned}$$

By merely increasing the draft and combustion rate, the register temperature has been raised from 141.2 deg. fahr. to 197.5 deg. fahr., and the heat-capacity has been increased from 58,500 to 130,000 B.t.u. per hr., or an increase of 122 per cent, but the free area through the furnace, and the leader pipe area have remained the same.

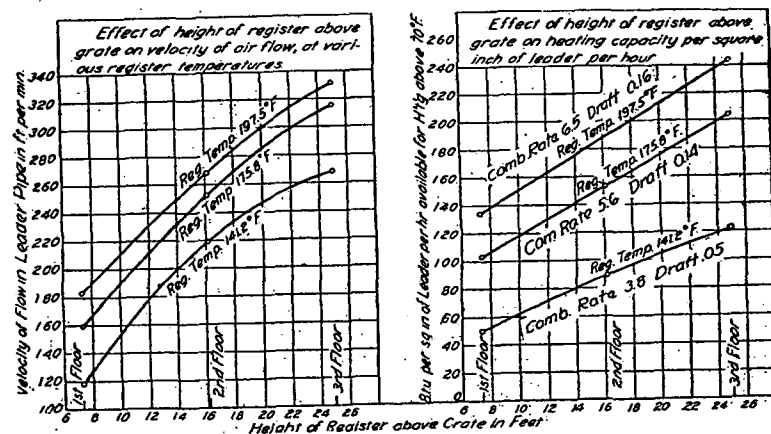


FIG. 49. CHARTS SHOWING EFFECT OF HEIGHT OF REGISTER ABOVE GRATE UPON VELOCITY OF AIR FLOW AND HEATING CAPACITY

It should, therefore, be apparent that the rating of any furnace in square inches of leader pipe area means nothing unless the air temperature at the registers is also definitely stated at the same time.

The preceding discussion is in no sense an argument against rating on the free area basis, but rather an argument to show the manufacturer and the installer the vital importance of fixing upon some standard register temperature, so that ratings in square inches of leader pipe area will be definite and can be made comparable and understandable by both the manufacturer and the engineer. The Advisory Committee on Furnace Research of the *National Warm Air Heating and Ventilating Association* has recently approved a maximum register temperature of 180 deg. fahr. for warm air furnace heating systems.

Every manufacturer of warm air furnaces should give this matter his careful consideration for the fixing of the register temperature places a definite maximum rating on each of his furnaces.

CHAPTER X

OIL FUEL FOR INDUSTRIAL AND DOMESTIC HEATING

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 naphtha, benzene, 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 Baumé gravity, viscosity, flash point, and cold test, or temperature at which it will cease to be fluid.

Material for this article was furnished especially for THE GUIDE by Byron K. Eaton, Chicago, and A. H. Ballard, New York.

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 79. 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 companies 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 × 3/8 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 Baumé 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

GAS heating appliances may be divided into two general classes, namely those which discharge their products of combustion indoors and those which discharge their products of combustion outdoors, as follows:

1. *Products of Combustion Discharged Indoors*

- a. Space Heaters { (1) Luminous Flame { (a) Radiant Type
(2) Bunsen Flame { (b) Convection Type
b. Gas Fired Steam Radiators.

2. Products of Combustion Discharged Outdoors

- | | | | | |
|---------------------------------|---|-----------------------|---------------------|-------------------------------|
| a. Localized..... | { | (1) Fireplace Heaters | { | (a) Gas Logs |
| | | | (b) Radiant Heaters | |
| | { | (2) Vented | { | (a) Gas Fired Steam Radiators |
| (b) Gas Fired Hot-Air Radiators | | | | |
| (c) Garage Heaters | | | | |
| (d) Stoves | | | | |
| b. Central Plants | { | (1) Hot Air | { | (a) Radiators |
| | | | (b) Furnaces | |
| | { | (2) Radiation | { | (a) Hot Water |
| (b) Vapor | | | | |
| (c) Steam | | | | |

Unvented appliances are appropriate only in a limited way. The same is true of vented appliances for localized heating.

Of central heating plants, the choice between the various systems is governed by the same considerations that affect the selection of coal burning apparatus.

EFFICIENCY

The *gross* heating value of a gas is usually referred to in codes of regulatory bodies; most gas men also refer to the *gross* value when designating the heating power of their fuel. It is the basis upon which gas fuel is sold. Yet, some manufacturers of appliances, in rating their product, have taken as a basis the lower *net* heating value. The distinction should be thoroughly understood when comparisons are made.

For example for an hypothetical gas, having a *gross* heating value of 550 B.t.u. per cu. ft., and a *net* heating value of 500 B.t.u. per cu. ft., and

*Material for this section was prepared especially for THE GUIDE by E. P. Bailey, Jr., Cleveland, and H. C. Eckenroth, San Francisco, Calif. Photos for this section were furnished through the courtesy of C. M. H. Kernchen, Cleveland, and the authors.

a gas steam boiler, giving an evaporation of 465 lb. of water (from and at 212 deg. fahr.) with a consumption of 1,000 cu. ft. of gas:

$$\text{Efficiency} = \frac{\text{B.t.u. in steam}}{\text{B.t.u. in gas}} = \frac{\text{lb. water} \times 970.4}{\text{cu. ft.} \times \text{B.t.u. per cu. ft.}}$$

$$\text{With gross value} : \frac{451,236}{550,000} = 82.04 \text{ per cent}$$

$$\text{With net value} : \frac{451,236}{500,000} = 90.25 \text{ per cent}$$

Furthermore, it will be seen that the maximum efficiency possible, based upon the gross heat value of the above gas (without condensing the water vapor in the flue gas), would be $\frac{500}{550}$, or 90.90 per cent.

Efficiencies of 80 per cent based on the gross heat value of gas fuel, are obtainable in properly designed vented appliances. It should be remembered that the efficiency of a gas appliance in actual operation closely approaches that determined in laboratory tests.

WASTE FROM USING GAS IN COAL BURNING APPARATUS

In coal stoves or coal furnaces the path traveled by the flame is short and the radiating surface is relatively small. For this reason, the use of gas in such stoves is always wasteful and will require about three times as much gas for the same heating service as would be required if the gas were used in a properly built natural-gas furnace. Even with perfect combustion in the fire pot of a coal stove or coal furnace the waste will usually be about 75 per cent. Properly built natural-gas furnaces have a longer fire travel and much more radiating surface than coal furnaces, and are, therefore much more efficient.¹

Hot air furnaces, designed for use either with manufactured or natural gas, are available in sizes ranging from 5,000 cu. ft. 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 sq. ft. to 7,500 sq. ft. rated capacity (steam). Typical gas warm-air furnace and boiler are pictured in Figs. 50 and 51, respectively.

RATINGS

Gas appliance manufacturers have followed the custom established by coal appliance manufacturers in rating their product in terms of cu. ft. (warm air) and sq. ft. of radiation (water and steam). Gas appliance ratings in these terms are generally empirical, however; they are selected

¹"Waste and Correct Use of Natural Gas in the Home"; Sec. 29; Technical Paper 257, Department of the Interior, Bureau of Mines; by Samuel S. Wyer.

to conform in size with a coal appliance of equivalent power under ordinary operating conditions.

The capacity of a gas furnace or boiler is subject to much smaller fluctuations than a boiler employing solid fuel; the element of length of firing period does not enter into consideration; heating surfaces remain clean for longer period of time. Although most coal boilers are rated on an 8-hr. firing period (with anthracite coal and clean heating surfaces) for catalog purposes, the architect or heating engineer makes allowances for less favorable conditions when deciding upon appropriate equipment. Gas appliance manufacturers give to their product a rating comparable

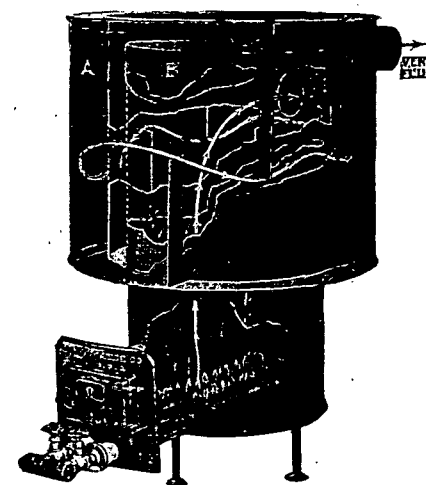


FIG. 50. VIEW OF GAS-FIRED WARM AIR FURNACE

to that of a coal boiler on the 8-hr. basis. In other words, where a 2,400 sq. ft. coal boiler would be chosen, a 2,400 sq. ft. gas boiler would generally be appropriate.

It is a common practice for gas boiler manufacturers also to give their boilers a rating in terms of "Available B.t.u." (B.t.u. per hour available in the steam or water at the boiler outlets).

A gas furnace or boiler will show essentially the same capacity or efficiency with any gas fuel, provided steps are taken to furnish proper burner equipment and air regulation for each type of fuel. 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 completely burn the gas) is almost the same for any typical commercial gas, as is shown in Table 80.

TABLE 80. VOLUME OF AIR REQUIRED FOR COMBUSTION OF DIFFERENT GASES*

GAS	B.T.U. PER CU. FT.	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

*Thomson King, *American Gas Journal*, October 22, 1921.

The fact that "more air is burned" with one fuel than another does not necessarily affect the efficiency with those particular fuels; the air required varies almost directly as the B.t.u. content of the combustibles.

FUEL REQUIREMENTS FOR GAS HEATING

It is a fact, based upon experience, 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 pilot light of the gas-fired furnace or boiler is lighted on the first cool day of the season. Thereafter, the system generally operates entirely under thermostatic control; upon many days when very little heat is required to keep the inside temperature at 70 or 72 deg., and when it would be considered impracticable to start a coal fire, the gas-fired appliance will be working. Furthermore, the gas unit can operate at maximum capacity hour after hour, without attention; in the coldest weather, then, premises do not cool below the temperature ordinarily maintained.

Table 81 gives an approximate idea of fuel requirements in various climates, and is based upon a heating season of seven calendar months:

TABLE 81. 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, for 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 square foot is one-half that shown in table.)

The requirements of individual installations may vary considerably from an average of several. Generally, stores, offices, factories or other commercial premises require less heat per season than do residential buildings provided with an equal amount of radiation. This is borne out on investigation of some actual installations.

CONDENSATION IN VENT PIPES

An important point to care for in gas heating work is the ever-present condensation resulting from the combustion of gas. To those who have had experience with gas appliances, it is hardly necessary to mention the *eating out* or deteriorating of the vent pipe, the water dripping from every joint, the scale and the corrosion forming at the joints.

Ordinary galvanized iron vent pipe last from six months to a year and a half at the best, but makes a messy unsatisfactory installation from the start as the water or condensation is apparent from the first day the

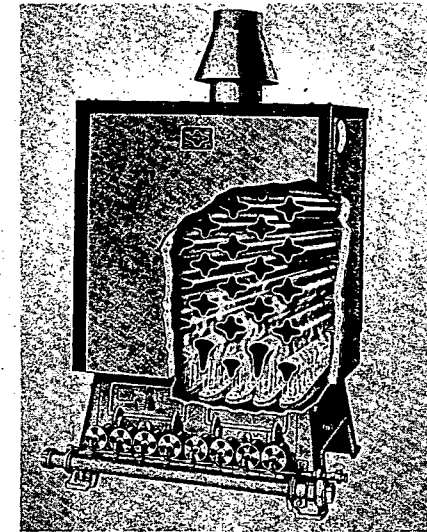


FIG. 51. STEAM HEATING UNIT FOR HOUSE HEATING SERVICE

appliance is put into service. In many cases the interior of this pipe is painted with acid resisting paint, and while this adds somewhat to the life of the pipe, it does not in any way tend to eliminate the condensation. This applies also to copper pipe. Planished iron pipe is also used, but is little better than painted galvanized iron pipe.

In some cases the efficiency of the appliance has been dropped from 85 to 60 per cent, to allow for a greater heat or stack loss in an effort to vaporize and carry off the greater part of this condensation. This, however, is a very feeble effort to eliminate this evil—it being entirely at the expense of the consumer.

The solution of the problem is: *First*, to have a minimum of condensation and, *Second*, to carry this off, thereby eliminating practically all of the condensation "on the job." This was accomplished recently

by lining ordinary galvanized-iron pipe with 1 in. of a patented, porous insulating material that will not disintegrate in water and withstands a temperature of 500 deg. fahr. or more.

The result is that the interior of the pipe, being well insulated, reaches a maximum temperature in a comparatively short space of time, while the exterior is practically cold. This makes for a minimum amount of condensation. The small amount of condensation taking place during the first 5 or 10 min. that the appliance is lighted, is absorbed on the



FIG. 52. GAS-FIRED HOT WATER HEATING UNIT IN PACIFIC COAST MANUFACTURING PLANT

surface of this insulating material, and then is evaporated and passed off in the form of water vapor as soon as the interior of the flue pipe has reached a temperature of 212 deg.

In all cases a gas flue or chimney should be treated exactly the same as flues from oil, coal or wood burning appliances and should be carried to the roof of the building with a suitable top to make for a proper draught. Running a pipe to an outside wall and up 3 or 4 ft. does not make for a proper draught and in most cases causes a down draught. Therefore, this type of vent should never be used.

CHAPTER XII

AUTOMATIC HEAT CONTROL

AUTOMATIC heat control, despite a popular impression that it is a luxury, is one of the fundamental principles of life, and without its influence life on the earth would be impossible. The intelligent application and control of heat in one way or another is a fundamental of civilization. It is almost impossible to conceive of any contact we have with any physical adjunct of civilization in which heat and the accurate control of heat has not had a major influence.

Temperature control is achieved by preventing over-heating. It develops from this that automatic heat control in itself must always effect an economy.

In order to be practically useful, heating plants must be able to warm living spaces when extreme cold prevails outside. Extreme cold outside is rare, occurring perhaps during 5 per cent of the heating season. Unless it is held in check, the big, powerful heating apparatus which must be provided against the 5 per cent time, will overheat the occupants and waste their stored and perhaps irreplaceable fuel during 95 per cent of the heating season.

NEED OF HEAT REGULATION

By far the greatest number of heated rooms in the world probably have single direct radiators, and the tendency is for these radiators to be hot all over, or cold all over. Variations of many degrees in temperature in 1 hr. are possible. With stoves or fireplace the intensity of the fire can be varied, as the cold outside indicates, but the grate must be big enough to burn the maximum amount of fuel, and even a grate or a stove is difficult to control for one-half or one-quarter capacity.

Ventilated rooms, especially when fans are used, may have very rapid air changes, and the temperature variation may be many degrees in even 1 min. Herein lies the great opportunity for automatic heat control, preventing the unbearable sudden changes which cause drafts; promoting comfort and so promoting happiness; saving waste; conserving limited visible stored fuel.

It has come to be universally admitted that mechanically ventilated buildings must have automatic heat control. Every residence needs automatic heat control because shutting off a radiator or a register, which a persecuted occupant may sometimes do (he generally opens a window) has little if any effect on the remote fire in the heater, and fuel used for overheating always is wasteful.

Material for this section was prepared especially for THE GUIDE by S. R. Lewis, Chicago, Ill., who is indebted to G. H. Blanding, John Horning, F. W. Powers, of Chicago, and C. W. Sweatt, Minneapolis, for their hearty and helpful cooperation.

When buildings are heated from central stations, especially those using steam or vapor, automatic heat control is imperatively necessary, since heat must be available at all times in full power, and it is beyond human ability to manipulate manual controlling apparatus with sufficient nicety to prevent overheating.

When gas or oil are used as fuel, automatic control of combustion is necessary in order that the fuel costs may not be prohibitive. With quickly responsive fuels such as gas or oil, automatic heat control applied to the burners is remarkably effective and its influence is especially noticeable.

With coal as fuel and automatic control of combustion there is so much stored heat in the firebox that necessarily the volume of heat output lags behind the thermostatic influence of a change in dampers. Ashes, clinkers, etc., affect the intensity of the fire, but nevertheless the automatic control is far superior in comfort and economy to manual control.

Service hot water, no matter how it may be heated, constantly fluctuates between a scalding temperature and an unsatisfactory lukewarm condition, unless controlled automatically.

Temperature and humidity, or moisture content, are inseparably associated as factors of comfort and in nearly all industrial applications of heat. Automatic heat control becomes automatic humidity control as soon as the influence of evaporation can be applied. Thus a wet bulb thermometer indicates percentage of moisture, and a moistened thermostat can be made automatically to regulate humidity.

All systems of automatic heat control use thermostats. Thermostats are almost infinite in their variety.

Solids and gases change in volume when influenced by temperature. Electrical conductors change in resistance when influenced by temperature. Thus there is one type of thermostat which consists of an expansible hollow enclosure containing a small amount of volatile fluid having a boiling point below the range of temperature to be controlled. This fluid, vaporizing under the influence of the temperature to which the instrument is exposed, develops a pressure proportional to the temperature change.

There is another type of thermostat which has two pieces of metal of different characteristics so attached to each other that very slight temperature changes will cause the assembly to bend in one way or the other, due to unequal expansion and contraction of the different metals.

Another thermostat consists of a simple plate or tube of some organic composition having an especially high coefficient of expansion.

In some cases the movement of the thermostat is transferred to a liquid in a tube, and as friction is slight under such conditions and as a liquid is nearly incompressible, valves or dampers may be operated.

In other cases the thermostat controls the opening or closing of a small valve, which in turn controls a current of compressed air. This compressed air, by means of pressure diaphragms, operates valves or dampers, controlling the heat. Since there is no particular limit to the number or size or remoteness of the valves and dampers when compressed air is used, this helpful intermediary is commonly employed on all very large installations.

TWO DIVISIONS IN TEMPERATURE CONTROL

There are two grand divisions in modern temperature control apparatus. The simple class is one in which the thermostat and valve are self-contained, without outside power. These devices are generally adapted particularly to individual applications. They control service hot water, and do it perfectly, whether by valves on the heating pipes or by dampers on the heaters, or by valves on the oil or gas supply pipes. They control all kinds of residence heating, usually by a thermostat on some representative room, with dampers on the heater or valves on the main supply from a central station. They control ovens, dryers, vats, etc., in industrial work. When coal-fired heaters are controlled, as for residences, it has been found exceedingly desirable that not only shall there be a thermostat in the heated space, but also that there shall be a thermostat in the heater or pipes, which, when the house is warm and has shut off, will still protect the combustion requirements by maintaining a limited temperature against the next demand. The first thermostat in the house is not far from human, but the combination of the two, you see, becomes almost superhuman.

Automatic control of automobile cooling is one of the recent interesting developments, and is of very great value. It is usually applied by varying the volume of the cooling air.

The other and more elaborate class of temperature control apparatus uses some outside power. This is generally pneumatic, but may be electric or hydraulic, or may be by springs or weights. The thermostat controls the power, which, naturally, is practically unlimited.

By the beneficent application of power, controlled by thermostats, many interesting things can be accomplished. For instance, by means of clocks, the temperature automatically is kept comparatively low at night and is raised for the day. In large buildings where many rooms are to be controlled, the cost for a central pneumatic system is much less than that for so many individual units of the self-contained type. A small automatically governed air compressor is used, and the air piping is usually installed while the building is under construction.

It is possible for large buildings, such as dormitories, having many similar rooms, to install an incomplete or partial system of automatic heat control, using for each general exposure or side of the building a single thermostat and cut-off valve. If consideration is given to this feature when designing the piping, the installation can be very simple and the results will be found decidedly worth while. It is notoriously true that such buildings without automatic control will be too cold on the shady side if the general heating is reduced enough to keep the windows closed on the sunny side, and that open windows will follow the sun around if the general heating is accommodated to the shady side. Need we suggest that open windows and economy are not compatible?

Hot water radiators are rather slow to respond to manipulation of the circulation valve, due to the considerable storage of heat in the water. It used to be a hobby to put certain bedroom hot-water radiators in recesses, with doors in front of them, so that bedrooms could be cooled quickly at night and warmed quickly in the morning. Such an arrangement has many advantages, and will undoubtedly save fuel. Capitalizing

this idea, there is now available a well-insulated radiator cover, carrying its own thermostat and shutters which will shut off the circulation of air and the radiation of heat without interfering with the circulation of the heating medium inside the radiator, and will control automatically the room temperature while also providing a more or less handsome radiator camouflage.

There are highly specialized applications of automatic heat control, and in connection with the type which uses independent power there has developed a great field of manual remote control for distant valves and dampers, both pneumatically and electrically.

There are also a number of instruments operating on different principles, which will indicate continuously and accurately the temperature conditions at remote points. Co-ordination between the temperature requirement and the fuel consumption is not always possible without some human interposition, and thus it is found that accurate arrangements for temperature indication are a necessary auxiliary to automatic heat control.

The occupants of a theater may be protected against overheating by one thermostat which controls dampers or valves so, that, when the room temperature reaches say 70 deg. cool air is introduced. If the theatre is crowded the temperature will pretty surely increase, even if large volumes of air are introduced, and the thermostat will call for cooler air. But if air of more than a few degrees, say 10 deg., cooler than the air in the room is introduced, no matter what that temperature may be, drafts will result. Therefore an additional thermostat may be placed in the air duct outside of the room, set to receive power only after the first thermostat has called for cool air, and preventing the entering air from becoming cooler than a point which can be tolerated by the occupants.

In large theaters which have artificial cooling, trouble has been experienced when the seats, particularly in the balcony, having a steep incline, are only partly occupied. The cool air provided for the seats which are unfortunately empty, being heavier, runs like so much water down the incline, striking the people in the lower occupied areas from behind, and making them uncomfortable. It has been found possible by the judicious installation of a sufficient number of thermostats, to control the temperature of the entering air in zones so as to compensate to a great extent for this peculiarity.

There is a large general office having tremendous floor areas distant from windows, and in which refrigeration has to be used for artificial cooling whenever the outside temperature is warmer than about 50 deg. There are a number of private offices having few occupants. The general open spaces, due to high intensity of occupation and many lights, require an entering air temperature so low in order to maintain comfort that the connecting and more or less open private offices get too cool. It happens that steam always is available, so that the thermostats in the private offices are permitted to turn on the steam as required, and the warmer the day, much to the surprise of the operators and to the comfort of the executives, the more steam there is in the private office radiators.

This experience suggests that when artificial cooling is provided via refrigerated water in an air washer, instead of drawing through in the

conventional manner, the supply fan should blow through the washer, with a by-pass around it, giving two temperatures of air even in summer, from which mixing dampers controlled by thermostats in the various rooms or departments may draw, as required to promote comfort in each.

Many refractory and even amusing cases might be cited wherein the thermostats have been located improperly. In hot water-storage tanks, for instance, thermostats have been condemned because they were inserted too close to the entering cold-water current, or were placed too near the heating coils. The thermostats invariably reflect truly the conditions which exist exactly where the thermostats are placed.

There are numerous cases, particularly in schools, where great buildings were regulated perhaps for years with much satisfaction, except for two rooms, one of which seemed always to be too hot, the other of which, "due to some bad or careless feature in the design," never received enough heat. Eventually a true diagnostician discovered that the thermostat in Room A was connected to the damper in Room B, and the thermostat in Room B was connected to the damper in Room A. Such a thing may happen very easily. Of course when heating the building first both rooms would take warm air until perhaps A having sunshine and a large number of occupants, arrived at 68 deg. first. The thermostat dutifully called for cool air and cool air came pouring into B. The thermostat in B, being thus cooled, continued to ask for warm air, delivering it in quantities to A, already overheated.

To militate against maladjustments in the connecting of the terminals, one progressive manufacturer, using electric motive power, covers his various wires and leads with insulation of different distinctive colors (same idea as Ford uses for ignition wiring).

An interesting combination where central station steam supply is used is that of a pressure regulator with an electric cut-off valve, the thermostat acting to vary the pressure gradually or to shut it all off, as requirements may indicate.

Automatic control is applied successfully to prevent scalding from baths, and is particularly desirable in institutions for children and in institutions for mental afflictions, as the thermostats will cause the mixing of the warm water with the cold to deliver any desired combination.

TESTS INDICATE VALUE OF AUTOMATIC HEAT CONTROL

There have been many tests to demonstrate the effect of automatic heat control. For instance, with an average outside temperature of 36 deg. it was found that with the usual sort of installation the thermostat would keep the heat shut off 21 hr. out of a possible 24, and that with an average outside temperature of 16 deg. the heat was on the radiator only a trifle more than 5 hr. per day.

The savings in fuel to be gained by automatic heat control are enormous. In many large institutions, such as universities, having central stations, high-grade supervision, meters, etc., the savings have been proved to equal one-half of the uncontrolled consumption.

In one metered city club a saving of 27 per cent was made by installing automatic-heat control. This is after the two seasons were equalized for outside temperature.

Of two similar office buildings, one having automatic heat control, the other without it, both metered, during four years the automatic controlled building used an average of 556 lb. of steam per sq. ft. of radiation, while the other used 894 lb. of steam per sq. ft. of radiation, around 38 per cent to be credited to the control.

CHAPTER XIII

INSULATION

HEAT LOSS FROM UNINSULATED SURFACES

THE determination as to whether pipes and other heated surfaces should be insulated is made after a consideration of the heat loss from such surfaces if they are allowed to remain bare. The heat losses from bare pipes are given in Table 82, together with the number of pounds of coal required to produce these quantities of heat, and the cost of the same.

Example.—Three hundred feet of bare 3-in. pipe containing steam at 10-lb. gage, and located in a room where the air is at 70 deg. Fahr., will radiate $2.46 \times (239.4 - 70) \times 300 = 125,020$ B.t.u. per hr. The corresponding expenditure of coal is $3 \times 3,292 = 9,876$ lb. per month if steam is kept in the pipe continuously, and the value of the coal at \$12 per ton is $\$8.24 \times 3 \times \frac{12}{4} = \74.16 per month.

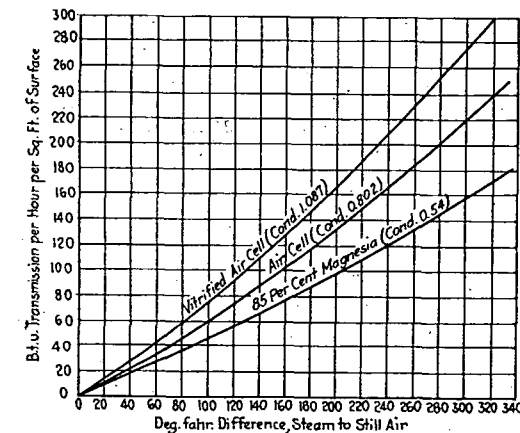


FIG. 53. HEAT TRANSMISSION IN B.T.U. PER HOUR PER SQUARE FOOT OF COVERED PIPE (1 IN. COVERING)

The heat loss from uninsulated flat surfaces or surfaces of large radius, such as boilers, feed-water heaters, heating and ventilating ducts and flues, hot-water tanks, etc., is given in Table 83 in B.t.u. per square foot

Material for this section was prepared especially for THE GUIDE by L. L. Barrett and L. B. McMillan, New York.

TABLE 82—LOSSES FROM HORIZONTAL BARE-IRON STEAM PIPES*
From 100 Lineal Ft. of Pipe per Month of 30 Days with Steam in Pipes 24 Hr. per Day. Coal at \$4.00 per Ton of 2000 Lb.

GAGE PRESS. TEMP.	Pipe Size	Hot Water		10 Lb.		80 Lb.		120 Lb.		160 Lb.		200 Lb.		200 Lb. and 100 Deg. Fahr. Superheat.		275 Lb. and 250 Deg. Fahr. Superheat.	
		Pounds Loss	B.t.u. per lineal ft. per deg. fahr.	Dollars Loss	Pounds Coal	B.t.u. per lineal ft. per deg. fahr.	Dollars Loss	Pounds Coal	B.t.u. per lineal ft. per deg. fahr.	Dollars Loss	Pounds Coal	B.t.u. per lineal ft. per deg. fahr.	Dollars Loss	Pounds Coal	B.t.u. per lineal ft. per deg. fahr.	Dollars Loss	Pounds Coal
1 1/4"		1.31	526	0.905	3.24	0.873	3.92	0.815	5.25	0.846	5.63	0.875	8.80	10.15	64.60	1.375	
1 1/2"		1.81	763	1.305	4.51	1.270	4.51	1.178	5.25	1.242	5.63	1.280	12.56	14.60	92.20	2.020	
1 3/4"		2.65	1060	1.821	6.28	1.786	6.28	1.678	5.25	1.742	5.63	1.820	17.94	20.50	132.20	2.820	
2"		3.24	1297	2.142	7.38	2.106	7.38	1.982	5.25	2.046	5.63	2.120	20.50	23.50	168.90	3.690	
2 1/4"		3.86	1545	2.560	8.88	2.524	8.88	2.390	5.25	2.454	5.63	2.528	24.20	27.50	200.40	4.300	
2 1/2"		4.50	1824	2.976	10.88	2.940	10.88	2.806	5.25	2.870	5.63	2.944	28.20	32.00	230.00	4.960	
2 3/4"		5.18	2070	3.392	12.88	3.356	12.88	3.222	5.25	3.286	5.63	3.360	32.20	36.50	260.00	5.580	
3"		5.82	2316	3.808	14.88	3.772	14.88	3.638	5.25	3.702	5.63	3.776	36.20	40.50	288.00	6.160	
3 1/4"		6.46	2562	4.224	16.88	4.188	16.88	4.048	5.25	4.112	5.63	4.186	40.20	44.50	316.00	6.740	
3 1/2"		7.10	2808	4.640	18.88	4.604	18.88	4.464	5.25	4.528	5.63	4.602	44.20	48.50	344.00	7.320	
3 3/4"		7.74	3054	5.056	20.88	5.020	20.88	4.880	5.25	4.944	5.63	5.018	48.20	52.50	372.00	7.900	
4"		8.38	3300	5.472	22.88	5.436	22.88	5.296	5.25	5.360	5.63	5.434	52.20	56.50	400.00	8.480	
4 1/4"		9.02	3546	5.888	24.88	5.852	24.88	5.712	5.25	5.776	5.63	5.850	56.20	60.50	428.00	9.060	
4 1/2"		9.66	3792	6.304	26.88	6.268	26.88	6.132	5.25	6.196	5.63	6.270	60.20	64.50	456.00	9.640	
4 3/4"		10.30	4038	6.720	28.88	6.684	28.88	6.548	5.25	6.612	5.63	6.686	64.20	68.50	484.00	10.220	
5"		10.94	4284	7.136	30.88	7.100	30.88	6.964	5.25	7.028	5.63	7.102	68.20	72.50	512.00	10.800	
5 1/4"		11.58	4530	7.552	32.88	7.516	32.88	7.380	5.25	7.444	5.63	7.518	72.20	76.50	540.00	11.380	
5 1/2"		12.22	4776	7.968	34.88	7.932	34.88	7.796	5.25	7.860	5.63	7.934	76.20	80.50	568.00	11.960	
5 3/4"		12.86	5022	8.384	36.88	8.348	36.88	8.212	5.25	8.276	5.63	8.350	80.20	84.50	596.00	12.540	
6"		13.50	5268	8.800	38.88	8.764	38.88	8.628	5.25	8.692	5.63	8.766	84.20	88.50	624.00	13.120	
6 1/4"		14.14	5514	9.216	40.88	9.180	40.88	9.044	5.25	9.108	5.63	9.182	88.20	92.50	652.00	13.700	
6 1/2"		14.78	5760	9.632	42.88	9.596	42.88	9.460	5.25	9.524	5.63	9.598	92.20	96.50	680.00	14.280	
6 3/4"		15.42	6006	10.048	44.88	10.012	44.88	9.876	5.25	9.940	5.63	10.014	96.20	100.50	708.00	14.860	
7"		16.06	6252	10.464	46.88	10.428	46.88	10.292	5.25	10.356	5.63	10.430	100.20	104.50	736.00	15.440	
7 1/4"		16.70	6498	10.880	48.88	10.844	48.88	10.708	5.25	10.772	5.63	10.846	104.20	108.50	764.00	16.020	
7 1/2"		17.34	6744	11.296	50.88	11.260	50.88	11.124	5.25	11.188	5.63	11.262	108.20	112.50	792.00	16.600	
7 3/4"		17.98	6990	11.712	52.88	11.676	52.88	11.540	5.25	11.604	5.63	11.678	112.20	116.50	820.00	17.180	
8"		18.62	7236	12.128	54.88	12.092	54.88	11.956	5.25	12.020	5.63	12.094	116.20	120.50	848.00	17.760	
8 1/4"		19.26	7482	12.544	56.88	12.508	56.88	12.372	5.25	12.436	5.63	12.510	120.20	124.50	876.00	18.340	
8 1/2"		19.90	7728	12.960	58.88	12.924	58.88	12.788	5.25	12.852	5.63	12.926	124.20	128.50	904.00	18.920	
8 3/4"		20.54	7968	13.376	60.88	13.340	60.88	13.204	5.25	13.268	5.63	13.342	128.20	132.50	932.00	19.500	
9"		21.18	8214	13.792	62.88	13.756	62.88	13.620	5.25	13.684	5.63	13.758	132.20	136.50	960.00	20.080	
9 1/4"		21.82	8460	14.208	64.88	14.172	64.88	14.036	5.25	14.100	5.63	14.174	136.20	140.50	988.00	20.660	
9 1/2"		22.46	8706	14.624	66.88	14.588	66.88	14.452	5.25	14.516	5.63	14.590	140.20	144.50	1016.00	21.240	
9 3/4"		23.10	8952	15.040	68.88	15.004	68.88	14.868	5.25	14.932	5.63	15.006	144.20	148.50	1044.00	21.820	
10"		23.74	9198	15.456	70.88	15.420	70.88	15.284	5.25	15.348	5.63	15.422	148.20	152.50	1072.00	22.400	
10 1/4"		24.38	9444	15.872	72.88	15.836	72.88	15.700	5.25	15.764	5.63	15.838	152.20	156.50	1100.00	22.980	
10 1/2"		25.02	9690	16.288	74.88	16.252	74.88	16.116	5.25	16.180	5.63	16.254	156.20	160.50	1128.00	23.560	
10 3/4"		25.66	9936	16.704	76.88	16.668	76.88	16.532	5.25	16.596	5.63	16.670	160.20	164.50	1156.00	24.140	
11"		26.30	10182	17.120	78.88	17.084	78.88	16.948	5.25	17.012	5.63	17.086	164.20	168.50	1184.00	24.720	
11 1/4"		26.94	10428	17.536	80.88	17.500	80.88	17.364	5.25	17.428	5.63	17.492	168.20	172.50	1212.00	25.300	
11 1/2"		27.58	10674	17.952	82.88	17.916	82.88	17.780	5.25	17.844	5.63	17.918	172.20	176.50	1240.00	25.880	
11 3/4"		28.22	10920	18.368	84.88	18.332	84.88	18.196	5.25	18.260	5.63	18.334	176.20	180.50	1268.00	26.460	
12"		28.86	11166	18.784	86.88	18.748	86.88	18.612	5.25	18.676	5.63	18.750	180.20	184.50	1296.00	27.040	
12 1/4"		29.50	11412	19.200	88.88	19.164	88.88	19.028	5.25	19.092	5.63	19.166	184.20	188.50	1324.00	27.620	
12 1/2"		30.14	11658	19.616	90.88	19.580	90.88	19.444	5.25	19.508	5.63	19.582	188.20	192.50	1352.00	28.200	
12 3/4"		30.78	11904	20.032	92.88	19.996	92.88	19.860	5.25	19.924	5.63	20.000	192.20	196.50	1380.00	28.780	
13"		31.42	12150	20.448	94.88	20.412	94.88	20.276	5.25	20.340	5.63	20.414	196.20	200.50	1408.00	29.360	
13 1/4"		32.06	12396	20.864	96.88	20.828	96.88	20.640	5.25	20.704	5.63	20.778	200.20	204.50	1436.00	29.940	
13 1/2"		32.70	12642	21.280	98.88	21.244	98.88	21.108	5.25	21.172	5.63	21.246	204.20	208.50	1464.00	30.520	
13 3/4"		33.34	12888	21.696	100.88	21.660	100.88	21.532	5.25	21.596	5.63	21.670	208.20	212.50	1492.00	31.100	
14"		33.98	13134	22.112	102.88	22.076	102.88	21.948	5.25	22.012	5.63	22.086	212.20	216.50	1520.00	31.680	
14 1/4"		34.62	13380	22.528	104.88	22.492	104.88	22.364	5.25	22.428	5.63	22.502	216.20	220.50	1548.00	32.260	
14 1/2"		35.26	13626	22.944	106.88	22.908	106.88	22.776	5.25	22.840	5.63	22.914	220.20	224.50	1576.00	32.840	
14 3/4"		35.90	13872	23.360	108.88	23.324	108.88	23.192	5.25	23.256	5.63	23.330	224.20	228.50	1604.00	33.420	
15"		36.54	14118	23.776	110.88	23.740	110.88	23.608	5.25	23.672	5.63	23.746	228.20	232.50	1632.00	34.000	
15 1/4"		37.18	14364	24.192	112.88	24.156	112.88	24.024	5.25	24.088	5.63	24.162	232.20	236.50	1660.00	34.580	
15 1/2"		37.82	14610	24.608	114.88	24.572	114.88	24.440	5.25	24.504	5.63	24.578	236.20	240.50	1688.00	35.160	
15 3/4"		38.46	14856	25.024	116.88	24.988	116.88	24.856	5.25	24.920	5.63	24.994	240.20	244.50	1716.00	35.740	
16"		39.10	15102	25.440	118.88	25.404	118.88	25.272	5.25	25.336	5.63	25.410	244.20	248.50	1744.00	36.320	
16 1/4"		39.74	15348	25.856	120.88	25.820	120.88	25.688	5.25	25.752	5.63	25.826	248.20	252.50	1772.00	36.900	
16 1/2"		40.38	15594	26.272	122.88	26.236	122.88	26.104	5.25	26.168	5.63	26.242	252.20	256.50	1800.00	37.480	
16 3/4"		41.02	15840	26.688	124.88	26.652	124.88	26.520	5.25	26.584	5.63	26.658	256.20	260.50	1828.00	38.060	
17"		41.66	16086	27.104	126.88	27.068	126.88	26.936	5.25	26.992	5.63	27.066	260.20	264.50	1856.00	38.640	
17 1/4"		42.30	16332	27.520	128.88	27.484	128.88	27.352	5.25	27.416	5.63	27.490	264.20	268.50	1884.00	39.220	
17 1/2"		42.94	16578	27.936	130.88	27.900	130.88	27.768	5.25	27.832	5.63	27.906	268.20	272.50	1912.00	39.800	
17 3/4"		43.58	16824	28.352	132.88	28.316	132.88	28.184	5.25	28.248	5.63	28.322	272.20	276.50	1940.00	40.380	
18"		44.22	17070	28.768	134.88	28.732	134.88	28.600	5.25	28.664	5.63	28.738	276.20	280.50	1968.00	40.960	

*In this table coal has been figured at \$4.00 per ton of 2000 lb., 13,000 B.t.u. per lb. of coal; labor, boiler-room expense, etc., taken at \$1.00 per ton, making total value of coal fired at \$5.00 per ton. Boiler efficiency taken at 70 per cent; air temp. 70 deg. fahr. Experimental data obtained at the Mellon Institute.

AMERICAN SOCIETY of HEATING and VENTILATING ENGINEERS GUIDE, 1924-25

per hour per degree fahr. temperature difference. Pounds of coal used are given per 100 sq. ft. per month assuming continuous use of the apparatus, 70 per cent boiler efficiency, and 13,000 B.t.u. per lb. The "dollars" column represents the money value of the coal used per 100 sq. ft. per month assuming coal at \$4.00 per ton and boiler room expense at \$1.00 per ton.

TABLE 83. HEAT LOSS FROM UNINSULATED SURFACES

	TEMPERATURE DEG. FAHR.	HEAT LOSS* B.T.U. MONTH	LBS. COAL PER 100 SQ. FT. PER MONTH	DOLLARS PER 100 SQ. FT. PER MONTH
Hot Air.....	120	1.95	770	1.92
Hot Water.....	180	2.04	1780	4.45
Steam, 10-lb. gage.....	239	2.29	3065	7.65
“ 80 “ “.....	324	2.76	5545	13.86
“ 120 “ “.....	350	2.92	6480	16.22
“ 160 “ “.....	371	3.05	7250	18.13
“ 200 “ “.....	388	3.15	7950	19.87
“ 200 “ “ and 100 deg. fahr. superheat.....	488	3.88	12,830	32.05

heat loss per square foot of insulated pipe is somewhat dependent upon the pipe size it cannot be said that the data given by this figure is exact for all pipe sizes, but it is known that it is sufficiently so for all practical purposes in the heating and ventilating field. These curves are exact for 3-in. pipe. Similar curves for flat surfaces and surfaces of large radius, such as boilers, tanks, heaters, and ducts, are given in Fig. 54. When coverings are used other than those for which curves are given reference should be made to Table 84 which gives the conductivities of the various materials. That curve should then be used which represents the covering the conductivity of which is the nearest to the conductivity of the covering to be used. If greater accuracy is desired, interpolation may be resorted to.

Example.—What is the heat loss through a pipe covering of conductivity 0.9 at 200 deg. temperature difference? The conductivity of air cell is 0.802, and that of vitrified air cell is 1.087. The heat loss through air cell is 132 B.t.u., that through vitrified air cell is 165 B.t.u., so the heat loss through the covering under consideration is given by

$$\frac{X-132}{165-132} = \frac{0.9-0.802}{1.087-0.802}$$

or $X = 143$ B.t.u. per sq. ft. of pipe per hr.

While 1-in. thick covering is economically sufficient for most purposes in connection with heating and ventilating piping, greater thicknesses should be used on all boilers, piping, tanks, etc., where high pressure steam is used. Table 85 shows the thickness of covering required for maximum net saving with coal at \$4 per ton.

TABLE 85. THICKNESS OF COVERING FOR MAXIMUM NET SAVING WITH COAL AT \$4 PER TON

PIPE SIZE IN.	HOT WATER IN.	5 LB. IN.	100-200 LB. IN.	200 LB. AND 150 DEG. FAHR. SUPERHEAT IN.
3/4	1	1	1 1/2	2
1 1/2	1	1	1 1/2	2
3	1	1	2	2
6	1	1 1/2	2	3
12	1	1 1/2	2 1/2	3 1/2
Flat	1 1/2	2	3	4

When coverings thicker than 1 in. are used the losses vary considerably for the different thicknesses and reference must be made to the handbooks of the various manufacturers as lengthy tables are required for each thickness and kind of covering.

RADIATING SURFACE OF PIPES

In order to use the curves in Fig. 53 it is necessary to know the number of square feet of radiating surface in 1 linear ft. of pipe. Table 86 gives this data for the various standard pipe sizes.

TABLE 86. RADIATING SURFACE IN 1 LINEAR FOOT OF PIPE

PIPE SIZE IN.	SURFACE SQ. FT.	PIPE SIZE IN.	SURFACE SQ. FT.	PIPE SIZE IN.	SURFACE SQ. FT.
1/2	0.22	2	0.622	5	1.455
3/4	0.274	2 1/2	0.751	6	1.733
1	0.344	3	0.917	8	2.257
1 1/4	0.435	3 1/2	1.047	10	2.817
1 1/2	0.498	4	1.178	12	3.338

THICKNESS OF MAGNESIA COVERINGS

Magnesia coverings are not made exactly 1 in. thick, but their thickness varies with the size pipe for which they are intended. This is done for the reason that it has been demonstrated that the larger the pipe the more economical it is in the long run to use a thicker covering. The thickness for different pipe sizes are given in Table 87.

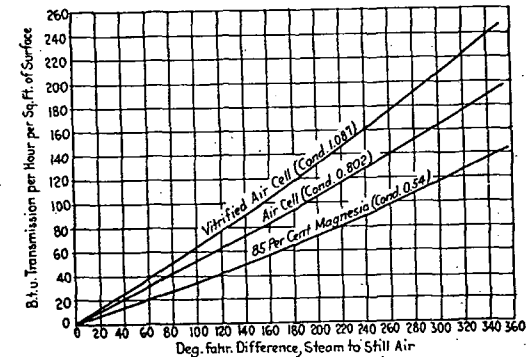


FIG. 54. HEAT TRANSMISSION IN B.T.U. PER HOUR PER SQUARE FOOT OF FLAT INSULATED SURFACE. (1 IN. COVERING)

Coverings made in thicknesses as shown in Table 87 are known as *Standard Thick* coverings. Since these thicknesses do not vary greatly from 1 in., the curves of heat loss for 1-in. thick coverings in Fig. 53 can be used in the case of standard thick coverings without error or practical

TABLE 87. THICKNESS OF MAGNESIA COVERINGS FOR VARIOUS PIPE SIZES

PIPE SIZE IN.	THICKNESS IN.
1/2 to 1 1/2 incl.	7/8
2 to 3 1/2 "	1 1/8
4 to 6 "	1 1/4
7 to 10 "	1 1/2
12 "	1 3/4

importance for heating and ventilating purposes. If great exactness is required it should be remembered that any increase in thickness over 1 in. will reduce the heat loss from that shown by the curves.

HEATING CONDUITS

When steam pipes are run between buildings they should be placed in some form of conduit and suitable insulation provided. The pipes must be supported so as to provide for expansion and contraction. 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.

NINE 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 straight runs.
2. Manholes should be provided at each expansion joint.
3. Branches should be taken off at or near an anchor.
4. An anchor should be placed wherever the line changes direction.
5. An expansion joint or bend must be placed between each two anchors.
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 less than 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 less than 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.

STYLES AND CONSTRUCTION OF CONDUITS COMMONLY USED

Filler Type.—The pipes are supported on rollers placed in a steel frame, and the lower part of this frame is set in concrete, thus supporting the pipes independent of the conduit. The pipes are protected by a split tile conduit and the entire space between the pipes and the tile is filled with an insulation filler. 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 placed in a steel frame. The space between the pipes and the insulating conduit lining may also be filled with an insulating filler. The conduit is placed on a tile base which also acts as an underdrain. A few inches of gravel or crushed rock are placed about the conduit and the tile base.

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. No underdrain is used with this conduit as any water seeping into the interior will 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.

CHAPTER XIV

PIPE

IN the present era of large-scale developments accompanied by intensive application of engineering principles in many of the basic industries, it has become increasingly important to give more study to the characteristics and properties of the materials entering into the structure and maintenance of their various contributing units. This is particularly true of pipe lines which often bear an important relation to efficient and economical operation.

STEEL PIPE

During the past 20 years in particular there has been a remarkable development in the wrought tubular industry, including the tonnage used, the capacity of mills, diversity of pipe service, and improvements in the material itself.

The factors which control the characteristics and properties, and thus produce the wonderful improvement in various tubular materials, are the facilities of the manufacturer; the special processes supplementing the fundamental ones; the availability and quality of raw materials; the ideals and skill of the men in the organization—their capacity for genuine accomplishment. Among the many evidences of this trend are: the improvements effected in the quality of the material, production of certain sizes of pipe up to 40 ft. lengths, diameters up to 96 in., a complete line of tubular products, full standard weight pipe, and marking with the name, are representative of the progressive attitude taken in the manufacture of wrought pipe. The increasing demands of the oil industry, which consumes nearly one-half of the pipe made, has been a stimulating factor in respect to improved quality.

Among the improvements none have received greater attention than the efforts to produce a uniform quality of steel. To secure and maintain uniformity, necessitates complete control of all materials and manufacturing operations—from ore to finished product. This practice of producing uniform pipe and steel and its fabrication into finished tubular products is supplemented by a mechanical process of roll-knobbling, to make the metal more uniformly dense when there is any tendency to physical irregularity in this respect.

Another condition which gives rise to electrolytic centers and pitting is the presence of irregular areas of heavy welding-scale on the surface of the finished product, caused by oxidation at the high temperature of

Material for this section was prepared especially for THE GUIDE, the part on Steel Pipe being contributed by F. N. Speller, Pittsburgh, that on Wrought Iron Pipe being the work of N. Bowland, Pittsburgh, and that on Copper and Brass Pipe being compiled by J. F. Gowen, W. A. Willis, W. G. Schneider, and H. H. R. Spofford, of the Copper and Brass Research Association, New York.

welding. This scale is strongly electro-negative to iron, like copper, and should therefore be removed. For a number of years efforts have been directed to accomplish this object and a scale removing process has finally been worked out, which is in effect a further application of the process of laterally working the steel above mentioned, but in this process the work is applied to the hot pipe in the finishing operations at a temperature below the welding heat. When the skelp has reached the proper temperature for welding, it is drawn through the customary type of welding bell forming an unfinished pipe of larger size than is usual. The pipe is then held on a cooling table until the temperature is reduced to about 1800 deg. fahr. It then passes through a series of rolls where it is reduced in size and elongated. These rolls reduce the pipe to its correct finished size. The reduction in the size of the pipe which it receives in passing through the series of rolls cracks the hardened welding-scale from both the interior and exterior surfaces of the pipe, leaving them clean and smooth.

After a pass through a set of cross rolls, to take care of any straightening that may remain to be done and to give the exterior a smooth, clean finish, the pipe is taken to a tank of water where it is dipped, lifted to a slanting position and the water allowed to rush out, carrying with it the loose scale from the pipe. Certain sizes have the loose scale blown out by a blast of compressed air instead of being dipped in the water.

The advantages of scale-free pipe are, its clean, smooth surfaces present and ideal base for the adherence of a galvanizing coating—full working capacity is assured, the interior being free from any obstructions tending to reduce the flow. This is important in heating and other piping work. Troubles caused by the deposit of scale in valves and strainers, and other apparatus, are practically eliminated, while pitting by corrosion is materially reduced.

These improvements naturally give rise to the thought that a longer life might reasonably be expected from the pipe under certain conditions, and while this has been the object of most of the research, experiments and perfection of processes, considerable improvement has been attained in this respect, the fact still remains that the life of pipe is governed largely by installation conditions, and no matter how well made or uniform the pipe may be, the life of pipe, particularly under severe corrosion conditions; such as, hot water supply lines, boiler feed and return lines, is limited, and some protective measures are necessary to secure a longer life.

For some years past considerable research and experimental work has been carried on to determine the causes of failure in pipe lines, and to ameliorate the effects of corrosion; to investigate unusual conditions of service, and to determine a practical means of corrosion prevention.

The electrolytic theory of corrosion as formulated in 1903 by Dr. Whitney has led to the development of certain protective systems which are based on the removal of dissolved oxygen from water. Careful experiments in various research laboratories have demonstrated that the amount of corrosion found is almost directly proportional to the amount of oxygen in solution, and varies directly as the temperature. The

predominating influence of free oxygen in water was suspected before this, as a result of the early study of pipe corrosion, for the most striking fact in practical pipe experience is that hot-water-heating systems invariably showed no corrosion to speak of after 35 or 40 years' use; whereas, frequently, hot-water-supply systems operating at the same average temperature with the same water lasted less than half this time. That this was independent of whether the material was iron or steel was fully demonstrated by many service tests which were conducted for a period of more than ten years, in which representative pipes of each class were installed alternately in hot-water lines.

TABLE 88. STANDARD PIPE—BLACK AND GALVANIZED*

All Weights and Dimensions are Nominal

SIZE	DIAMETERS		THICKNESS	WEIGHT PER FOOT			COUPLINGS			TEST PRESSURE IN POUNDS	
	External	Internal		Plain ends	Threads and couplings	THREADS PER INCH	Diameter	Length	Weight	Butt	Lap
1/4	0.405	0.269	0.068	0.244	0.245	27	0.562	3/4	0.029	700	.....
1/4	0.540	0.364	0.088	0.424	0.425	18	0.685	1	0.043	700	.....
1/2	0.675	0.493	0.091	0.567	0.568	18	0.848	1 1/4	0.070	700	.....
1/2	0.840	0.622	0.109	0.850	0.852	14	1.024	1 3/4	0.116	700	.....
3/4	1.050	0.824	0.113	1.130	1.134	14	1.281	1 3/4	0.209	700	.....
1	1.315	1.049	0.133	1.678	1.684	11 1/4	1.576	1 3/4	0.343	700	.....
1 1/4	1.660	1.380	0.140	2.272	2.281	11 1/4	1.950	2 1/4	0.535	700	1000
1 1/2	1.900	1.610	0.145	2.717	2.731	11 1/4	2.218	2 3/4	0.743	700	1000
2	2.375	2.067	0.154	3.062	3.078	11 1/4	2.760	2 3/4	1.208	700	1000
2 1/4	2.875	2.469	0.203	5.793	5.819	8	3.276	2 3/4	1.720	800	1000
3	3.500	3.068	0.216	7.575	7.616	8	3.948	3 1/4	2.498	800	1000
3 1/4	4.000	3.548	0.226	9.109	9.202	8	4.591	3 3/4	4.241	.....	1000
4	4.500	4.026	0.237	10.790	10.889	8	5.091	3 3/4	4.741	.....	1000
4 1/2	5.000	4.506	0.247	12.538	12.642	8	5.591	3 3/4	5.241	.....	1000
5	5.563	5.047	0.258	14.617	14.810	8	6.296	4 1/4	8.091	.....	1000
6	6.625	6.065	0.280	18.974	19.185	8	7.358	4 3/4	9.554	.....	1000
7	7.625	7.023	0.301	23.544	23.769	8	8.358	4 3/4	10.932	.....	1000
8	8.625	8.071	0.277	24.896	25.000	8	9.358	4 3/4	13.905	.....	800
8	8.625	7.981	0.322	28.554	28.809	8	9.358	4 3/4	13.905	.....	1000
9	9.625	8.941	0.342	33.907	34.188	8	10.358	5 1/4	17.236	.....	900
10	10.750	10.192	0.279	31.201	32.000	8	11.721	6 1/4	29.877	.....	600
10	10.750	10.136	0.307	34.240	35.000	8	11.721	6 1/4	29.877	.....	800
10	10.750	10.020	0.365	40.483	41.132	8	11.721	6 1/4	29.877	.....	900
11	11.750	11.000	0.375	45.557	46.247	8	12.721	6 3/4	32.550	.....	800
12	12.750	12.090	0.330	43.773	45.000	8	13.958	6 3/4	43.098	.....	600
12	12.750	12.000	0.375	49.562	50.706	8	13.958	6 3/4	43.098	.....	800
14 O. D.	14.000	13.250	0.375	54.568	55.824	8	15.208	6 3/4	47.152	.....	700
15 O. D.	15.000	14.250	0.375	58.573	60.375	8	16.446	6 3/4	59.493	.....	700
16 O. D.	16.000	15.250	0.375	62.579	64.500	8	17.446	6 3/4	63.294	.....	600
17 O. D.	17.000	16.214	0.393	69.704	72.602	8	18.683	7 1/4	90.941	.....	600
18 O. D.	18.000	17.182	0.409	76.840	80.482	8	19.921	7 1/4	108.672	.....	600
20 O. D.	20.000	19.182	0.409	85.577	89.617	8	21.921	7 1/4	120.187	.....	500

The permissible variation in weight is 5 per cent above and 5 per cent below.

Furnished with threads and couplings and in random lengths unless otherwise ordered.

Taper of threads is 1/4-in. diameter per foot length for all sizes.

The weight per foot of pipe with threads and couplings is based on a length of 20 ft., including the coupling, but shipping lengths of small sizes will usually average less than 20 ft.

All weights given in pounds. All dimensions given in inches.

On sizes made in more than one weight, weight desired must be specified.

*From National Tube Co.'s "Book of Standards."

All reliable data on this subject indicate that the composition of the iron—i.e., the varying amount of carbon, phosphorous, manganese, sulphur, silicon, oxides, slag and copper usually found in wrought iron and soft steel—makes very little difference in the amount or character of corrosion *under water*, although under atmospheric exposure the influence of composition is sometimes quite marked.

In practice, oxygen removal has been accomplished in two ways, namely; by de-aerating the water mechanically; and by fixing the free oxygen by chemical combination. Suitable apparatus is now being manufactured for this purpose.

TABLE 89. EXTRA STRONG PIPE—BLACK AND GALVANIZED*

All Weights and Dimensions are Nominal

SIZE	DIAMETERS		THICKNESS	WEIGHT PER FOOT PLAIN ENDS	TEST PRESSURE IN POUNDS	
	External	Internal			Butt	Lap
1/8	0.405	0.215	0.095	0.314	700	-----
1/4	0.540	0.302	0.119	0.535	700	-----
3/8	0.675	0.423	0.126	0.738	700	-----
1/2	0.840	0.546	0.147	1.087	700	-----
3/4	1.050	0.742	0.154	1.473	700	-----
1	1.315	0.957	0.179	2.171	700	-----
1 1/4	1.660	1.278	0.191	2.996	1500	2500
1 1/2	1.900	1.500	0.200	3.631	1500	2500
2	2.375	1.939	0.218	5.022	1500	2500
2 1/2	2.875	2.323	0.276	7.661	1500	2000
3	3.500	2.900	0.300	10.252	1500	2000
3 1/2	4.000	3.364	0.318	12.505	-----	2000
4	4.500	3.826	0.337	14.983	-----	2000
4 1/2	5.000	4.290	0.355	17.611	-----	1800
5	5.563	4.813	0.375	20.778	-----	1800
6	6.625	5.761	0.432	28.573	-----	1800
7	7.625	6.625	0.500	38.048	-----	1500
8	8.625	7.625	0.500	43.388	-----	1500
9	9.625	8.625	0.500	48.728	-----	1500
10	10.750	9.750	0.500	54.735	-----	1200
11	11.750	10.750	0.500	60.075	-----	1100
12	12.750	11.750	0.500	65.415	-----	1100
14 O. D.	14.000	13.000	0.500	72.091	-----	1000
15 O. D.	15.000	14.000	0.500	77.431	-----	1000
16 O. D.	16.000	15.000	0.500	82.771	-----	1000

The permissible variation in weights is 5 per cent above and 5 per cent below. Furnished with plain ends and in random lengths unless otherwise ordered. All weights given in pounds. All dimensions given in inches. In addition to the above test, on sizes 1/8-in. to 1-in. inclusive, the pipe is jarred with a hammer while under pressure.

*From National Tube Co.'s "Book of Standards."

WROUGHT IRON PIPE

Wrought iron pipe is generally designated by the word *genuine* when the product referred to is that produced by the puddling process and its cost is from 30 to 60 per cent higher than steel pipe, depending upon its size. In the average heating, plumbing or power piping system the cost of pipe is about 10 to 20 per cent of the installation cost, with the remain-

TABLE 90. GENUINE WROUGHT IRON PIPE—BLACK OR GALVANIZED

All Weights and Dimensions are Nominal

	Size	Outside diam., in.	Inside diam., in.	Std. wt. plain ends, lbs. per ft.	Couplings		
					Outside diam., in.	Length, in.	Weight, lbs.
Standard							
Buttweld	$\frac{1}{4}$	0.540	0.367	0.424	0.750	1.000	0.059
	$\frac{3}{8}$	0.675	0.489	0.567	0.968	1.343	0.156
	$\frac{1}{2}$	0.840	0.617	0.850	1.078	1.343	0.168
	$\frac{3}{4}$	1.050	0.819	1.130	1.312	1.531	0.243
	1	1.315	1.043	1.678	1.656	1.718	0.425
Buttweld and Lapweld	$1\frac{1}{4}$	1.660	1.369	2.272	1.984	2.062	0.631
	$1\frac{1}{2}$	1.900	1.604	2.717	2.281	2.312	0.884
Lapweld	2	2.375	2.060	3.652	2.750	2.500	1.100
	$2\frac{1}{2}$	2.875	2.460	5.793	3.312	3.125	2.100
	3	3.500	3.059	7.575	4.031	3.125	3.025
	$3\frac{1}{2}$	4.000	3.538	9.109	4.500	3.687	3.900
	4	4.500	4.016	10.790	4.968	3.687	4.200
	$4\frac{1}{2}$	5.000	4.496	12.538	5.531	4.218	6.200
	5	5.563	5.036	14.617	6.281	4.125	8.250
	6	6.625	6.053	18.974	7.375	4.156	10.800
	7	7.625	7.010	23.544	8.375	5.000	14.650
	8	8.625	8.059	28.696	9.406	5.000	16.250
	9	9.625	8.927	33.907	10.687	6.375	33.700
	10	10.750	10.181	31.201	11.937	6.750	42.900
	10	10.750	10.124	34.240	11.937	6.750	42.900
	11	11.750	10.005	40.483	11.937	6.750	42.900
	12	12.750	12.077	43.773	13.875	6.750	49.100
12	12.750	11.985	49.562	13.875	6.937	49.100	

Extra Heavy

Buttweld	1/4	0.540	0.295	0.535	0.843	1.250	0.125
	3/8	0.675	0.417	0.738	0.968	1.343	0.156
	1/2	0.840	0.539	1.087	1.109	1.500	0.200
	3/4	1.050	0.735	1.473	1.406	2.125	0.460
Buttweld and Lapweld	1	1.315	0.949	2.171	1.656	2.375	0.625
	1 1/4	1.660	1.269	2.996	2.094	2.750	1.150
	1 1/2	1.900	1.491	3.631	2.375	2.750	1.300
	2	2.375	1.929	5.022	2.937	3.625	2.400
Lapweld	2 1/2	2.875	2.311	7.661	3.531	4.125	4.250
	3	3.500	2.887	10.252	4.187	4.250	5.200
	3 1/2	4.000	3.350	12.505	4.750	4.437	6.900
	4	4.500	3.811	14.983	5.250	4.437	7.500
	4 1/2	5.000	4.275	17.611	5.671	4.375	7.700
	5	5.563	4.797	20.778	6.375	5.000	10.850
	6	6.625	5.743	28.573	7.500	5.437	15.500
	7	7.625	6.603	38.048	8.625	6.250	24.300
	8	8.625	7.604	43.388	9.500	6.250	24.000
	9	9.625	8.604	48.728	10.687	6.375	33.700
	10	10.750	9.729	54.735	11.937	6.750	42.200
	11	11.750	10.729	60.075	-----	-----	-----
	12	12.750	11.729	65.415	13.875	6.937	49.100

TABLE 90. GENUINE WROUGHT IRON PIPE—BLACK OR GALVANIZED—Continued
All Weights and Dimensions are Nominal

	Size	Outside diam., in.	Inside diam., in.	Std. wt. plain ends, lbs. per ft.	Couplings			
					Outside diam., in.	Length, in.	Weight, lbs.	
Double Extra Heavy								
Buttweld	$\frac{1}{4}$	0.840	0.226	1.714	Same as for Extra Heavy			
	$\frac{3}{4}$	1.050	0.413	2.440				
	$1\frac{1}{4}$	1.315	0.576	3.659				
	$1\frac{1}{4}$	1.660	0.874	5.214				
Buttweld and Lapweld	$1\frac{1}{4}$	1.900	1.078	6.408	Same as for Extra Heavy			
Lapweld	2	2.375	1.480	9.029	Same as for Extra Heavy			
	$2\frac{1}{2}$	2.875	1.742	13.695				
	3	3.500	2.270	18.583				
	$3\frac{1}{2}$	4.000	2.697	22.850				
	4	4.500	3.119	27.541				
	$4\frac{1}{2}$	5.000	3.546	32.530				
	5	5.563	4.028	38.552				
	6	6.625	4.857	53.160				

Permissible variation in weight is 2 1/2 per cent below and 5 per cent above.
Standard pipe furnished with threads and couplings in random lengths; extra heavy and double extra heavy with plain ends, and in random lengths unless otherwise ordered. Extra heavy and double extra heavy pipe fitted with threads and couplings at an extra charge above regular.

Expansion of Wrought Iron Pipe

INITIAL	INCREASE IN LENGTH PER 100 FT. WHEN HEATED TO									
	160°	180°	200°	212°	228°	240°	250°	259°	267°	274°
Temperature										
Zero, in.	1.28	1.44	1.60	1.69	1.82	1.92	2.00	2.07	2.13	2.20
32° in.	1.02	1.18	1.34	1.43	1.56	1.66	1.74	1.81	1.87	1.94
64° in.	0.77	0.93	1.09	1.18	1.31	1.41	1.49	1.56	1.61	1.69
	Hot Water			Water Boils	5 lb.	10 lb.	15 lb.	20 lb.	25 lb.	30 lb.

Wrought iron pipe expands, in inches, per 100 ft., 4/5 of the increase in temperature of steam or water it is subjected to, over the temperature at the time of installation, divided by 100.
Example.—Temperature when installed, 32 deg., 10 lb. pressure = 240 deg., difference 208 deg., 4/5 of which equals 1.66 in. expansion per 100 ft.

ing cost covering the items of fittings, valves, installation, shop costs, supervision and overhead.

When it is recalled that a pipe failure may cause the loss of the first investment and may also be accompanied by costly repair bills on interior walls, floors and decorations it is important to choose pipe which will give the maximum assurance of long life.

In ordering genuine wrought iron pipe a specification that is frequently used is as follows:

Manufacturer's Name or "Brand;" or
Genuine Wrought Iron Pipe.

Finish: (Black or Galvanized)

Weight: (Full Standard Weight, or Extra Heavy Weight)

Nipples: Must be made up from genuine wrought iron specified for pipe, of the same quality, weight, and finish as for the latter.

In accordance with established practice of manufacturers of genuine wrought iron pipe it is sold with the guarantee somewhat as follows:

- (1) All pipe is guaranteed to be made of genuine wrought iron aggregated from a solidifying mass of pasty particles of highly refined metal which, without subsequent fusion, are incorporated with a minutely and uniformly distributed quality of silicate slag.

COPPER AND BRASS PIPE

Copper and brass tubing are commonly stocked and supplied by manufacturers and distributors in sizes varying from 1/8 to 10 in. o. d. and in gages from 2 to 25 B & S and Stubbs.

Cooper and brass piping are stocked and supplied in regular and extra heavy iron pipe sizes. Both tubing and piping are usually stocked in 12 ft. lengths, and can be obtained in lengths from 2 to 20 ft. or more if required.

The use of brass piping for water supply service is widely increasing in the domestic, institutional and industrial fields, and the growing interest in its use and application is primarily due to the wider public knowledge of the economic and engineering advantages of brass in pipe, pipe-fittings, plumbing and heating installations. The serviceability and usefulness of brass piping is due principally to its inherent resistance to corrosion.

An outstanding example of its use and field is afforded by the general employment of brass piping and fittings in boiler feed lines throughout, from meter or hot-well to pump, to feed-water heater to boiler, as well as in circulating and drip systems.

Corrosion is caused by the chemical interaction between the oxygen of the atmosphere and the metallic surfaces. This type of corrosion or oxidation is universal and is the chief cause of the deterioration and decay of metals and alloys used in engineering. Other types of corrosion or chemical decomposition frequently occur and are very often due to the interaction of acids on the metals, the latter replacing the hydrogen constituent of the acid to form a metallic salt.

The chemical corrosion of metals is greatly accelerated by temperature, and the degree of activity depends on the nature of the metals themselves.

Brass, which is a mixture of copper and zinc, the copper greatly predominating, is incomparably less active from a chemical point of view than the irons and steels, and does not rust or oxidize at anything like the rapidity under ordinary exposure to the atmosphere.

In cities sulphur dioxide, hydrogen chloride, hydrogen sulphide and other ingredients which may be looked upon as accidental, also have a

distinct corrosive influence on the materials of engineering. The affinity of iron for oxygen, which may be looked upon as the chief factor of corrosion, is apparent to the most casual observer in the rust developed, which is evident on every hand. That this activity of corrosion is greatly accelerated by an elevation in temperature, is readily seen in the blacksmith shop, where iron oxidizes to form a heavy scale in the short time that elapses between the forge and the hammer.

Not so with brass. Its oxidation is slow and years of exposure are required to effect a noticeable corrosion. Metals may be subjected to air, water, sulphurous fumes, nitrogen, hydrogen and free carbon dioxide. The nitrogen is inert, but the oxygen and free or half-bound carbon dioxide in the presence of moisture exercise a distinct corrosive influence, the latter exhibiting, with water, the corroding effects of a weak acid. Iron or steel under these exposures are incomparably more subject to attack than brass, a fact demonstrated by daily experience and extensive research in the laboratory.

Internal corrosion, accelerated by higher temperatures is most to be feared and is often the determining factor in endurance. We often see an old iron pipe that is pitted completely through at certain points, due to this action. The proof of this assertion is shown in the more rapid corrosion of hot-water piping than cold. In cold water piping the temperature of the water restrains the chemical interaction, but gases released at points where a partial vacuum obtains, still exercise a corrosive effect.

The iron oxides have a much greater volume than the metallic iron from which they were originally derived. A 1½ in. pipe, would be entirely closed up when only 1/27 of the thickness of its wall would have been converted into oxides, and in a 1 in. pipe only 1/40. This results in "wire drawing" and greatly reduces the volume of the stream at outlets and leads to complaints that the pressure is abnormally low, whereas the real source of trouble is in excessive interior corrosion.

Brass piping is immune to this type of corrosion, and always delivers water free from discoloration or rust. Due to its maintenance of a smooth, unruined interior, full flow and pressure are continued throughout the life of the system, and piping friction losses are kept reduced to the minimum.

Under conditions usually obtaining, good quality brass piping and fittings will satisfy all requirements. The architect engineer or contractor should by all means require that piping and fittings be supplied by a reputable dealer, the product of a reputable manufacturer.

Certain known special conditions of corrosion may require special mixtures, in order to obtain for the piping system the longest life. Among such instances might be mentioned salt water service, for which a universal recommendation is "admiralty" mixture (70 per cent copper, 29 per cent zinc, and 1 per cent tin.) Where unusual factors of corrosion are present, the engineer or contractor should heed the recommendations of the pipe manufacturer. *In all cases, pipe fittings should have approximately the same composition as the metal of the pipe itself.*

TABLE 91. WEIGHTS AND MEASUREMENTS OF SEAMLESS BRASS AND COPPER TUBE
IRON PIPE SIZES. REGULAR AND EXTRA HEAVY

IRON PIPE SIZES	1/4	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	3 1/2	4	4 1/2	5	6	7	8	9	10
<i>Regular</i>																		
Brass, weight per lineal foot	246	437	612	811	1,024	1,235	1,465	1,706	1,950	2,194	2,438	2,682	2,926	3,170	3,414	3,658	3,902	4,146
Copper, weight per lineal foot	371	624	847	1,070	1,293	1,516	1,739	1,962	2,185	2,408	2,631	2,854	3,077	3,300	3,523	3,746	3,969	4,192
Exact outside diameter	.405	.540	.675	.810	.945	1.080	1.215	1.350	1.485	1.620	1.755	1.890	2.025	2.160	2.295	2.430	2.565	2.700
Exact inside diameter	.371	.506	.641	.776	.911	1.046	1.181	1.316	1.451	1.586	1.721	1.856	1.991	2.126	2.261	2.396	2.531	2.666
Exact thickness of wall	.034	.067	.067	.067	.067	.067	.067	.067	.067	.067	.067	.067	.067	.067	.067	.067	.067	.067
Brass, theoretical safe working pressure, Factor safety six	1776	1465	1160	1024	840	750	628	580	509	461	440	427	412	400	375	366	357	340
Copper, theoretical safe working pressure, Factor safety six	1332	1102	870	798	630	563	471	435	381	346	337	320	308	300	281	275	267	255
Internal area cross section	.057	.104	.192	.305	.533	.863	1.406	2.068	2.855	3.783	4.857	6.173	7.730	9.540	11.600	13.910	16.470	19.290
Thickness of wall at bottom of thread	.036	.040	.043	.048	.052	.059	.065	.070	.076	.081	.087	.093	.099	.105	.111	.117	.123	.129
<i>Extra Heavy</i>																		
Brass, weight per lineal foot	353	593	805	1,011	1,222	1,433	1,644	1,855	2,066	2,277	2,488	2,699	2,910	3,121	3,332	3,543	3,754	3,965
Copper, weight per lineal foot	524	847	1,070	1,293	1,516	1,739	1,962	2,185	2,408	2,631	2,854	3,077	3,300	3,523	3,746	3,969	4,192	4,415
Exact outside diameter	.405	.540	.675	.810	.945	1.080	1.215	1.350	1.485	1.620	1.755	1.890	2.025	2.160	2.295	2.430	2.565	2.700
Exact inside diameter	.371	.506	.641	.776	.911	1.046	1.181	1.316	1.451	1.586	1.721	1.856	1.991	2.126	2.261	2.396	2.531	2.666
Exact thickness of wall	.034	.067	.067	.067	.067	.067	.067	.067	.067	.067	.067	.067	.067	.067	.067	.067	.067	.067
Brass, theoretical safe working pressure, Factor safety six	4442	3401	2508	2166	1739	1500	1250	1142	1008	904	846	814	783	740	703	666	629	592
Copper, theoretical safe working pressure, Factor safety six	3318	2551	1881	1626	1302	1125	938	857	755	678	635	611	586	555	524	493	462	431
Internal area cross section	.057	.104	.192	.305	.533	.863	1.406	2.068	2.855	3.783	4.857	6.173	7.730	9.540	11.600	13.910	16.470	19.290
Thickness of wall at bottom of thread	.036	.040	.043	.048	.052	.059	.065	.070	.076	.081	.087	.093	.099	.105	.111	.117	.123	.129
Number of threads per inch	27	18	14	11	8	6	5	4	3	2	1	1	1	1	1	1	1	1
Approximate length of threads	1 1/2"	1 1/2"	1 1/2"	1 1/2"	1 1/2"	1 1/2"	1 1/2"	1 1/2"	1 1/2"	1 1/2"	1 1/2"	1 1/2"	1 1/2"	1 1/2"	1 1/2"	1 1/2"	1 1/2"	1 1/2"

Note—Weights are in pounds, Diameter and thickness in inches, Area in square inches. The safe working pressure is calculated on thickness of walls at bottom of thread and indicates pounds per square inch internal pressure.

Brass pipe lends itself to economy in the labor costs of installation. It can be readily cut, bent, threaded and otherwise machined. At screw joints the threads do not corrode out at the roots and cause leaks, and such joints can, if necessity arises, be remade without injury to the pipe. If a building equipped with brass piping is torn down, the old piping and fittings can be used again or sold for a high scrap value.

The accompanying Table 91 gives weights and sizes for copper and brass tubing, in iron pipe sizes.

CHAPTER XV

PIPE SIZES FOR
WATER SUPPLY SERVICE

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 92.

TABLE 92. 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.....	$\frac{1}{2}$	$\frac{3}{4}$	1	$1\frac{1}{4}$	$1\frac{1}{2}$	$1\frac{3}{4}$	2	2	2	Flush
Gal. per Min.....	30	50	80	120	140	160	200	250	300	Valves
Pipe Size.....	1	$1\frac{1}{4}$	$1\frac{1}{2}$	2	2	2	$2\frac{1}{2}$	$2\frac{1}{2}$	$2\frac{1}{2}$	
Urinals—										
Gal. per Min.....	6	12	20	32	42	56	72	90	120	Tanks
Pipe Size.....	$\frac{1}{2}$	$\frac{3}{4}$	1	$1\frac{1}{4}$	$1\frac{1}{2}$	$1\frac{3}{4}$	$1\frac{3}{4}$	2	2	Flush
Gal. per Min.....	25	37	45	75	85	100	125	150	175	Valves
Pipe Size.....	1	$1\frac{1}{4}$	$1\frac{1}{2}$	$1\frac{3}{4}$	$1\frac{3}{4}$	2	2	2	2	
Lavatories and Wash Sinks—										
Based upon Each Faucet										
Gal. per Min.....	4	8	12	24	30	40	48	64	75	
Pipe Size.....	$\frac{1}{2}$	$\frac{3}{4}$	$\frac{3}{4}$	1	1	$1\frac{1}{4}$	$1\frac{1}{4}$	$1\frac{1}{4}$	$1\frac{1}{4}$	
Bath Tubs—										
Gal. per Min.....	15	30	40	80	96	112	144	192	240	
Pipe Size.....	$\frac{3}{4}$	1	$1\frac{1}{4}$	$1\frac{1}{2}$	2	2	2	$2\frac{1}{2}$	$2\frac{1}{2}$	
Shower Baths—										
Gal. per Min.....	8	16	32	64	96	128	192	256	320	8" rain
Pipe Size.....	$\frac{1}{2}$	$\frac{3}{4}$	$1\frac{1}{4}$	$1\frac{1}{2}$	2	2	$2\frac{1}{2}$	$2\frac{1}{2}$	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.....	$\frac{3}{4}$	1	$1\frac{1}{4}$	$1\frac{1}{2}$	$1\frac{3}{4}$	2	2	2	$2\frac{1}{2}$	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. The hot water faucets are to be disregarded when estimating risers and mains.

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

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 95, 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 92 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 92 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 of pipe will be determined as follows:

TABLE 93. WATER RISERS FOR MANUFACTURING BUILDINGS, LOFT BUILDINGS, APARTMENT HOUSES, HOTELS

			PIPE SIZE WITH 10 LB. DROP
10th Floor	100 gal.	60% = 60	2"
10 and 9	200 x 0.60	90% = 108	2 1/4"
10 and 9 and 8	300 x 0.60	80% = 144	2 1/2"
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 92, and for the main supply use 25 per cent of total of gallons used by fixtures and then take pipe size from Table 94 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 94 which show that for a building 100 ft. in height, a pressure drop of 100 lb. can be used on the fixture branches and that for a building 50 ft. in height, a pressure drop of 75 lb. can be used on the fixture branches; Table 92, 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 94. 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								
	3/4	1	1 1/4	1 1/2	2	2 1/2	3	3 1/2	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	276	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 95. 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.
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
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
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 94, at the pressure drop indicated.

The following examples show how to use Table 94:

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 93 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 94 and 95. On the top floor it will be necessary to use a 1 1/2 in. branch to carry 75 gal. per min. with a pressure drop of 30 lb. but that at 50 ft. vertically from the supply, a 1 1/4 in. branch pipe will carry 74 gal. per minute, therefore 1 1/4 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 95 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 93 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 94 will show that a 3 1/2 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, all the computations given herein 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.

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 $\times 2.31$; 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.

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

$$H = \frac{(0.16 \times CF)^2 \times L}{(3d)^2} \quad (3) \quad H = \frac{(1.2 G)^2 \times L}{(3d)^2} \quad (4)$$

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.

$$H_1 = \left(\frac{0.83 G}{d^2 \times 13} \right)^2 \text{ or } H_1 = \left(\frac{0.16 CF}{d^2 \times 13} \right)^2$$

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

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

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

Usually this can be neglected except for very close calculations.

PART II

CHAPTER XVI

VENTILATION

INTRODUCTION

VENTILATION is the science of supplying air having all the properties necessary and conducive to good health.

Early in the progress of the art it was considered that a room was well ventilated when a sufficient quantity of outside air at proper temperature was brought in. With buildings widely separated so that the outside air was not contaminated by contact with large groups of people, and the various operations of industry, this method usually provided sufficient ventilation. In the thickly populated districts of our large cities, where the buildings are large and close together, air is vitiated by contact with great masses of people, and by the various manufacturing processes and industrial activities far beyond the allowable limits for good ventilation. One good example of outside air contamination comes from the large number of motor vehicles in the streets producing great volumes of dust, objectionable odors, and poisonous gases.

Good ventilation, therefore, implies more than the supply of any given quantity of outside air. The various constituents, and the quality of the air itself within the ventilated space must be considered individually, and the verdict as to the satisfaction resulting from ventilation must be rendered in accordance with the perfection of each of these factors, and their relation to each other. It is immaterial whether the air is introduced direct from outdoors, whether it passes through a purification process, or if, after being purified, it is recirculated.

To be well ventilated the air in a room must have the ability to remove the proper amount of heat from the human body normally clothed. In other words, it must have the proper cooling power, or effective temperature, as determined by its temperature humidity and air motion. This factor of ventilation is taken up in another section. The air must contain the required amount of oxygen for supporting human life, be free from harmful bacteria, and low in dust count. It must be reasonably free from bodily and other objectionable odors, and harmful gases, and must be supplied to all parts of the room in sufficient quantity to maintain a proper value for each of these factors.

The Synthetic Air Chart as developed by E. Vernon Hill with a few modifications to incorporate the latest information obtained from the Research Laboratory offers a convenient means of determining the percentage of perfection of each of the above factors entering into good ventilation, and, therefore, the percentage of perfection of ventilation in any room or building. The Synthetic Air Chart is taken up in another section.

Good ventilation exists when each of the factors mentioned going to make good air has the proper value, and the proper relation to each other, regardless of the method of obtaining the same. If outside air is good as pertaining to these factors, then good ventilation may be obtained by supplying a sufficient quantity of outside air. If, however, any of the factors required in good ventilation are not satisfactory for the outside air, then ventilation will not be good, regardless of the amount of such air supplied, unless such factors are corrected. Again, if all of the above factors are perfected by artificial conditioning, by washing, or by any other process, ventilation is perfect even though no outside air is used.

The processes and laws of chemistry and physics are well enough understood by the heating and ventilating engineer to enable him to artificially control at will all of the known factors pertaining to good ventilation, and it, therefore, becomes merely a question of economy as to whether it is better to artificially condition air and recirculate it, or to use outside air.

AMOUNT OF NEW AIR TO BE SUPPLIED PER PERSON

	CUBIC FEET PER MINUTE			Number of Air Changes per Hour
	Without Humidification or Recirculation	With Humidification but Without Recirculation	With Humidification and Recirculation	
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	

Note.—See paper Modern Trend in the Science of Ventilation, Perry West, JOURNAL, A. S. H. & V. E. June, 1924.

CHAPTER XVII

HOW TO USE THE SYNTHETIC AIR CHART

In view of the announcement that after three years of investigation of the question of a standard for measurement of ventilation, the Society had adopted the Synthetic Air Chart for the purpose of comparing the air conditions in any room with the ideal or standard conditions, the Research Bureau worked out the following description of its method of application. It was thought that the operation of the Synthetic Air Chart might not be found entirely clear without some explanation and the late John R. Allen, then director of the Research Bureau, submitted the following brief statement for the benefit of those interested, together with illustrations of the apparatus necessary to make the measurements involved.

THE Synthetic Air Chart offers a means of determining the percentage of perfect ventilation by considering all the known factors that make up the air conditions in a room. These factors with their proper weights, experimentally determined, are represented by columns arranged vertically across the chart. The base of each column represents the ideal condition, or 100 per cent perfect. Bordering on either side of the main column are two narrow columns marked “- %” and “+ %.” The former denotes the penalization to be subtracted from the Percent of Perfect Column, and the “+ %” denotes the condition considering only the one particular factor.

The various factors are divided into three groups, which are separated by the double lines. *First*, Wet Bulb Difference which includes Temperature, Humidity, and Air Motion; *second*, Dust, Bacteria, and Odors; *third*, Carbon Dioxide. The latter, although not really a factor, since it is not considered injurious, serves as an index of the amount of air supplied and of the distribution in the room. In addition, columns providing for Other Injurious Substances and for Distributions are given. The upper limit of any of these groups represents the condition where life would cease to exist. Hence at this point the “- %” column would indicate 100 per cent penalization. (Since the upper ends of the columns represent conditions not obtained in practice they are not included on the chart.)

To illustrate the method of graduating the columns, consider the first which is headed Wet Bulb Difference. When at rest with no air motion, the ideal wet bulb temperature is 56 deg. The upper portion of the column represents the unlivable condition which is approximately 106 deg. with 100 per cent humidity or a wet bulb difference of 50 deg. from the ideal. Any variation from 56 deg. would therefore represent a definite percentage of variation from the ideal. The graduations in the other columns were constructed in like manner.

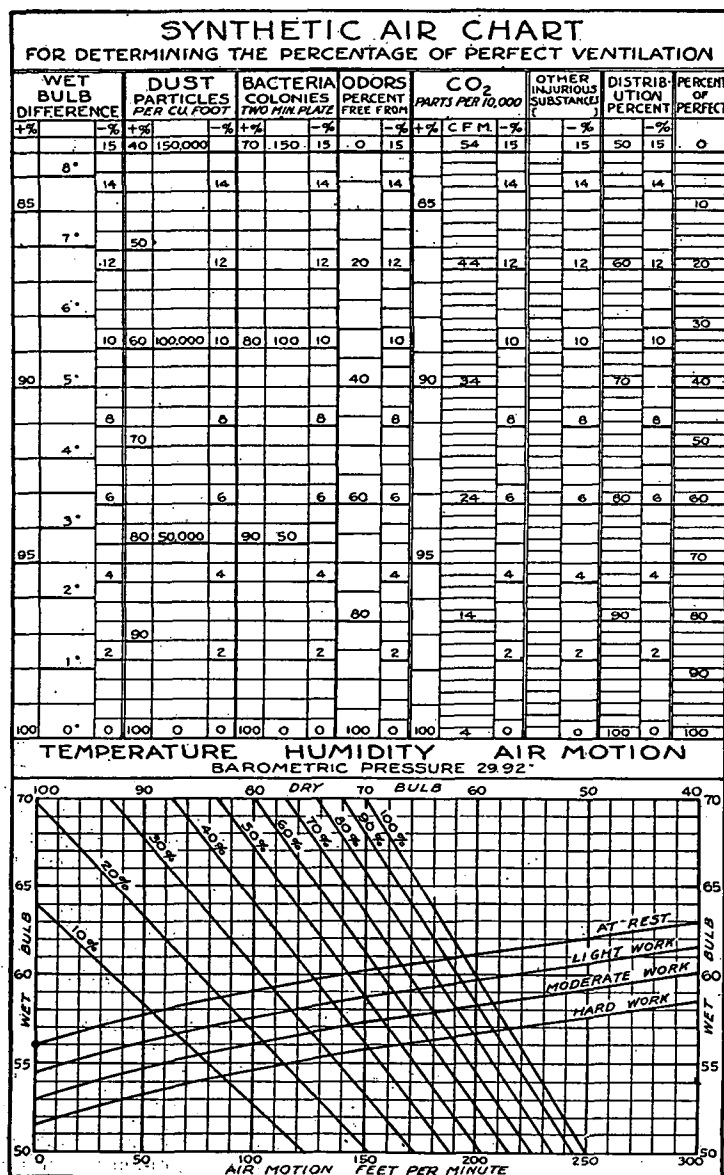


FIG. 55. THE SYNTHETIC AIR CHART

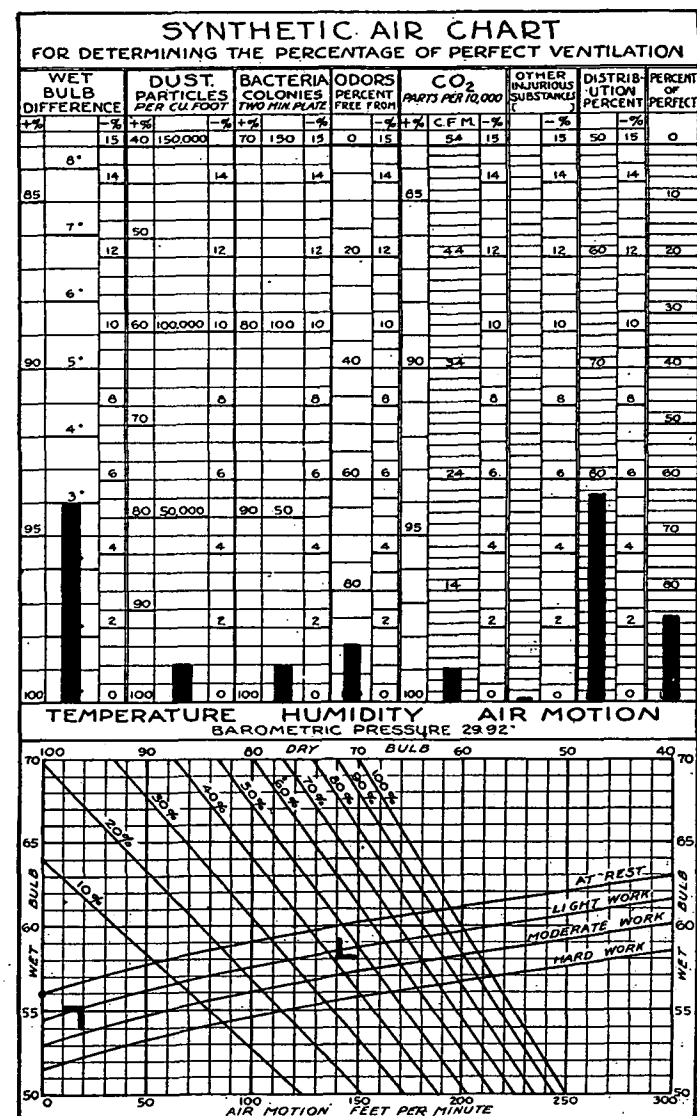


FIG. 56. ILLUSTRATION OF THE USE OF THE SYNTHETIC AIR CHART

After the values of all the factors have been determined by test, the results are shown on the chart by a heavy vertical line ($\frac{1}{8}$ in. wide) and the height of the line will indicate the results obtained in the test. Penalization for all the factors may then be read directly opposite the top of each line. All the “-%’s” are then totaled and the sum subtracted from 100 per cent to determine the Percent of Perfect ventilation for the room as a whole. This result is plotted in the last column headed Percent of Perfect. For example, if the sum of all “-%’s” found in the different columns is $15\frac{3}{8}$ per cent, then the difference between 100 and $15\frac{3}{8}$, or $84\frac{5}{8}$ per cent, is plotted in the last column as the final Percent of Perfect.

TO MAKE THE TEST

Temperature, Humidity, and Air Motion.—Temperatures and humidities shall be determined with a sling psychrometer. The extent and direction of air movement in the room may be determined by observing the velocity of a puff of vapor from an

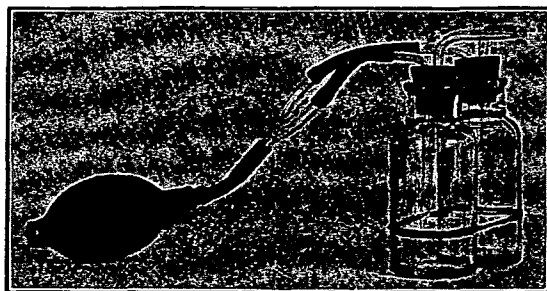


FIG. 57. AMMONIUM-CHLORIDE APPARATUS FOR DETERMINING VELOCITY AND DIRECTION OF AIR CURRENTS

ammonium-chloride apparatus, such as shown in Fig. 57. This apparatus consists of a bottle of hydrochloric acid and a bottle of ammonium chloride, each bottle having a two-holed rubber stopper supplied with bent glass tubing similar to a wash bottle. A small pressure bulb forces the air through the two bottles simultaneously, and when the acid vapors and the ammonium vapors unite, a cloud of ammonium-chloride vapor is formed. This cloud is readily visible and the velocity and direction of the air currents may be studied from it.

Dust.—Dust determinations are made by the use of a direct-counting instrument in which the air is caused to impinge against a cover slip coated with adhesive material. The particles are counted under the microscope and the result placed upon a cubic foot basis. By direct counting is meant a method where the dust particles are studied and counted as they originally existed in the air, and the particles are not broken up or altered in shape, size, or nature by processes of sampling or counting.

Bacteria.—Bacterial determinations shall be made in accordance with the standard adopted by the *American Public Health Association*. Petri dishes 4 in. in diameter (See Fig. 58) containing standard agar, are exposed in the room for 2 min. They are then carefully covered and incubated for 48 hr. at 22 deg. cent. The colonies on the plate are then counted.

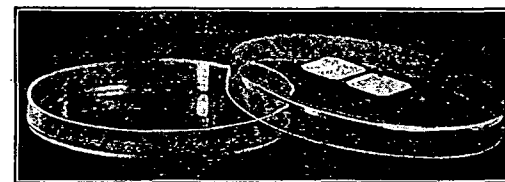


FIG. 58. CULTURE PLATES FOR DETERMINING THE BACTERIA IN AIR

Odors.—Odors shall be determined in accordance with the following rating:

100 per cent freedom from odors.....	Perfect
95 per cent freedom from odors.....	Very faint
90 per cent freedom from odors.....	Faint
85 per cent freedom from odors.....	Noticeable
80 per cent freedom from odors.....	Distinct
75 per cent freedom from odors.....	Decided
70 per cent freedom from odors.....	Strong

The determination shall be made immediately upon going into the room from the outer air.

Carbon Dioxide.—The apparatus necessary to take samples of air for CO_2 determinations consists of a 120 cu. cm. rubber-stoppered bottle and a constant-pressure rubber bulb, as shown in Fig. 59. To take a sample, the rubber tube attached to the bulb is inserted to the bottom of the bottle and held at arm's length so that the sample will not become contaminated by expired air. The tube is closed by compressing it between the

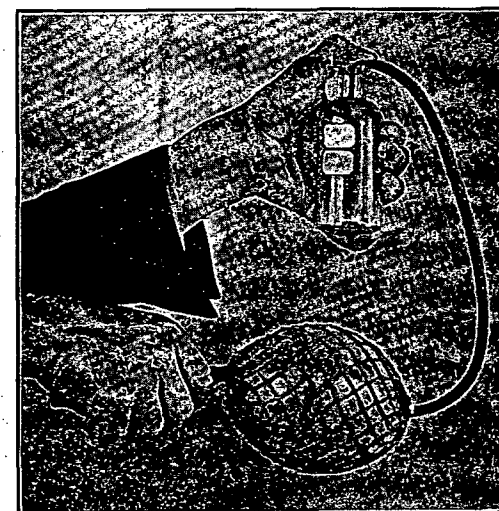


FIG. 59. TAKING AN AIR SAMPLE

thumb and neck of the bottle and the net-covered bulb is filled with air by pressing the uncovered bulb with the hand; the thumb is then released and the intruding air replaces the air originally in the bottle. This operation is repeated three times, after which the tube is removed and the bottle is tightly sealed with a rubber stopper. An analysis of the sample is then made with a Peterson-Palmquist air-analysis instrument, the result being given in parts of CO₂ per 10,000 parts of air.

In the chart in Fig. 60 is shown how the air supply may be determined from the CO₂ readings. Suppose an analysis of the air sample taken in the room shows that the average CO₂ content is 7 parts per 10,000. Then if the outdoor air contains 4 parts per 10,000, the difference is 3 parts. Locate the 3 on the horizontal scale of the chart, and pass vertically up to the curve; from the point of intersection with the curve transverse to the vertical scale which will show that 2,000 cu. ft. of air per hr. per person is being supplied to the room.

Distribution.—The distribution of the air in a room shall be determined from the CO₂ readings taken in the various parts of the room. The following example illustrates the method of calculating the result. Assume four samples taken resulting in the following analysis:

Station	Parts of CO ₂ per 10,000
1	6.4
2	7.4
3	9.2
4	5.0
Average 7.0	

The variation at the various stations above or below the average is as follows:

Station	
1	7.0 - 6.4 = 0.6
2	7.4 - 7.0 = 0.4
3	9.2 - 7.0 = 2.2
4	7.0 - 5.0 = 2.0

Then the average variation from the average CO₂ is determined as follows:

$$\frac{0.6 + 0.4 + 2.2 + 2.0}{4} = 1.3$$

The percentage of variation is therefore equal to $1.3 \div 7.0 = 18.6$ per cent. Therefore the percentage distribution = $100 - 18.6 = 81.4$ per cent.

Other Injurious Substances.—This column is used only in special cases where, owing to the nature of the processes carried on, some particularly injurious substance is being given off to the air. The column is then graduated, consistent with the nature of the substance.

For example, suppose that the contaminating substance is carbon monoxide. Grubner states that symptoms of poisoning are distinct when the air contains 0.02 of one per cent of this gas, and that death ensues in a short time when the air contains 0.05 of one per cent. Whitthaus states that when air containing carbon monoxide is breathed, the body retains about one-half of the gas inhaled. The poison therefore accumulates in the blood, and small amounts in the air may produce death if inhaled over a sufficient period of time. It is apparent therefore for our purpose that the lethal dose of 0.05 of one per cent is too high, and that 0.02 of one per cent, considering the time factor, would be nearer the truth. In arranging our scale in the column headed Other Injurious Substances, we would therefore consider air free from CO as 100 per cent and air containing two parts in 10,000 as 0 per cent, or air containing one part of CO would be 50 per cent, one-half parts, 25 per cent, etc.

For example, if a test is made of the air in a garage or other place where CO is found, and the result shows two parts of CO in 100,000 parts of air, the penalization factor

would be 10 per cent, and this amount would be added to the other minus percentages or penalization factors, and the total subtracted from 100 to obtain the final Percentage of Perfect.

The Comfort Chart.—The interrelation of temperature, humidity, and air motion is shown in the lower portion of the chart. The intersection of the Air Motion line and the Physical State line determines the proper wet bulb temperature. This point should be indicated on the chart by a small angle (thus $\angle$) the apex of the angle coinciding with the point of intersection of the lines. The observed dry bulb and wet bulb is also indicated by an angle (thus $\angle$). The difference between the desirable wet bulb and the observed wet bulb is plotted in the first column of the air chart marked Wet Bulb Difference.

Number and Location of Stations.—The number of stations where samples are to be taken shall be determined from the floor areas in the room. One station should be allowed

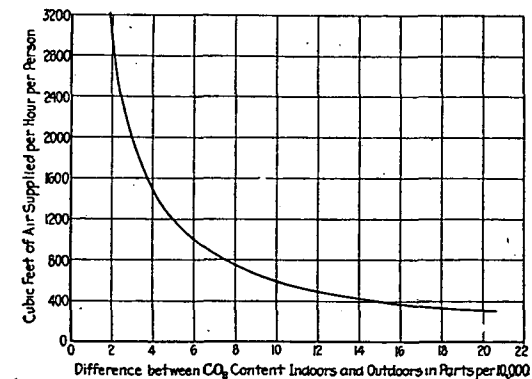


FIG. 60. CURVE TO DETERMINE AIR SUPPLY FROM CO₂ READINGS

for each 200 sq. ft. of floor space. In no case shall less than four samples be taken. The room should be divided equally into imaginary areas and a station located in the center of each area. All samples are to be taken in the breathing zone which is from 2 to 6 ft. from the floor.

RECORDING THE RESULTS

To illustrate the method of determining the Percentage of Perfect Ventilation, consider the results of a test as given below. The average results in a room are found as follows:

Dry Bulb temperature.....	72 deg.
Wet Bulb temperature.....	58 deg.
Air Motion.....	20 ft. per min.
Physical State.....	Light work
Dust.....	10,000 particles per cu. ft.
Bacteria.....	10 colonies on a 2-min. plate
Odors.....	90 per cent free from
CO ₂	7 parts per 10,000
Other injurious substances.....	None
Distribution.....	81.4

These values are now represented on the chart by a $\frac{1}{8}$ -in. vertical line drawn in the center of each of the respective columns. The proper wet-bulb temperature is determined by noting the point of intersection of the "light work line" and the 20-ft. air motion line; this is 55 deg. wet bulb. Since the actual wet-bulb temperature as determined by the test is 58 deg. then the wet bulb difference is 3 deg. This value is plotted in the first column and the penalization as read in the "- %" portion is - 5 $\frac{3}{8}$ per cent. For the 10,000 particles of Dust, the penalization is a - 1 per cent; for the Bacteria, - 1 per cent; for the Odors, - 1 $\frac{1}{2}$ per cent; for the CO₂, - $\frac{1}{8}$ per cent; for Other Injurious Substances, - 0 per cent, and for Distribution, - 5 $\frac{3}{8}$ per cent. The sum of all these penalizations is - 15 $\frac{3}{8}$ per cent. Therefore the Percent of Perfect ventilation in the room is 100 - 15 $\frac{3}{8}$ = 84 $\frac{1}{8}$ per cent. This value is then plotted in the last column marked Percent of Perfect.

CHAPTER XVIII

HOW TEMPERATURE, HUMIDITY AND AIR MOTION AFFECT HUMAN COMFORT

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.

Material for this section was prepared especially for THE GUIDE by F. C. Houghten, New York, N. Y.

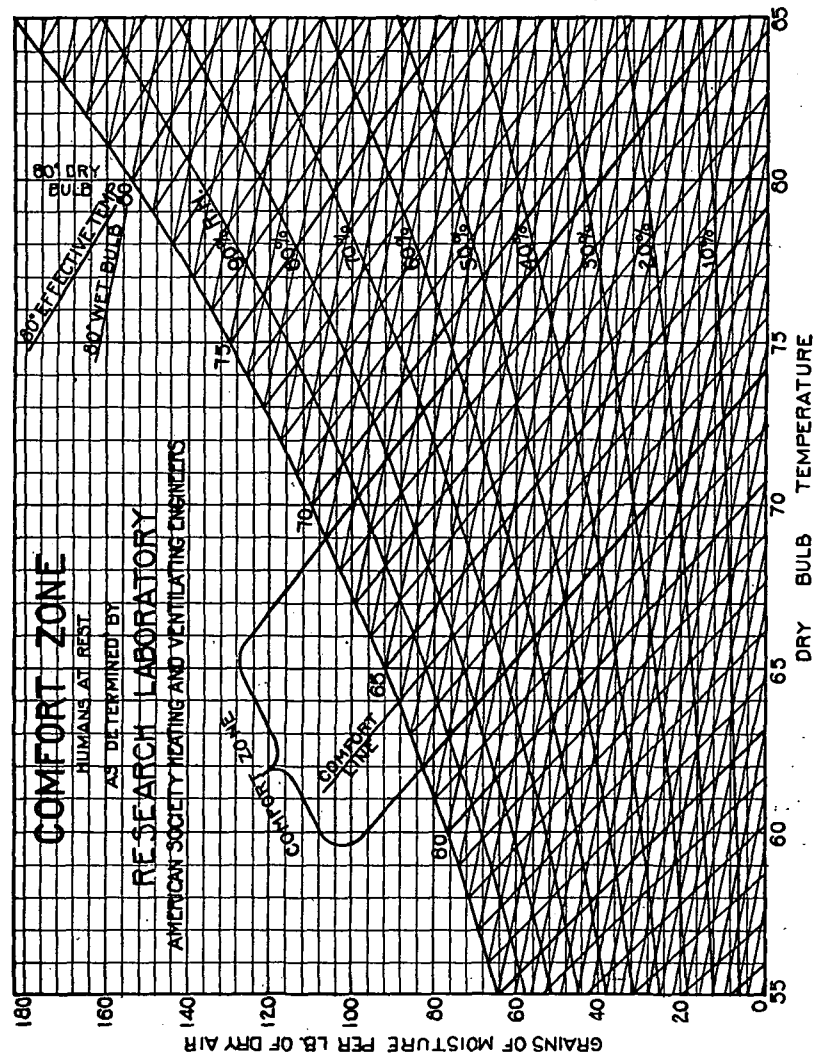


FIG. 61. THE COMFORT CHART FOR HUMANS AT REST

The relation of temperature and humidity to comfort in still air is given in Figs. 61 and 62.

The effect of air motion upon the comfort, or effective temperature lines, is shown in Fig. 63 in which effective temperature lines are given both for still air, and for a velocity of 300 ft. per minute. Data can

FIG. 61. THE COMFORT CHART FOR HUMANS AT REST

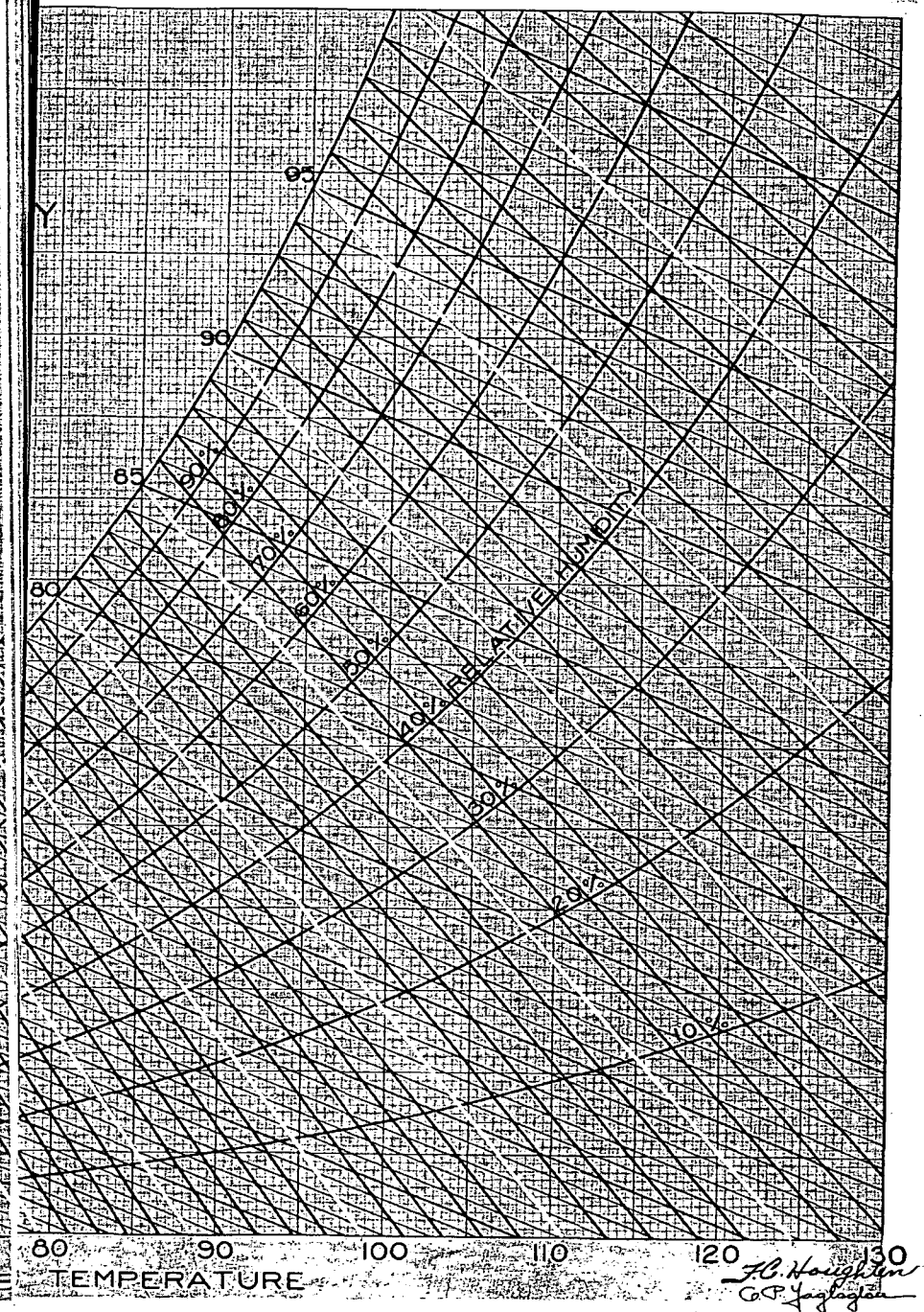
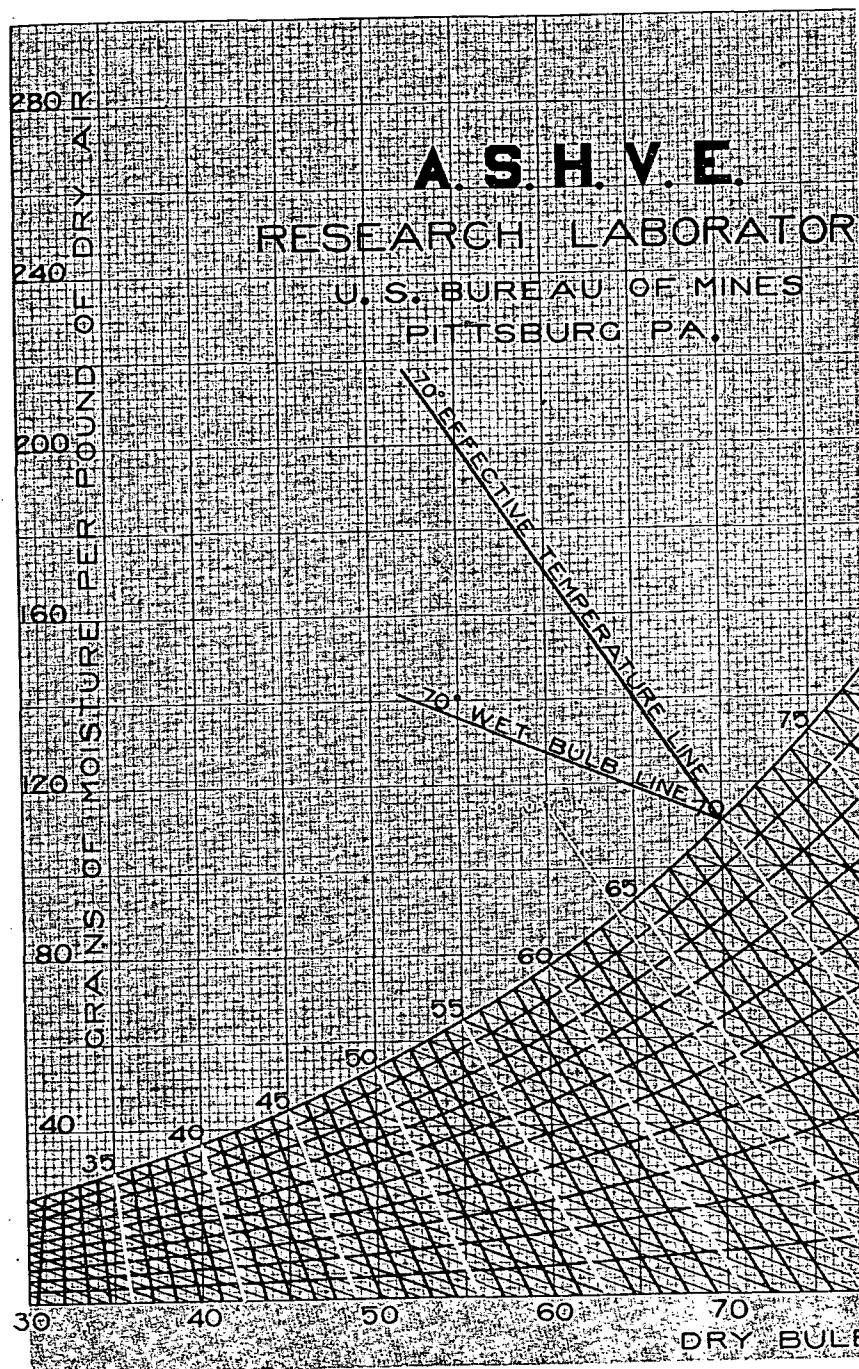


FIG. 62. STANDARD PSYCHROMETRIC CHART WITH EQUAL COMFORT LINES SUPERIMPOSED

better be taken from the Tables 96 to 102, which cover still and various moving air conditions.

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 96 to 102 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

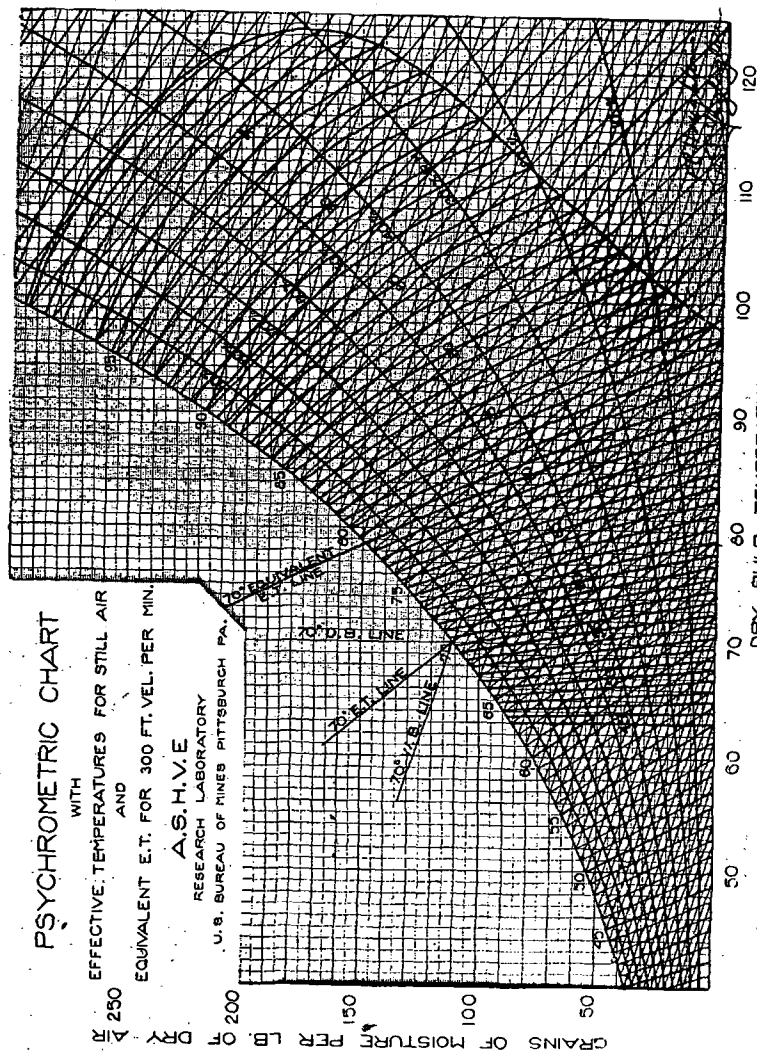


FIG. 63. PSYCHROMETRIC CHART WITH EFFECTIVE TEMPERATURE (FOR STILL AIR) AND EQUIVALENT EFFECTIVE LINES FOR 300 FT. VELOCITY

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 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 96 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 97 to 102 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 99) 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 96 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 100 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 clothing 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.

TABLE 96. RELATION BETWEEN DRY AND WET BULB TEMPERATURES AND EFFECTIVE TEMPERATURE FOR STILL AIR

Dry Bulb Temp.	Wet Bulb Temperature															
	25	30	35	40	45	49	52	54	56	58	60	62	64	66	68	70
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	57.0	58.0	58.7	59.4	60.2	61.1	62.0				
62			54.5	55.8	57.0	58.0	58.7	59.4	60.2	61.1	62.0	63.0	64.0			
64				56.8	58.1	59.0	59.7	60.5	61.3	62.1	63.0	64.0	65.0	66.0		
66				57.9	59.1	60.0	60.8	61.5	62.3	63.1	64.0	65.0	66.0	67.0	68.0	
68				58.9	60.1	61.1	61.8	62.5	63.3	64.1	65.0	66.0	67.0	68.0	69.0	70.0
70				59.9	61.1	62.0	62.7	63.4	64.2	65.1	66.0	66.9	67.8	68.7	69.7	70.7
72				60.9	62.0	63.0	63.7	64.4	65.2	66.0	66.9	67.8	68.7	69.7	70.7	71.8
74					63.9	64.9	65.5	66.2	67.0	67.8	68.6	69.6	70.5	71.5	72.5	73.5
76					64.8	65.7	66.3	67.1	67.9	68.6	69.6	70.4	71.3	72.3	73.3	74.4
78					65.6	66.5	67.2	67.9	68.7	69.5	70.4	71.2	72.1	73.1	74.1	75.2
80						67.8	68.4	69.1	70.0	70.7	71.5	72.4	73.2	74.2	75.2	76.3
83						69.0	69.7	70.3	71.1	71.8	72.6	73.4	74.3	75.3	76.2	77.3
86							71.1	71.8	72.6	73.4	74.1	74.9	75.8	76.7	77.6	78.6
90								73.6	74.3	75.0	75.7	76.6	77.4	78.2	79.1	80.1
95									75.8	76.6	77.3	78.1	78.8	79.7	80.6	81.6
100										78.0	78.7	79.5	80.3	81.1	81.9	82.8
105											80.2	80.7	81.6	82.4	83.3	84.1
110												84.1	84.8	85.6	86.4	87.3
120													88.7	89.3	90.3	91.1
														92.8	93.1	94.2
															95.7	96.7
																98.3
																100.6
																101.3
																102.6

TABLE 97. RELATION BETWEEN DRY AND WET BULB TEMPERATURES AND EFFECTIVE TEMPERATURE FOR 50 FT. AIR VELOCITY

Dry Bulb Temp.	Wet Bulb Temperature															
	25	30	35	40	45	49	52	54	56	58	60	62	64	66	68	70
30																
35	31.7	31.3	31.0													
40	35.9	36.1	36.5	37.2												
45		41.4	41.6	42.2	43.1											
50		45.0	45.3	46.0	46.8	47.6	48.3									
54			47.9	48.8	49.8	50.6	51.1	51.6								
57				50.3	51.2	52.2	52.9	53.5	54.0	54.6	55.4	56.3	57.0	57.8		
60				51.4	52.7	54.0	54.4	55.0	55.5	56.3	57.0	58.4	59.1	60.1	62.4	
62					54.0	55.0	55.7	56.2	56.8	57.6	58.6	59.5	60.3	61.0	62.4	64.7
64					55.0	55.8	57.0	57.3	57.8	58.6	59.5	60.3	61.0	62.4	63.2	64.7
66					56.3	57.4	58.3	58.5	59.4	60.0	60.5	61.4	62.3	63.2	64.0	65.0
68					58.2	59.0	59.7	60.2	60.8	61.5	62.3	63.2	64.0	65.0	66.0	67.1
70					59.5	60.3	61.0	61.5	62.3	62.8	63.6	64.5	65.2	66.0	67.0	68.0
72						61.5	62.0	62.6	63.2	63.7	64.4	65.3	66.0	67.0	68.0	69.3
74						62.7	63.4	64.0	64.4	64.8	65.5	66.3	67.0	68.0	69.0	70.0
76						64.2	64.7	65.2	65.5	65.9	66.5	67.4	68.2	69.1	69.9	71.0
78						65.2	65.7	66.2	66.6	67.3	67.8	68.5	69.5	70.3	71.3	72.4
80							66.6	67.2	67.8	68.6	69.4	70.3	71.0	72.0	73.0	73.9
83							67.8	68.8	69.5	70.3	70.8	71.6	72.4	73.1	74.0	75.0
86								71.5	72.0	72.5	73.0	73.6	74.2	74.9	75.6	76.5
90									74.0	74.5	75.0	75.6	76.2	77.0	77.7	78.5
95										77.3	77.4	77.8	78.3	78.8	79.5	80.4
100											78.5	78.8	79.4	79.8	80.5	81.4
105												80.5	81.4	82.4	83.3	84.8
110													81.7	82.6	83.6	84.5
120														85.0	85.7	86.5
															88.5	89.3
																90.4
																92.5
																95.4
																98.3
																100.4
																101.1
																102.3

TABLE 98. RELATION BETWEEN DRY AND WET BULB TEMPERATURES AND EFFECTIVE TEMPERATURE FOR 100 FT. AIR VELOCITY.

Dry Bulb Temp.	Wet Bulb Temperature															
	25	30	35	40	45	49	52	54	56	58	60	62	64	66	68	70
30																
35																
40																
45																
50	32.2	31.7	31.2	30.7	30.2	29.8	29.4	29.0	28.6	28.2	27.8	27.4	27.0	26.6	26.2	25.8
54	36.9	37.7	38.5	39.3	40.0	40.7	41.4	42.1	42.8	43.5	44.2	44.9	45.6	46.3	47.0	47.7
57	41.6	41.7	41.9	42.3	42.6	43.0	43.4	43.8	44.2	44.6	45.0	45.4	45.8	46.2	46.6	47.0
60																
62																
64																
66																
68																
70																
72																
74																
76																
78																
80																
83																
86																
90																
95																
100																
105																
110																
120																

TABLE 99. RELATION BETWEEN DRY AND WET BULB TEMPERATURES AND EFFECTIVE TEMPERATURE FOR 200 FT. AIR VELOCITY.

Dry Bulb Temp.	Wet Bulb Temperature															
	25	30	35	40	45	49	52	54	56	58	60	62	64	66	68	70
30																
35																
40																
45																
50																
54																
57																
60																
62																
66																
68																
70																
72																
74																
76																
78																
80																
83																
86																
90																
95																
100																
105																
110																
120																

TABLE 100. RELATION BETWEEN DRY AND WET BULB TEMPERATURES AND EFFECTIVE TEMPERATURE FOR 300 FT. AIR VELOCITY

Dry Bulb Temp.	Wet Bulb Temperature															
	25	30	35	40	45	49	52	54	56	58	60	62	64	66	68	70
30																
35																
40																
45																
50																
54																
57																
62																
64																
66																
68																
70																
72																
74																
76																
78																
80																
83																
86																
90																
95																
100																
105																
110																
120																

TABLE 101. RELATION BETWEEN DRY AND WET BULB TEMPERATURES AND EFFECTIVE TEMPERATURE FOR 500 FT. AIR VELOCITY

Dry Bulb Temp.	Wet Bulb Temperature															
	25	30	35	40	45	49	52	54	56	58	60	62	64	66	68	70
30																
35																
40																
45																
50																
57																
60																
62																
64																
66																
68																
70																
72																
74																
76																
78																
80																
83																
86																
90																
95																
100																
105																
110																
120																

TABLE 102. RELATION BETWEEN DRY AND WET BULB TEMPERATURES AND EFFECTIVE TEMPERATURE FOR 700 FT. AIR VELOCITY

Dry Bulb Temp.	Wet Bulb Temperature												Effective Temperature											
	25	30	35	40	45	49	52	54	56	58	60	62	64	66	68	70	72	74	77	80	85	90	95	100
30																								
35																								
40																								
45																								
50																								
54																								
57																								
60																								
62																								
64																								
66																								
68																								
70																								
72																								
74																								
76																								
78																								
80																								
83																								
86																								
90																								
95																								
100																								
105																								
110																								
120																								

CHAPTER XIX

AIR WASHERS AND FILTERS

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 so 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 humidifying 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 humidification above that required for heating the air. The following Table 103 gives the heat required from various outside entering wet bulb temperatures to various dew point temperatures corresponding to a relative humidity of 70 deg.

TABLE 103. 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 humidifying 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 humidifying efficiency, or the percentage of reduction in the initial wet bulb depression without external alteration of heating the circulating water.

CHAPTER XX

AIR CONDITIONING

INTRODUCTION

IT seems that the logical exposition of this subject is the one which most clearly can show the attitude of those expert in it. Like all of the sciences, of which this is surely one, it is made up in its entirety of two parts: *the first*, which is the basis of course, is composed of the fundamental principles and laws, the mathematics, graphs and tables; *the second*, is the application of the science to industry, which constitutes, its reason for existing. It has been demonstrated so many times that the science of air conditioning has many ramifications, each of which has its governing law possible of explanation and mathematically reducible to visible and (to the initiated) easily legible chart and table. The development of each of such underlying principles may be made the subject of an article such as this, and at its conclusion the reader will know—only that single phase. The subject should, however, as far as general interest is concerned, be developed from the second rather than the first of the divisions of the science; that is, from its economic side. Only in this way can a general survey be made and an understanding of the value to industry be obtained.

RANKS AS AN IMPORTANT INDUSTRIAL SCIENCE

It may be well to point out here, how essentially an industrial science air conditioning is; being recognized by, and having its great usefulness, through its effects—and not through the means whereby such effects are obtained. So the expert, knowing the principles and the apparatus, and having the background of industrial experience, solves each problem as it is presented, not as a new engineering development painstakingly to be worked out step by step, but surely and accurately—secure in the knowledge that such a treatment of air must, and unfailingly will, produce such an effect upon the material or process under consideration. In the face of such sureness of *effect*, what interest attaches to the means used, in comparison? For it is as true as in manufacturing, in the final analysis, that the finished product is the thing; the ultimate purchaser does not care what the raw materials, or what the process through which they travel. So in this case, not even the delivered *manufactured* air is the goal, but only the materials and the processes as they are changed, modified or varied, by the primary effects of the controlled climate or weather by which they are surrounded.

Material for this section was prepared especially for THE GUIDE by A. M. Lissauer, Louisville, Ky.

DEFINITION OF AIR CONDITIONING

It would seem, therefore, that a logical definition for air conditioning from this standpoint, to act as a foundation for further enlargement on the subject, would be as follows: *The obtaining of pre-determined effects upon material, persons or air in an enclosure, by treating them with atmospheric air whose temperature, moisture content, relative humidity or purity, singly or in any combination, are under control.*

An analysis of this definition may indicate the real importance of this science. Prior definitions and, it may be said, the term "air conditioning" itself, deem to have circumscribed and clouded it. It has always been the tendency of lay engineers to assume, partially due to the name with which the science has been christened, that the ultimate object was to control the heat and moisture of air, as much for its own sake as for any other. It seems, today, that only the expert industrial conditioning engineer visualizes the subject in its broadest sense and sees the treatment of the air as only the means to an end; he, only, realizes it to be a necessary step in a process whose object is not the functioning of a scientific toy, but a real industrial triumph measurable in dollars and cents. The manufacturer and his advisory engineers, educated as they have been on the basis of the narrower definition, for considering air conditioning, cannot be blamed when proposing it for the factory, as a luxury. Presented to them as a means of obtaining a new or a more perfect product, or of eliminating a stumbling block in the way of progress, the reaction is dramatically opposite, and the proposal is considered in the light of offering a necessity.

How are these valuable reactions in "persons, materials and air" to be obtained? As concerns materials, and by that is meant all solids (and, in special cases, also liquids and gases) which are raw, partially finished or finished materials in industrial manufacture—consider this fact; with few exceptions they all, depending upon the physical characteristics of the surrounding air, vary in moisture content. Furthermore, this variation and moisture content has a specific effect upon the appearance, weight, texture, conductivity, strength and workability of the material. Taking these two facts together then, it is evident that one who knows their interrelation as applying to each specific material, can, by a change in the atmosphere, mold and shape the physical character of the material at will. Such a phenomenon can be understood when a comprehension of the basic principle of the industrial phase of air conditioning is obtained. The law is, that the moisture in the air, varying with its concentration (practically independently of its temperature) exerts a definite pressure; also, that the moisture content in a material exerts a measurable pressure, varying with its concentration and the temperature of the material. When a material is fully immersed in air, there is an immediate tendency for the vapor pressure to equalize; if that of the material is lower, moisture will flow into it—if higher, moisture will flow out of it, until, if time is given, a balance is arrived at. Now, therefore, if the surrounding air is held at a given vapor pressure and temperature, a predetermined moisture content of the material is the inevitable result. The time element enters into this as into all processes, also an unbelievably great background of experimentation; but the basic principle remains simple

and understandable. *Relative humidity*, that one term besides *temperature* which is known to the reading public, is the only measurable condition of the atmosphere, which, being controlled, in turns governs both essentials—absolute moisture and temperature. The fact that there are several different ways of controlling this relative humidity, while interesting to the specialist, is not essential information as far as this exposition is concerned.

In general, as regards people, the phenomena of heating, cooling, high or low relative humidity and purity of air in which they live, have been thoroughly investigated and the results to date cataloged.

The increase in efficiency of workers in an atmosphere of moderate temperature and humidity, over that in extreme heat, cold and moisture,

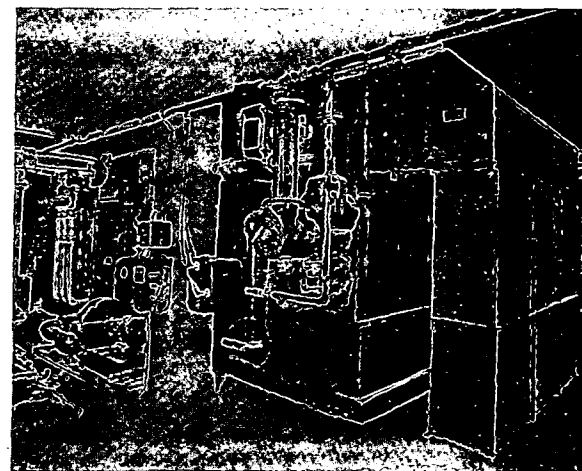


FIG. 64. AIR CONDITIONING PLANT IN CALIFORNIA THEATER

the decrease in sickness and absenteeism, when the workroom atmosphere is pure and fresh, are too well known to require more than mention here. Every one has, on himself, noted the effects of the extremes of the seasons and needs no more than a reminder to recall them. A committee of this Society, and several distinguished members, have presented reports and papers on the subject—figures are available for proof that comfort of workers is a practical consideration in industry, showing monetary dividends, whether the conditioning is primarily for the workers' benefit or has these advantages to add as a by-product to those arising from an installation made for other purposes.

The effect on air, other than that which has undergone specific treatment, may be taken to be the third important function of air conditioning, either when considered alone or in combination with the hydro-metric treatment of materials. Any drying system in which the drying air is recirculated and mixed continuously with air pretreated for the

purpose of controlling its physical characteristics comes under this classification.

Who has not seen, or at least heard, of the steam filled rooms in drying establishments, paper and textile mills, whose atmosphere is cleared by the introduction of volumes of air pretreated to dissolve the clouds of free vapor. Such effects cannot be produced economically and surely by rule of thumb methods.

It is true that such a broad field claimed for air conditioning may be the subject of criticism from general heating and ventilating engineers, those to whom custom has given jurisdiction over steamfitting and plumbing as well as the ventilation, as such, of dwellings, schools and theaters. It would seem, however, that engineers whose lives are devoted to the discovery and application, scientifically, of the basic principles of psychrometry, whose elaborate and skillfully trained organizations of specialists have no other reason for existing than the design and building of apparatus assemblies for clothing in material form the results of their accurate calculations, and whose whole wide experience makes possible the only logical basis for selling—the guaranteeing of results, unquestionably should be the ones to include in their field any types of air systems which include air treatments as defined heretofore. No vapor absorption or drying installation, no evaporative cooling or water spray air cleansing system, can be dignified as an air engineering problem until the same meticulous care and attention to detail are devoted to them, as to what has heretofore been considered true air conditioning.

Now, having set forth the bill of particulars establishing air conditioning as a science embracing a great field, it might be interesting to make a rapid survey of some of the high spots which may act as beacons to those whose interest in the subject is not wholly academic.

AIR CONDITIONING IN TEXTILE INDUSTRY

Strange to say, that industry which today is, as a whole, the most enthusiastic subscriber to the benefits which air conditioning offers, was the first to realize them and to take steps to secure, crudely, it is true, at the time, all the good that climate could offer. The textile industry, founded and carefully developed in the most consistently damp and even temperatured parts of the British Isles, prospered and became famous to a great extent because of the uniformity of quality of product. This high quality and its practically unvarying standard was to no small extent due to climatic conditions, as they influenced the moisture regain of the material in process. Even there, however, at some seasons the natural moisture was not sufficient or the natural temperature too high. Quickly the manufacturers seized upon and put into effect weird and wonderful schemes, from drenching floors to steam jets and water pans, with which to let them muddle through. The American manufacturer, however, far more progressive, is not tied down to locality in order to secure an approximately ideal and equable climate; other and now more important considerations may be made paramount, and the desired product of uniform standard every day is secured by air conditioning. It may, today, be stated almost as an axiom that the modern progressive

textile mill in this country would about as soon leave off its roof as to omit its air conditioning equipment.

Humidifying as a study necessarily was developed first, as the textile field offered the most fertile and profitable ground for this work; subsequently followed such other industries as that of printing and lithographing, where constant regain meant constant paper stretch and perfect registering of multicolor impressions. Consider how the addition and regulation of moisture in air has affected the manufacturer of macaroni, the oxidation of paint and varnish coats in the automobile, furniture and piano industries, the perfecting of the bread we eat and the milling of the flour from which it is made, the enamelware field, and the innumerable scientific drying processes for handling materials from garbage to bricks. All of these and many more have their individual problem,



FIG. 65. CHOCOLATE DIPPING ROOM OF MIDDLE WESTERN CANDY FACTORY

thought unsolvable until the adaptation of manufactured weather proved science again able to do the impossible.

Sometimes the summer weather or its equivalent in the factory is the stumbling block—high temperatures, high humidities, excessive regains. However, if weather is at fault, then in its controlled state it can be made to undo its harmful work. So developed dehumidifying: the abstraction of excess moisture from air, fitting it to reduce the moisture contents of material, when put to work at moderate temperatures. In other words, reducing the moisture contents of the air so far that its vapor pressure would be lower than that of the material exposed to it, even though the temperature of that material were lower than the ordinary seasonal temperature. Take hard candy, for instance. This cooked sugar, in an amorphous state, cooling in the usual summer weather, absorbs water just like any other material; given enough time, the clear, hard, compact mass forms a solid solution with the absorbed water, and the sugar slowly but surely crystallizes out as it was before the cooking. Cool the same

candy in air deprived of its excess vapor and winter time quality is obtained. Many other processes in the candy factory—the chocolate dipping and packing, the starch and storage rooms, gain by the use of cold, dry air.

DEHUMIDIFYING

As with its ally, humidifying, dehumidifying serves a long list of industries. The bakery, for the unvarying temperatures in its dough rooms, the cooling of the loaves, the cooling of mixers, the drying of biscuit with confectionary coatings, the chilling of storage rooms, needs air conditioning to insure mass quality production. The manufacturers of artificial silk and pearls would be at a standstill without dehumidified air, the motion picture film and photographic paper industries would be shut down a third of the year without it. The drying of fine gelatin, the summer growth of mushrooms, the year-round production of yeast, the storage of furs moth-free, the wartime products of time-fuses and airplane parts, the making of rubber gloves and automobile tires, the drying and handling of matches, are a few among the notable dependents of this science. To this list can be added dozens more, each reader being able to recognize some. The test is: when the products or processes due to the weather, on any day or during any season, are not up to standard, the need for air conditioning is established.

The science has been carried in some few cases even beyond the service of specific processes in certain industries. Even Nature has been assisted; witness the infant incubators; note also the methods developed by the specialists for crowding into successive units of time, the sequence of ideal conditions so often interrupted in Nature as to take months and years for completion of the natural processes. Such refining of process has been worked out successfully for such widely separated items as the curing of tobacco and the drying of lumber. The effects of manufactured weather, eliminating the interruptions of Nature, has opened such a broad field that by comparison the one heretofore claimed for this science is almost infinitesimal.

So we have defined the term and have illustrated its meaning as we understand it. If an idea of the immense usefulness of this science to industry has been given, and if an understanding that it can only be scientifically applied by the specialist qualified by study, research and experience, has been obtained, then the object of this article has been fully accomplished.

CHAPTER XXI

DESIGN AND CONSTRUCTION OF AIR DUCTS

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. 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 104. 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 105. 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 104.

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 following chart Fig. 66.

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 $\frac{1}{3}$ to $\frac{1}{2}$ and the loss through heater at less than $\frac{1}{2}$ of the total 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.

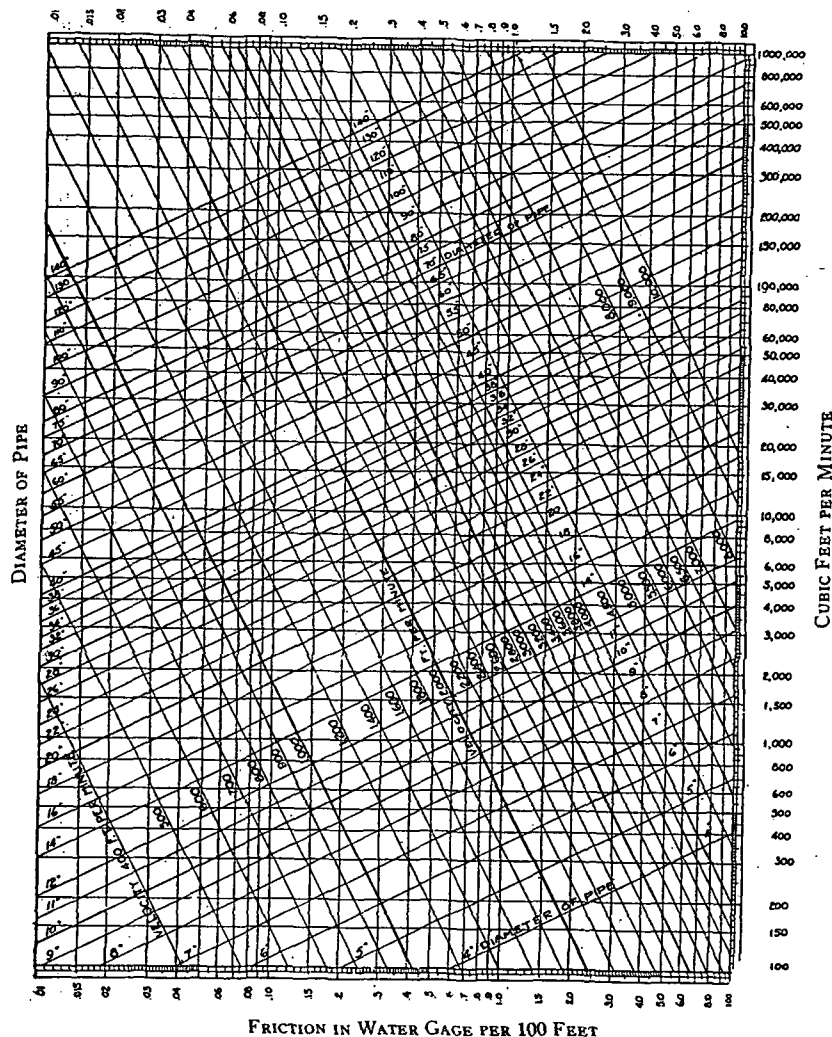


FIG. 66. FRICTION CHART

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: $D = \frac{4WH}{2W + 2H}$, 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:

$$D = \frac{W}{0.79 \sqrt[5]{\left(\frac{W}{H}\right)^2 + \left(\frac{H}{W}\right)^2}}$$

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 $\frac{1}{8}$ 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.

CHAPTER XXII

HOW TO USE THE PITOT TUBE

THE Committee rendered a careful report which included two tables and a list of references on the theory of the Pitot tube and the derivation of formulae. An extract from the report is given below.

The reading should be taken at a cross section where the pipe is straight and the flow undisturbed. This should be preferably at least 10 diameters from the fan outlet, from an elbow, or from a change in cross section in the duct. The readings should be taken over a plane at right angles to, and the tube should be pointed in a direction parallel to, the direction of the air flow.

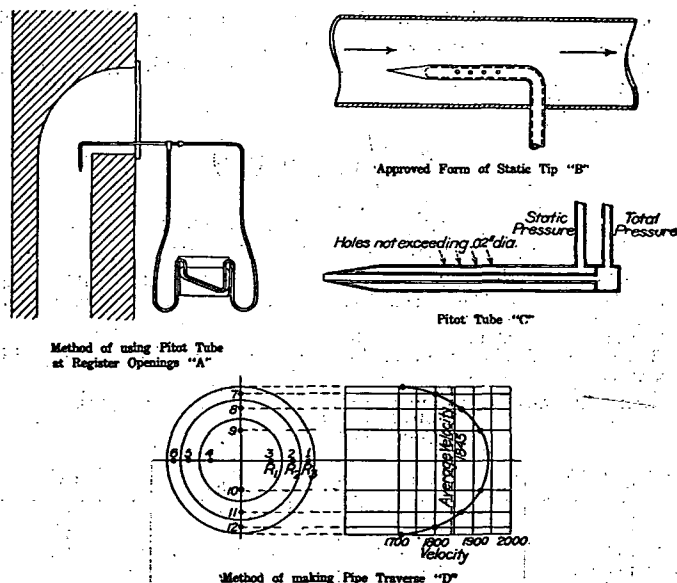


FIG. 67. STANDARD METHOD OF USING PITOT TUBE

The most difficult reading to take accurately in a current of air is the static pressure. The approved form of static tip shown by Fig. 67, diagram B, is the form recommended for fan-testing work. There should be eight or more clean holes 0.02 in. in diameter, an equal number on each side of a $\frac{1}{4}$ -in. tube $\frac{1}{16}$ -in. thick. The most approved form of Pitot tube combines the foregoing static tip with an impact tube as shown by diagram C, by means of which total, static, or velocity pressure may be read.

From Report of Committee on Standardization of the Use of the Pitot Tube, A. S. H. V. E. TRANSACTIONS, Vol. XX, 1914.

AMERICAN SOCIETY OF HEATING and VENTILATING ENGINEERS GUIDE, 1924-25

In making a traverse of a rectangular duct, the cross sectional area may be divided into a number of smaller rectangles and a reading taken in the center of each small rectangle.

A round pipe should be divided into at least three concentric zones of equal area *per foot in diameter* and four readings taken on a circle drawn through the center of area of each zone or ring.

That is, readings should be taken across the horizontal and vertical axis of the pipe as shown on diagram D. The location of these points from the center is shown together with the accompanying Table 106, which gives the distance from the center of the pipe to point of reading, expressed in per cent of the pipe diameter.

To get exact results a small pipe should be divided into more zones than a pipe of larger diameter, as the ratio of frictional surface to cross sectional area is greater, hence the more static pressure in proportion to the impact pressure, which correspondingly reduces the velocity pressure.

The corresponding velocities for each of these readings should be determined and an average taken of all of these velocities in order to compute the air quantity. *Inasmuch as the velocity varies as the square root of the pressure, accurate results cannot be obtained by averaging the pressure readings and taking the corresponding velocity as the average.*

TABLE 106. PIPE TRAVERSE FOR PITOT TUBE READINGS

Distance from Center of Pipe to Point of Reading in Per Cent of Pipe Diameter

NO. OF EQUAL AREAS IN TRAVERSE	NO. OF READ- INGS	1ST R ₁	2ND R ₂	3RD R ₃	4TH R ₄	5TH R ₅	6TH R ₆	7TH R ₇	8TH R ₈
3	12	20.4	35.3	45.5					
4	16	17.7	30.5	39.4	46.6				
5	20	15.5	27.2	35.3	41.7	47.4			
6	24	14.5	25.0	32.3	38.2	43.3	47.9		
7	28	13.4	23.1	29.9	35.3	40.1	44.3	48.2	
8	32	12.5	21.6	28.0	33.2	37.6	41.5	45.1	48.4

The velocity may be determined from the velocity pressure by use of the formula,

$$v = 1096.5 \sqrt{\frac{P}{W}}$$

v = velocity in ft. per min.

P = pressure in in. of water.

W = weight of air in lb. per cu. ft. under the existing conditions of temperature, barometer and humidity.

With dry air at 70 deg. and 29.92 in. barometer,

$W = 0.0749$ whence the formula becomes

$$v = 4005 \sqrt{P}$$

With saturated air at 70 deg. and 29.92 in. barometer,

$W = 0.0735$ and

$$v = 4046 \sqrt{P}$$

For dry air at any temperature and pressure,

$$W = \frac{0.0028862B}{1 + 0.0021758T}$$

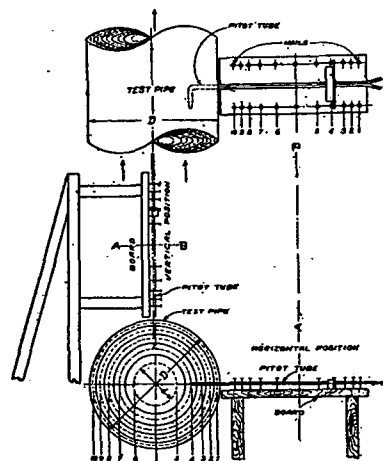


FIG. 68. CONVENIENT METHOD OF CLAMPING PITOT TUBE FOR TEST

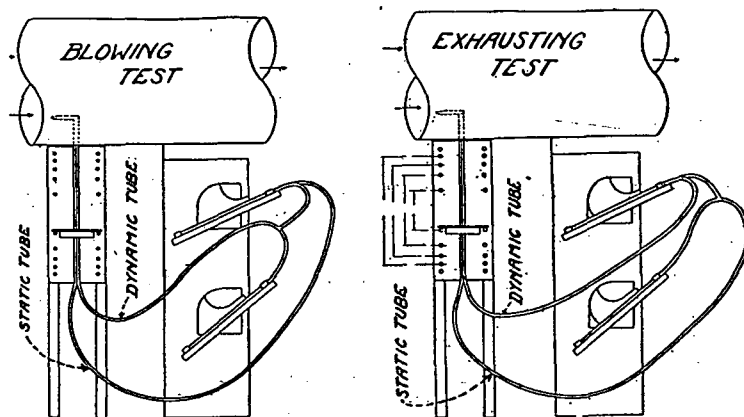


FIG. 69. METHOD OF CONNECTING APPARATUS WHERE STATIC PRESSURE IN DUCT IS BELOW ATMOSPHERE

For moist air:

$$W = \frac{0.0028862B - 0.001088e}{1 + 0.0021758T}$$

where

B = height of barometer in inches of mercury.

T = temperature in deg. fahr.

e = vapor pressure.

(Source—W. H. Carrier.)

Where approximate results only are desired:

For circular pipe, multiply the velocity pressure taken at the center of the pipe by 0.81 or the velocity by 0.91.

For rectangular pipe, no definite factor can be given, which is even approximately correct, that will cover the varying proportions of width to height of the cross sectional area of rectangular ducts.

The Committee recommends the Pitot tube as a simple and convenient instrument for the measurement of air or gases, which, when used with the proper care and accuracy of reading, gives results with an error of less than $1\frac{1}{2}$ per cent with velocity pressure ranging from 0.1 in. upwards.

DIRECTIONS FOR FIELD TESTS WITH THE PITOT TUBE

For the information of those who are not familiar with the use of the Pitot tube, the following explanation is appended by the Guide Publication Committee.

In determining the velocity and pressures of air in ducts by the use of a Pitot Tube, a hole must be punched in the duct preferably at least 10 diameters of the duct from the fan inlet or outlet or from an elbow or change in cross section of the duct. For ordinary determinations, this hole should be made at the center of the top or bottom of the duct and made just large enough to admit the Pitot tube. Where great accuracy is desired or where it is necessary to make readings close to the fan outlet or to elbows, both horizontal and vertical readings should be made.

In order to make readings at the points in the duct indicated in Table 106, in the above report, it will be found convenient to clamp the Pitot tube in a block as indicated in Fig. 68 and construct a board with nails or pegs inserted so as to hold the tube at the desired points.

For measuring pressures exceeding 1 in., the ordinary manometer is sufficiently accurate. However, in ventilation systems, where the velocity pressure is usually below 1 in. the inclined manometer containing gasoline, usually colored for convenience in reading, will be found most convenient and accurate. Inclined manometers can be obtained with either a fixed inclination or constructed so that various inclinations for different ranges of pressure may be obtained. The latter will be found more convenient and accurate for general field use as they are so constructed that they may be mounted on a tripod or on any vertical or horizontal support.

Having mounted the Pitot tube and manometers as indicated in Fig. 69, it is usually the practice to connect them by means of rubber tubing, special care being taken to have air-tight connections. This can be tested by blowing into the tube and then closing the openings in the tube with the fingers and observing any drop in the manometer. If a noticeable drop occurs, it indicates loose connections.

When a static pressure above atmospheric exists in the duct, the manometers and Pitot tube should be connected as shown in diagram for blowing tests. The upper manometer which is connected both to the dynamic and static tubes will record the difference or velocity pressure, while the lower manometer which is connected only to the dynamic tube, will record the dynamic pressure. Both of these readings will

be positive. The static pressure can be obtained by subtracting the velocity pressure from the dynamic pressure.

In making a test where the static pressure within the duct is below that of the atmosphere, connect apparatus as shown for exhausting test in Fig. 69. The upper manometer will record the velocity pressure which will be positive, while the lower manometer will record static pressure which will be negative.

As stated in the above report, for accuracy the velocity corresponding to each reading should be calculated separately and then the velocities should be averaged. However, for field work, if the readings are taken at the positions shown in the centers of the rings or circles of equal area, there will be no appreciable error if the readings are averaged and the velocity computed on the mean.

Corrections must be made for the specific gravity of the gasoline and the inclination of the manometer.

Example.—In a blowing test conducted as here outlined, using a manometer inclined 1 to 10 for the velocity reading, and using colored gasoline with a specific gravity of 0.74, a reading of one inch was observed. The air was practically dry at 120 deg. Fahr., barometer at 30 in. The equivalent inches of water will be $1 \times 1/10 \times 0.74$ or 0.074 inches of water. The weight of the air will be

$$W = \frac{0.0028862 \times 30}{1 + 0.0021758 \times 120} = 0.0687$$

then

$$v = 1096.5 \sqrt{\frac{0.074}{0.0687}}$$

$$v = 1140 \text{ ft. per minute.}$$

CHAPTER XXIII

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.

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



FIG. 70. HEAT AND VAPORS FROM IRONING OPERATIONS IN LAUNDRY REMOVED BY EXHAUST SYSTEM

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 107 to 109, 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.

TABLE 107. 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 108. 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

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.

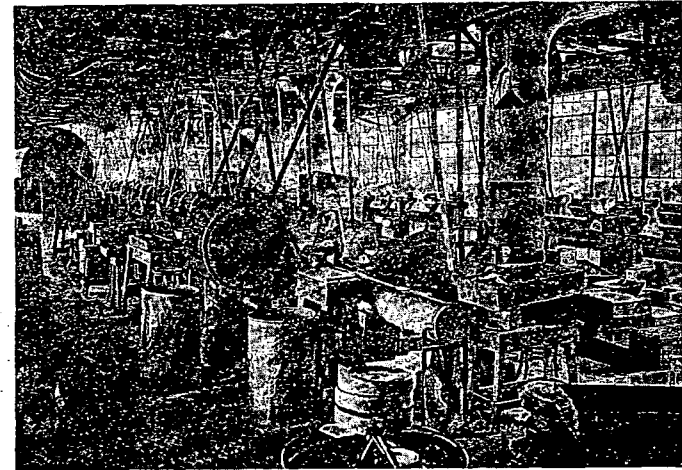


FIG. 71. EXHAUST AND CONVEYING SYSTEM HANDLES WASTE FROM WOOD-WORKING MACHINES

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.

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.

TABLE 109. 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

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.

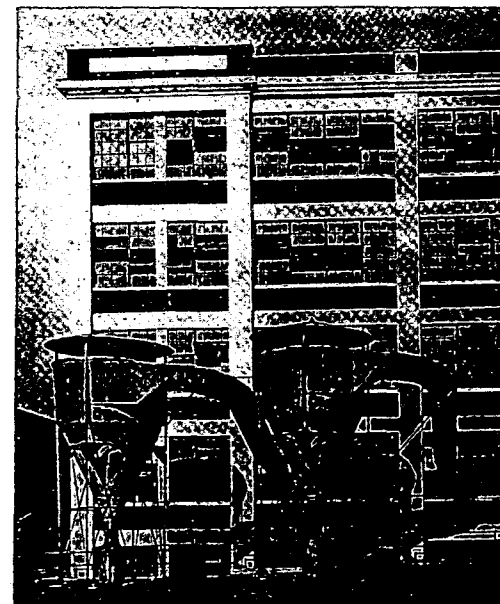


FIG. 72. COLLECTORS ON ROOF OF NEW JERSEY PIANO FACTORY

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 110. The sum of all these volumes gives the total volume to be handled by the exhaust fan.

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.

TABLE 110. 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

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 furthest from the fan. The friction drop for these sections can be determined by reference to Table 111. Total friction loss in the piping system is the friction drop in furthest

TABLE 111. 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.

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.

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.

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 possible.

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 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 XXIV

REFRIGERATION

REFRIGERATION may be accomplished mechanically, as in the case of anhydrous ammonia, sulphur dioxide, carbon dioxide, ethyl chloride, etc., or chemically by the use of aqueous ammonia, known as the absorption system.

In the use of mechanical refrigeration in the United States anhydrous ammonia is the most popular refrigerant. Authorities estimate that anywhere from 95 to 98 per cent is accomplished by this method.

The ammonia in the form of vapor is drawn from the cooling pipes located in the cold storage rooms or brine tank through a pipe line called the suction line by the action of the compressor. It is then converted into a super-heated gas and discharged from the compressor through a line called the pipe line into the ammonia condenser. The gas as it enters the condenser is quite hot and contains heat generated by compression as well as heat taken from the goods in storage. In the condenser the gas is cooled by the use of water and converted into ammonia liquid under pressures which vary according to the temperature of the cooling water. The ammonia liquid is then condensed under the pressure of the condenser and the cooling pipes in the storage rooms or brine tanks as the case may be, where it is expanded into the cooling pipes, reducing the pressure as the volume increases. The liquid ammonia at the reduced pressure boils inside of the cooling pipes at a low temperature and thereby produces the desired cooling effect in the space surrounded by the cooling pipes. As the ammonia boils it is again converted into a vapor and drawn back to the compressor through the suction line. This completes the cycle of operation.

CONDENSERS

Condensers are classified in practically three classes: *atmospheric*, *double pipe*, and *submerged*.

The atmospheric condenser consists of a coil of pipe standing vertically with a water distributing trough over the top pipe, the ammonia is on the inside of the pipe. The water running down over the outside of the condenser, condenses the ammonia on the inside of the pipe. Most atmospheric condensers are constructed of 2-in. pipe. Atmospheric condensers must be placed in open places where the outside air has free access to the same, preferably the roof of a building.

Double pipe condensers consists of two concentric pipes also in the form of a coil, the inner pipe containing the water and the surrounding or outer pipe the ammonia. Most double pipe ammonia condensers consist of 2-in. for the outer pipe and 1½-in. for the inner pipe, although some condensers have been made of 2½-in. and 1½-in. pipes, and some of 3-in. and 2-in. pipes.

Material for this section was prepared especially for THE GUIDE by Lee Nusbaum, Philadelphia, Pa.

TABLE 112. CUBIC INCHES OF AMMONIA VAPOR TO BE CIRCULATED TO PRODUCE ONE TON OF REFRIGERATION IN TWENTY-FOUR HOURS

CONDENSER PRESSURE		Gage	AMMONIA VAPOR IN CUBIC FEET PER MINUTE													
Temperature of Liquid			TEMP. OF SUCTION	TEMP. OF SUCTION												
Abs.				Abs.												
Temperature of Liquid				95	110	125	140	155	170	185	200	215	230	245		
91° F.				109.7	124.7	139.7	154.7	169.7	184.7	199.7	214.7	229.7	244.7	259.7		
108° F.				109.7	124.7	139.7	154.7	169.7	184.7	199.7	214.7	229.7	244.7	259.7		
108° F.				109.7	124.7	139.7	154.7	169.7	184.7	199.7	214.7	229.7	244.7	259.7		
108° F.				109.7	124.7	139.7	154.7	169.7	184.7	199.7	214.7	229.7	244.7	259.7		
108° F.				109.7	124.7	139.7	154.7	169.7	184.7	199.7	214.7	229.7	244.7	259.7		
108° F.				109.7	124.7	139.7	154.7	169.7	184.7	199.7	214.7	229.7	244.7	259.7		
108° F.				109.7	124.7	139.7	154.7	169.7	184.7	199.7	214.7	229.7	244.7	259.7		
108° F.				109.7	124.7	139.7	154.7	169.7	184.7	199.7	214.7	229.7	244.7	259.7		
108° F.				109.7	124.7	139.7	154.7	169.7	184.7	199.7	214.7	229.7	244.7	259.7		
108° F.				109.7	124.7	139.7	154.7	169.7	184.7	199.7	214.7	229.7	244.7	259.7		
108° F.				109.7	124.7	139.7	154.7	169.7	184.7	199.7	214.7	229.7	244.7	259.7		
108° F.				109.7	124.7	139.7	154.7	169.7	184.7	199.7	214.7	229.7	244.7	259.7		
108° F.				109.7	124.7	139.7	154.7	169.7	184.7	199.7	214.7	229.7	244.7	259.7		
108° F.				109.7	124.7	139.7	154.7	169.7	184.7	199.7	214.7	229.7	244.7	259.7		
108° F.				109.7	124.7	139.7	154.7	169.7	184.7	199.7	214.7	229.7	244.7	259.7		
108° F.				109.7	124.7	139.7	154.7	169.7	184.7	199.7	214.7	229.7	244.7	259.7		
108° F.				109.7	124.7	139.7	154.7	169.7	184.7	199.7	214.7	229.7	244.7	259.7		
108° F.				109.7	124.7	139.7	154.7	169.7	184.7	199.7	214.7	229.7	244.7	259.7		
108° F.				109.7	124.7	139.7	154.7	169.7	184.7	199.7	214.7	229.7	244.7	259.7		
108° F.				109.7	124.7	139.7	154.7	169.7	184.7	199.7	214.7	229.7	244.7	259.7		
108° F.				109.7	124.7	139.7	154.7	169.7	184.7	199.7	214.7	229.7	244.7	259.7		
108° F.				109.7	124.7	139.7	154.7	169.7	184.7	199.7	214.7	229.7	244.7	259.7		
108° F.				109.7	124.7	139.7	154.7	169.7	184.7	199.7	214.7	229.7	244.7	259.7		
108° F.				109.7	124.7	139.7	154.7	169.7	184.7	199.7	214.7	229.7	244.7	259.7		
108° F.				109.7	124.7	139.7	154.7	169.7	184.7	199.7	214.7	229.7	244.7	259.7		
108° F.				109.7	124.7	139.7	154.7	169.7	184.7	199.7	214.7	229.7	244.7	259.7		
108° F.				109.7	124.7	139.7	154.7	169.7	184.7	199.7	214.7	229.7	244.7	259.7		
108° F.				109.7	124.7	139.7	154.7	169.7	184.7	199.7	214.7	229.7	244.7	259.7		
108° F.				109.7	124.7	139.7	154.7	169.7	184.7	199.7	214.7	229.7	244.7	259.7		
108° F.				109.7	124.7	139.7	154.7	169.7	184.7	199.7	214.7	229.7	244.7	259.7		
108° F.				109.7	124.7	139.7	154.7	169.7	184.7	199.7	214.7	229.7	244.7	259.7		
108° F.				109.7	124.7	139.7	154.7	169.7	184.7	199.7	214.7	229.7	244.7	259.7		
108° F.				109.7	124.7	139.7	154.7	169.7	184.7	199.7	214.7	229.7	244.7	259.7		
108° F.				109.7	124.7	139.7	154.7	169.7	184.7	199.7	214.7	229.7	244.7	259.7		
108° F.				109.7	124.7	139.7	154.7	169.7	184.7	199.7	214.7	229.7	244.7	259.7		
108° F.				109.7	124.7	139.7	154.7	169.7	184.7	199.7	214.7	229.7	244.7	259.7		
108° F.				109.7	124.7	139.7	154.7	169.7	184.7	199.7	214.7	229.7	244.7	259.7		
108° F.				109.7	124.7	139.7	154.7	169.7	184.7	199.7	214.7	229.7	244.7	259.7		
108° F.				109.7	124.7	139.7	154.7	169.7	184.7	199.7	214.7	229.7	244.7	259.7		
108° F.				109.7	124.7	139.7	154.7	169.7	184.7	199.7	214.7	229.7	244.7	259.7		
108° F.				109.7	124.7	139.7	154.7	169.7	184.7	199.7	214.7	229.7	244.7	259.7		
108° F.				109.7	124.7	139.7	154.7	169.7	184.7	199.7	214.7	229.7	244.7	259.7		
108° F.				109.7	124.7	139.7	154.7	169.7	184.7	199.7	214.7	229.7	244.7	259.7		
108° F.				109.7	124.7	139.7	154.7	169.7	184.7	199.7	214.7	229.7	244.7	259.7		
108° F.				109.7	124.7	139.7	154.7	169.7	184.7	199.7	214.7	229.7	244.7	259.7		
108° F.				109.7	124.7	139.7	154.7	169.7	184.7	199.7	214.7	229.7	244.7	259.7		
108° F.				109.7	124.7	139.7	154.7	169.7	184.7	199.7	214.7	229.7	244.7	259.7		
108° F.				109.7	124.7	139.7	154.7	169.7	184.7	199.7	214.7	229.7	244.7	259.7		
108° F.				109.7	124.7	139.7	154.7	169.7	184.7	199.7	214.7	229.7	244.7	259.7		
108° F.				109.7	124.7	139.7	154.7	169.7	184.7	199.7	214.7	229.7	244.7	259.7		
108° F.				109.7	124.7	139.7	154.7	169.7	184.7	199.7	214.7	229.7	244.7	259.7		
108° F.				109.7	124.7	139.7	154.7	169.7	184.7	199.7	214.7	229.7	244.7	259.7		
108° F.				109.7	124.7	139.7	154.7	169.7	184.7	199.7	214.7	229.7	244.7	259.7		
108° F.				109.7	124.7	139.7	154.7	169.7	184.7	199.7	214.7	229.7	244.7	259.7		
108° F.				109.7	124.7	139.7	154.7	169.7	184.7	199.7	214.7	229.7	244.7	259.7		
108° F.				109.7	124.7	139.7	154.7	169.7	184.7	199.7	214.7	229.7	244.7	259.7		
108° F.				109.7	124.7	139.7	154.7	169.7	184.7	199.7	214.7	229.7	244.7	259.7		
108° F.				109.7	124.7	139.7	154.7	169.7	184.7	199.7	214.7	229.7	244.7	259.7		
108° F.				109.7	124.7	139.7	154.7	169.7	184.7	199.7	214.7	229.7	244.7	259.7		
108° F.				109.7	124.7	139.7	154.7	169.7	184.7	199.7	214.7	229.7	244.7	259.7		
108° F.				109.7	124.7	139.7	154.7	169.7	184.7	199.7	214.7	229.7	244.7	259.7		
108° F.				109.7	124.7	139.7	154.7	169.7	184.7	199.7	214.7	229.7	244.7	259.7		
108° F.				109.7	124.7											

Some of the advantages of the double pipe condenser are that it may be placed near the other apparatus and does not have to be placed outside as in the case of the atmospheric condenser. Further, on the double pipe condenser the cold water enters on the bottom and meets the liquid ammonia, sending the liquid ammonia away much cooler than in the case of the atmospheric condenser, where the hot water comes in contact with the liquid ammonia.

When an atmospheric condenser is worn out it must be entirely scrapped, while in a double pipe condenser, the water pipes, which are the only pipes to deteriorate can easily be replaced. Another advantage of the double pipe type is that it is easily cleaned by a spiral tube cleaner, while it is a much more tedious and uncertain job to clean the outside of the atmospheric condenser. The submerged condenser consisting of a tank containing water in which a coil conveying the ammonia is submerged is seldom used now.

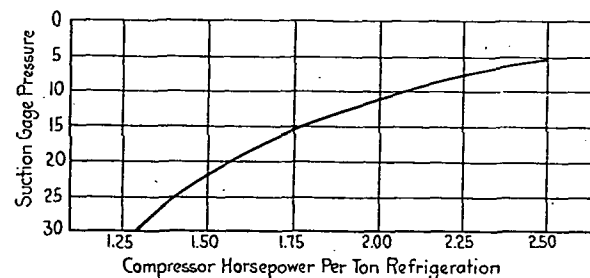


FIG. 73. RELATIVE HORSE-POWER CONSUMPTION AT VARIOUS BACK PRESSURES

The capacity of an ammonia compressor is governed mostly by the pressure of the ammonia gas, or vapor entering it. The higher the pressure the heavier the ammonia and consequently more pounds of ammonia will be pumped through the system per stroke of the compressor. The refrigeration accomplished is directly proportioned to the pounds of ammonia circulated in a given time. The higher the suction or inlet pressure the greater will be the refrigerating capacity of that plant. Roughly about 0.43 lb. of ammonia must be circulated through the system per minute per ton of refrigeration.

When cooling and holding products in a room, the temperature at which they must be held will be determined largely by the nature of the goods Table 116. The circulating ammonia must be several degrees lower in temperature than the room. Ammonia at any stated temperature has a relative pressure which would consequently be the pressure of the ammonia entering the compressor and would therefore govern the capacity of it. It is desirable, from the power consumption basis, to operate the compressor with the highest possible back pressure, but this hardly ever exceeds 40-lb. gage pressure. Fig. 73 shows the relative horse-power consumption at various back pressures. This curve based upon averages and practical installations might deviate somewhat.

TABLE 113. PROPERTIES OF SODIUM CHLORIDE BRINE

SALT REQUIRED		FREEZING POINT		AMMONIA SUC. PRES.		DEGREES SALOMETER at 60° F.	DEGREES BAUME at 60° F.	SPECIFIC GRAVITY AT 60° F.	SPECIFIC HEAT	PER CENT OF SALT BY WEIGHT
Pounds per Gal.	Pounds per Cu. Ft.	Degrees Fahrenheit	Degrees Centigrade	At Freezing Point of Brine	At 5° Above Freezing Point of Brine					
0.084	0.63	+30.5	-0.8	45.0#	52.0#	4	1.0	1.007	0.992	1.0
0.099	0.74	+29.3	-1.5	43.5	50.0	8	2.0	1.016	0.984	2.5
0.212	1.58	+28.6	-1.9	43.0	48.0	10	3.0	1.019	0.979	3.0
0.266	1.92	+27.8	-2.3	42.0	46.5	12	4.0	1.023	0.972	3.5
0.300	2.24	+27.1	-2.7	41.0	45.0	14	5.0	1.028	0.968	4.0
0.344	2.57	+26.6	-3.0	40.5	43.5	16	6.0	1.030	0.960	5.0
0.433	3.24	+25.2	-3.8	38.5	44.5	20	6.5	1.037	0.946	7.0
0.522	3.92	+23.9	-4.5	37.5	43.5	24	9.5	1.045	0.946	7.0
0.617	4.63	+22.5	-4.7	36.0	41.5	28	10.0	1.053	0.939	8.0
0.708	5.30	+21.2	-5.3	34.0	40.0	32	9.7	1.063	0.905	10.0
0.802	6.00	+19.9	-6.7	33.0	38.5	36	10.7	1.078	0.892	10.0
0.897	6.70	+18.7	-7.4	31.5	37.0	40	12.6	1.091	0.874	12.0
1.082	8.20	+16.0	-8.9	29.0	34.0	48	15.7	1.116	0.855	15.0
1.268	10.40	+12.2	-11.0	25.0	30.0	60	20.4	1.155	0.795	20.0
1.458	12.40	+6.1	-14.7	20.0	24.0	80	24.0	1.196	0.753	24.0
1.650	14.40	+1.2	-16.5	16.0	20.0	96	25.8	1.204	0.771	26.0
1.848	16.40	+0.5	-17.3	15.5	19.6	100	25.8	1.204	0.771	26.0
2.048	18.40	-1.1	-18.2	15.5	19.6	100	25.8	1.204	0.771	26.0
2.250	20.40	-1.7	-19.1	15.5	19.6	100	25.8	1.204	0.771	26.0
2.458	22.40	-2.4	-20.1	15.5	19.6	100	25.8	1.204	0.771	26.0
2.610	24.40	-3.1	-21.0	15.5	19.6	100	25.8	1.204	0.771	26.0
2.810	26.40	-3.8	-22.2	15.5	19.6	100	25.8	1.204	0.771	26.0
3.010	28.40	-4.5	-23.5	15.5	19.6	100	25.8	1.204	0.771	26.0
3.210	30.40	-5.2	-24.8	15.5	19.6	100	25.8	1.204	0.771	26.0
3.410	32.40	-6.0	-26.1	15.5	19.6	100	25.8	1.204	0.771	26.0
3.610	34.40	-6.8	-27.4	15.5	19.6	100	25.8	1.204	0.771	26.0
3.810	36.40	-7.6	-28.7	15.5	19.6	100	25.8	1.204	0.771	26.0
4.010	38.40	-8.4	-30.0	15.5	19.6	100	25.8	1.204	0.771	26.0
4.210	40.40	-9.2	-31.3	15.5	19.6	100	25.8	1.204	0.771	26.0
4.410	42.40	-10.0	-32.6	15.5	19.6	100	25.8	1.204	0.771	26.0
4.610	44.40	-10.8	-33.8	15.5	19.6	100	25.8	1.204	0.771	26.0
4.810	46.40	-11.6	-35.1	15.5	19.6	100	25.8	1.204	0.771	26.0
5.010	48.40	-12.4	-36.3	15.5	19.6	100	25.8	1.204	0.771	26.0
5.210	50.40	-13.2	-37.6	15.5	19.6	100	25.8	1.204	0.771	26.0
5.410	52.40	-14.0	-38.9	15.5	19.6	100	25.8	1.204	0.771	26.0
5.610	54.40	-14.8	-40.2	15.5	19.6	100	25.8	1.204	0.771	26.0
5.810	56.40	-15.6	-41.5	15.5	19.6	100	25.8	1.204	0.771	26.0
6.010	58.40	-16.4	-42.8	15.5	19.6	100	25.8	1.204	0.771	26.0
6.210	60.40	-17.2	-44.1	15.5	19.6	100	25.8	1.204	0.771	26.0
6.410	62.40	-18.0	-45.4	15.5	19.6	100	25.8	1.204	0.771	26.0
6.610	64.40	-18.8	-46.7	15.5	19.6	100	25.8	1.204	0.771	26.0
6.810	66.40	-19.6	-48.0	15.5	19.6	100	25.8	1.204	0.771	26.0
7.010	68.40	-20.4	-49.3	15.5	19.6	100	25.8	1.204	0.771	26.0
7.210	70.40	-21.2	-50.6	15.5	19.6	100	25.8	1.204	0.771	26.0
7.410	72.40	-22.0	-51.9	15.5	19.6	100	25.8	1.204	0.771	26.0
7.610	74.40	-22.8	-53.2	15.5	19.6	100	25.8	1.204	0.771	26.0
7.810	76.40	-23.6	-54.5	15.5	19.6	100	25.8	1.204	0.771	26.0
8.010	78.40	-24.4	-55.8	15.5	19.6	100	25.8	1.204	0.771	26.0
8.210	80.40	-25.2	-57.1	15.5	19.6	100	25.8	1.204	0.771	26.0
8.410	82.40	-26.0	-58.4	15.5	19.6	100	25.8	1.204	0.771	26.0
8.610	84.40	-26.8	-59.7	15.5	19.6	100	25.8	1.204	0.771	26.0
8.810	86.40	-27.6	-61.0	15.5	19.6	100	25.8	1.204	0.771	26.0
9.010	88.40	-28.4	-62.3	15.5	19.6	100	25.8	1.204	0.771	26.0
9.210	90.40	-29.2	-63.6	15.5	19.6	100	25.8	1.204	0.771	26.0
9.410	92.40	-30.0	-64.9	15.5	19.6	100	25.8	1.204	0.771	26.0
9.610	94.40	-30.8	-66.2	15.5	19.6	100	25.8	1.204	0.771	26.0
9.810	96.40	-31.6	-67.5	15.5	19.6	100	25.8	1.204	0.771	26.0
10.010	98.40	-32.4	-68.8	15.5	19.6	100	25.8	1.204	0.771	26.0
10.210	100.40	-33.2	-70.1	15.5	19.6	100	25.8	1.204	0.771	26.0
10.410	102.40	-34.0	-71.4	15.5	19.6	100	25.8	1.204	0.771	26.0
10.610	104.40	-34.8	-72.7	15.5	19.6	100	25.8	1.204	0.771	26.0
10.810	106.40	-35.6	-74.0	15.5	19.6	100	25.8	1.204	0.771	26.0
11.010	108.40	-36.4	-75.3	15.5	19.6	100	25.8	1.204	0.771	26.0
11.210	110.40	-37.2	-76.6	15.5	19.6	100	25.8	1.204	0.771	26.0
11.410	112.40	-38.0	-77.9	15.5	19.6	100	25.8	1.204	0.771	26.0
11.610	114.40	-38.8	-79.2	15.5	19.6	100	25.8	1.204	0.771	26.0
11.810	116.40	-39.6	-80.5	15.5	19.6	100	25.8	1.204	0.771	26.0
12.010	118.40	-40.4	-81.8	15.5	19.6	100	25.8	1.204	0.771	26.0
12.210	120.40	-41.2	-83.1	15.5	19.6	100	25.8	1.204	0.771	26.0
12.410	122.40	-42.0	-84.4	15.5	19.6	100	25.8	1.204	0.771	26.0
12.610	124.40	-42.8	-85.7	15.5	19.6	100	25.8	1.204	0.771	26.0
12.810	126.40	-43.6	-87.0	15.5	19.6	100	25.8	1.204	0.771	26.0
13.010	128.40	-44.4	-88.3	15.5	19.6	100	25.8	1.204	0.771	26.0
13.210	130.40	-45.2	-89.6	15.5	19.6	100	25.8	1.204	0.771	26.0
13.410	132.40	-46.0	-90.9	15.5	19.6	100	25.8	1.204	0.771	26.0
13.610	134.40	-46.8	-92.2	15.5	19.6	100	25.8	1.204	0.771	26.0
13.810	136.40	-47.6	-93.5	15.5	19.6	100	25.8	1.204	0.771	26.0
14.010	138.40	-48.4	-94.8	15.5	19.6	100	25.8	1.204	0.771	26.0
14.210	140.40	-49.2	-96.1	15.5	19.6	100	25.8	1.204	0.771	26.0
14.410	142.40	-50.0	-97.4	15.5	19.6	100	25.8	1.204	0.771	26.0
14.610	144.40	-50.8	-98.7	15.5	19.6	100	25.8	1.204	0.771	26.0
14.810	146.40	-51.6	-100.0	15.5	19.6	100	25.8	1.204	0.771	26.0
15.010	148.40	-52.4	-101.3	15.5	19.6	100	25.8	1.204	0.771	26.0
15.210	150.40	-53.2	-102.6	15.5	19.6	100	25.8	1.204	0.771	26.0
15.410	152.40	-54.0	-103.9	15.5	19.6	100	25.8	1.204	0.771	26.0
15.610	154.40	-54.8	-105.2	15.5	19.6	100	25.8	1.204	0.771	26.0
15.810	156.40	-55.6	-106.5	15.5	19.6	100	25.8	1.204	0.771	26.0
16.010	158.40	-56.4	-107.8	15.5	19.6	100	25.8	1.204	0.771	26.0
16.210	160.40	-57.2	-109.1	15.5	19.6	100	25.8	1.204	0.771	26.0
16.410	162.40	-58.0	-110.4	15.5	19.6	100	25.8	1.204	0.771	26.0
16.610	164.40	-58.8	-111.7	15.5	19.6	100	25.8	1.204	0.771	26.0
16.810	166.40	-59.6	-113.0	15.5	19.6	100	25.8	1.204	0.771	26.0
17.010	168.40	-60.4	-114.3	15.5	19.6	100	25.8	1.204	0.771	26.0
17.210	170.40	-61.2	-115.6	15.5	19.6	100	25.8	1.204	0.771	26.0
17.410	172.40	-62.0	-116.9	15.5	19.6	100	25.8	1.204	0.771	26.0
17.610	174.40	-62.8	-118.2	15.5	19.6	100	25.8	1.204	0.771	26.0
17.810	176.40	-63.6	-119.5	15.5	19.6	100	25.8	1.204	0.771	26.0
18.010	178.40	-64.4	-120.8	15.5	19.6	100	25.8	1.204	0.771	26.0
18.210	180.40	-65.2	-122.1	15.5	19.6	100	25.8	1.204	0.771	26.0
18.410	182.40	-66.0	-123.4	15.5	19.6	100	25.8	1.204	0.771	26.0
18.610	184.40	-66.8	-124.7	15.5	19.6	100	25.8	1.204	0.771	26.0
18.810	186.40	-67.6	-126.0	15.5	19.6	100	25.8	1.204	0.771	26.0
19.010	188.40	-68.4	-127.3	15.5	19.6	100	25.8	1.204	0.771	26.0
19.210	190.40	-69.2	-128.6	15.5	19.6	100	25.8	1.204	0.771	26.0
19.410	192.40	-70.0	-129.9	15.5	19.6	100	25.8	1.204	0.771	26.0
19.610	194.40	-70.8	-131.2	15.5	19.6	100	25.8	1.204	0.771	26.0
19.810	196.40	-71.6	-132.5	15.5	19.6	100	25.8	1.204	0.771	26.0
20.010	198.40	-72.4	-133.8	15.5	19.6	100	25.8	1.204	0.771	26.0
20.210	200.40	-73.2	-135.1	15.5	19.6	100	25.8	1.204	0.771	26.0
20.410	202.40	-74.0	-136.4	15.5	19.6	100	25.8	1.204		

TABLE 115. COLD STORAGE PIPING
Ratio of Cubic Feet of Room Space to One Lineal Foot of Various Size Ammonia and Brine Pipe

Cubic Feet of Space Per Cool	TEMP. 45° F.				TEMP. 40° F.				TEMP. 35° F.				TEMP. 30° F.				TEMP. 25° F.			
	Cu. Ft. to 1 Ft. of Pipe				Cu. Ft. to 1 Ft. of Pipe				Cu. Ft. to 1 Ft. of Pipe				Cu. Ft. to 1 Ft. of Pipe				Cu. Ft. to 1 Ft. of Pipe			
	DI. Ex.		Brine		DI. Ex.		Brine		DI. Ex.		Brine		DI. Ex.		Brine		DI. Ex.		Brine	
	1" 1/4"	2"	1" 1/4"	2"	1" 1/4"	2"	1" 1/4"	2"	1" 1/4"	2"	1" 1/4"	2"	1" 1/4"	2"	1" 1/4"	2"	1" 1/4"	2"	1" 1/4"	2"
12	100	3.4	5.8	2.8	4.6	150	3.5	2.5	4.1	140	2.7	4.3	2.2	3.4	130	2.8	2.9	2.9	1.7	2.4
20	220	3.5	5.9	2.9	4.7	200	3.1	5.1	2.6	4.1	180	2.8	4.4	2.3	3.5	160	2.4	3.6	1.7	2.5
50	320	3.6	6.1	3.1	4.8	300	3.2	5.2	2.7	4.2	270	2.9	4.5	2.4	3.6	250	2.5	3.7	1.8	2.6
100	700	3.8	6.3	3.3	5.1	600	3.4	5.5	2.8	4.4	500	3.1	4.7	2.5	3.8	400	2.7	3.9	1.9	2.7
250	1075	7.2	7.2	5.5	5.5	1000	6.3	6.3	4.8	4.8	925	5.4	4.1	4.1	850	4.5	3.4	3.4	2.9	2.9
500	1550	8.6	8.6	6.4	6.4	1500	7.5	7.5	5.6	5.6	1450	6.5	4.8	4.8	1400	5.4	4.4	4.4	3.4	3.4
1000	2250	9.8	9.8	7.4	7.4	2000	8.7	8.7	6.4	6.4	1750	7.6	5.5	5.5	1550	6.5	4.5	4.5	3.8	3.8
3000	3250	11.1	11.1	8.5	8.5	3000	10.1	10.1	7.3	7.3	2750	8.3	6.2	6.2	2500	7.5	5.8	5.8	4.2	4.2
5000	4250	14.1	14.1	11.1	11.1	4000	12.1	12.1	9.1	9.1	3750	11.1	7.5	7.5	3500	9.1	6.9	6.9	5.7	5.7
10000	5250	17.1	17.1	13.1	13.1	6000	15.1	15.1	11.1	11.1	5500	13.1	9.1	9.1	5000	11.1	8.9	8.9	7.3	7.3
20000	6250	21.1	21.1	16.1	16.1	8000	18.1	18.1	12.1	12.1	7500	16.1	10.1	10.1	7000	12.1	10.1	10.1	8.3	8.3
40000	7250	23.1	23.1	18.1	18.1	10000	20.1	20.1	14.1	14.1	9500	18.1	12.1	12.1	9000	14.1	12.1	12.1	9.3	9.3
70000	8750	29.1	29.1	24.1	24.1	15000	25.1	25.1	17.1	17.1	14000	22.1	15.1	15.1	13000	18.1	16.1	16.1	11.1	11.1
100000	10250	35.1	35.1	29.1	29.1	20000	30.1	30.1	20.1	20.1	18500	27.1	17.1	17.1	17500	20.1	18.1	18.1	12.1	12.1

TABLE 116. COLD STORAGE TEMPERATURES

ARTICLES	Deg. Fahr.	ARTICLES	Deg. Fahr.
FRUIT		LIQUIDS	
Apples.....	32-36	Beer, Ale, Porter, etc.....	33
Bananas.....	60	Cider.....	30
Berries, Fresh.....	36	Ginger Ale.....	36
Cranberries.....	33-36	Wines.....	40
Cantaloupes.....	40	Champagne.....	25-30
Dates, Figs, etc.....	50-55	FLOUR AND MEAL	
Fruits, Dried.....	35-40	Buckwheat Flour.....	36-40
Grapes.....	34-36	Corn Meal.....	36-40
Lemons.....	33-36	Oat Meal.....	36-40
Oranges.....	34-36	Wheat Flour.....	36-40
Peaches.....	34-36	VEGETABLES	
Pears.....	34-36	Asparagus.....	34-35
Watermelons.....	34-36	Cabbage.....	34-35
MEATS		Carrots.....	34-35
Brined.....	38	Celery.....	34-35
Beef, Fresh.....	33	Dried Beans.....	32-40
Beef, Dried.....	36-40	Dried Corn.....	35
Calves.....	32-33	Dried Peas.....	35-40
Hams, Ribs, Shoulders.....	20	Onions.....	36
Hogs.....	29-32	Parsnips.....	34-35
Lard.....	38	Potatoes.....	36-40
Livers.....	20-30	Sauerkraut.....	35
Sheep, Lambs.....	32	MISCELLANEOUS	
Ox-Tails.....	30	Cigars, Tobacco.....	35
Sausage Casings.....	20	Furs, Woolens, etc.....	35
Tenderloin, Butts, etc.....	33	Honey.....	45
FISH		Hops.....	40
Fresh Fish.....	20	Maple Syrup, Sugar.....	40
Dried Fish.....	36	Oils.....	35
Oysters in Shell.....	30-35	Poultry, Dressed, Iced.....	28-30
Oysters in Tub.....	25	Poultry, Dry Picked.....	26-28
CANNED GOODS		Poultry, Scalded.....	20
Sardines.....	35-40	Game, To Freeze.....	10-15
Fruits.....	35-40	Game, After Frozen.....	25-28
Meats.....	35-40	Poultry, To Freeze.....	10-15
BUTTER, EGGS, ETC.		Poultry, After Frozen.....	25-28
Butter.....	15	Nuts, in Shell.....	35-40
Butterine.....	15	Chestnuts.....	33
Cheese.....	34		
Eggs.....	31		

TABLE 117. FREEZING TIME IN HOURS TO FREEZE CAN OF ICE

TEMP. OF BRINE	WIDTH OF CAN								
	4"	5"	6"	7"	8"	9"	10"	11"	12"
10°	5.10	8.00	11.5	15.6	20.4	25.8	31.8	38.5	45.8
12°	5.60	8.75	12.6	17.3	22.4	28.4	35.0	42.3	50.4
14°	6.22	9.70	14.0	19.0	25.0	31.5	39.0	47.0	56.0
16°	7.00	11.00	15.8	21.5	28.0	35.5	43.7	53.0	63.0
18°	8.00	12.50	18.0	24.5	32.0	40.5	50.0	60.5	72.0
20°	9.30	14.60	21.0	28.5	37.3	47.2	58.3	70.5	84.0
22°	11.20	17.50	25.2	34.3	44.8	56.7	70.0	84.7	100.0
24°	14.00	21.00	31.5	42.8	56.0	71.0	87.5	106.0	126.0

Note.—Above table based on ice freezing from four sides. 11-in. can ice will take about 45 to 50 hr. to close, brine at 15.

TABLE 118. PROPERTIES OF VARIOUS FOOD PRODUCTS

SUBSTANCE	COMPOSITION		SPECIFIC HEAT ABOVE FREEZING IN HEAT UNITS	SPECIFIC HEAT BELOW FREEZING IN HEAT UNITS	LATENT HEAT OF FREEZING IN HEAT UNITS
	Water	Solids			
Water.....	.....	.....	1.00	0.50	144
Lean Beef.....	72.00	28.00	0.77	0.41	102
Fat Beef.....	51.00	49.00	0.60	0.34	72
Veal.....	63.00	37.00	0.70	0.39	90
Fat Pork.....	39.00	61.00	0.51	0.30	55
Eggs.....	70.00	30.00	0.76	0.40	100
Potatoes.....	74.00	26.00	0.80	0.42	105
Cabbage.....	91.00	9.00	0.93	0.48	129
Carrots.....	83.00	17.00	0.87	0.45	118
Milk.....	87.50	12.50	0.90	0.47	124
Oysters.....	80.38	19.62	0.84	0.44	114
White Fish.....	78.00	22.00	0.82	0.43	111
Eels.....	62.07	37.93	0.69	0.38	88
Lobster.....	76.62	23.38	0.81	0.42	108
Pigeon.....	72.40	27.60	0.78	0.41	102
Chicken.....	73.70	26.30	0.80	0.42	105
Ice Cream.....	.....	.....	0.80	.....	88
Wines.....	.....	.....	0.90	.....	.....

CHAPTER XXV

VENTILATORS AND NATURAL VENTILATION

OF the two methods of ventilating available, namely by mechanical means, and by the so-called natural forces, the latter 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 whatsoever, in such a manner as to assist and increase ventilation. Occasionally 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 comparison of this item is impossible.)

What is generally desired more specifically 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 outlet.

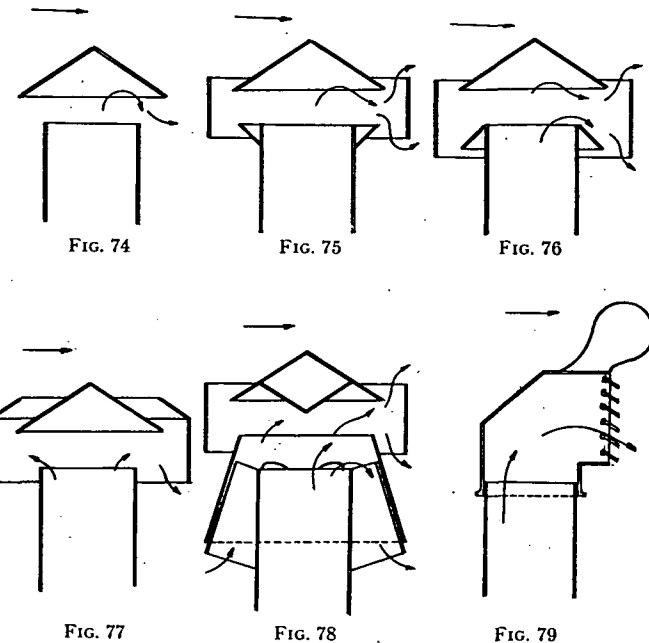
The simplest form of ventilator, shown in Fig. 74, consists of an outlet pipe with a conical hood above it. The addition of a storm band, as shown in Figs. 75, 76 and 77, gives an increased protection against the entrance of rain or snow. The storm band, if placed so close to the cones as to restrict 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. 78, in which siphons or ducts are introduced for the particular purpose of producing suction.

In the swiveling or rotary ventilators, typified by Figs. 79 and 80, 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. 81, 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



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. 82, is shown a rotary or air-turbine ventilator, which rotates continuously 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.

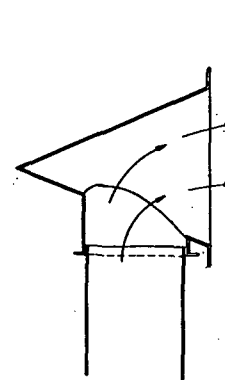


FIG. 80

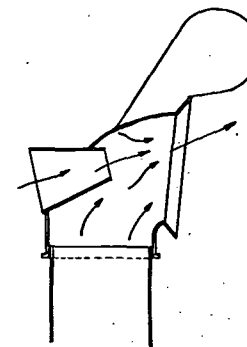


FIG. 81

ROTARY VENTILATORS

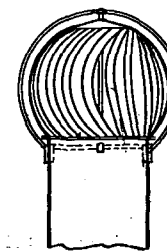


FIG. 82

AIR-TURBINE VENTILATOR

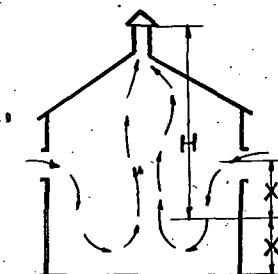
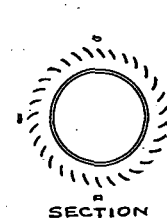


FIG. 83

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 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. 83, 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 on p. 166.

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 poisoning, 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.

CATALOG DATA SECTION

with

INDEX TO MODERN EQUIPMENT

(Pages 446-455)

and

INDEX TO ADVERTISERS

(Pages 456-458)

ATMOSPHERIC CONDITIONING CORPORATION

Main Office
 Monadnock Block Chicago 921 Lafayette Building Philadelphia Singer Building New York

Territorial Offices in the Principal Cities of the United States

Also Throughout Canada and London, England

Humidifying, Dehumidifying, Cleansing, Cooling, Humidity Control

Modern Ventilation

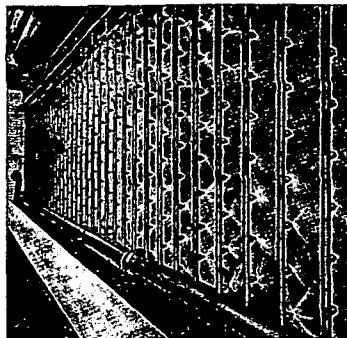
Modern Ventilation practice demands the removal of dust and foreign matter from incoming air whether it be for insuring comfort or providing healthful conditions for audience, student or employee and applies to efficiency and accuracy in many manufacturing processes.

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.

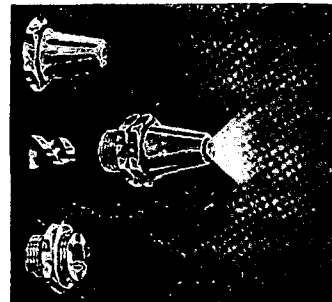
The design, manufacture and in some cases the installation of air conditioning apparatus in many types of buildings is our sole undertaking and during fifteen years of research and practice we have furnished hundreds of equipments with remarkable results.

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.

Humidifiers have been furnished for producing and maintaining the proper relative humidity.



View of Spray Chamber Showing Nozzles in Operation



Webster Spray Nozzle Used in All Atmospheric Installations

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.

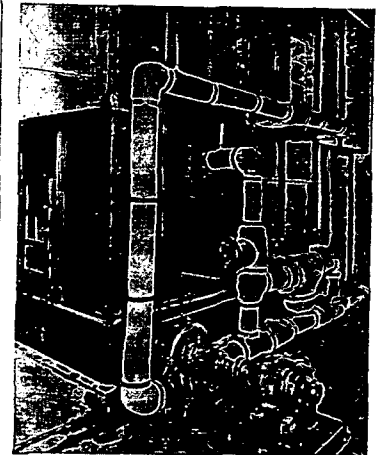
Webster System of Humidity Control may be applied to the various types of Webster Air Washers, Humidifiers and Dehumidifiers. Perfect in principle and accurate in operation—the chief controlling thermostat subject to water, a medium with four times the specific heat of air.

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.

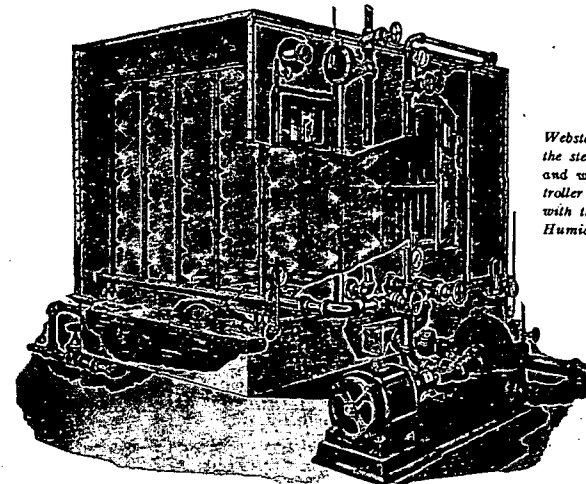
We gladly render service to those interested, in the form of recommendations



Atmospheric Dehumidifier, in successful operation since 1918 in large plant manufacturing food products

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 buyer wishes, but where we do accept an undertaking we will give our best thought and skill to its complete accomplishment.



Webster Humidifier showing the steam and water mixers and water temperature controller used in conjunction with the Webster System of Humidity Control.

Carrier Engineering Corporation

Offices and Laboratories: 750 Frelinghuysen Ave.

Newark, N. J.

Boston, 176 Federal St. New York, 39 Cortlandt St. Chicago, Transportation Bldg.
Buffalo, Prudential Bldg. Los Angeles, Douglas Bldg. Philadelphia, Land Title Bldg.

Carrier Engineering Co., Ltd.

BOMBAY

24, Buckingham Gate, London

PARIS

Engineers, Manufacturers, Contractors, specializing in the design and installation of automatically controlled Air Conditioning Equipment, Heating, Cooling, Ventilation, Humidification, Dehumidification, and the scientific application of Conditioned Air in Drying and Processing. Design and installation of Industrial Piping. Manufactured Weather to make "Every day a good day."

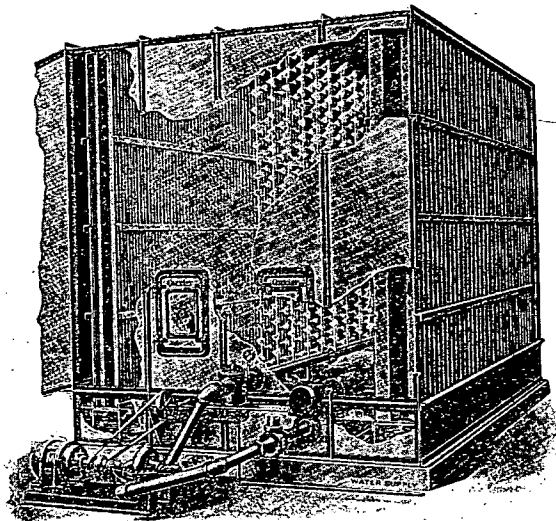
Air Conditioning is the science of mechanically regulating the (1) temperature, (2) humidity, (3) cleanliness and (4) effective distribution of the air within buildings or enclosures, such as dryrooms.

Based upon the pioneer research and invention of Willis H. Carrier during the last twenty years, this Corporation has developed scientifically effective and mechanically adequate equipment and automatic control for the conditioning of air. Carrier Equipment has been installed in more than one hundred distinctly different industries, as varied as the manufacture of chewing gum and cotton goods.

The tremendous fund of engineering and construction experience acquired in meeting these widely varying requirements enable us to offer a valuable service in the design of air conditioning equipment for any purpose.

The limitations of space herein preclude a complete technical description of the principles involved, the apparatus and the methods of automatic control employed.

Broadly, wherever *weather* or the variations of atmosphere temperature and humidity affect either the labor or the process of manufacture, Carrier Equipment can be applied to make "Every day a good day."



Typical Carrier Humidifier, with Sprays in operation.

Air enters the Humidifier at the right, thru the Distributor Plates, passes across the Spray Chamber where it is cleaned and saturated at the Spray Water temperature, and leaves the Machine thru the Eliminator Plates, which, by means of their wet Surfaces, complete the Cleansing Action, and eliminate entrained or free moisture.

Manufactured Weather (as we generally speak of *air conditioning*) can be provided in exact accordance with specific requirements. Humidifying equipment provides air that is clean, heated to any desired degree in winter, cooled to the outdoor Wet Bulb temperature in summer, moistened as required, and distributed uniformly and effectively to the area wherein it is to perform its functions, whether this be an entire building, separate departments of a building, the interior of a dryer or enclosed machines.

Dehumidifying equipment, during the winter season, performs all the functions of humidifying apparatus and, in addition, by the use of naturally cold water or mechanical refrigeration, meets every summer requirement; providing any temperature desirable and any degree of humidity or moistness required. Thus dehumidifying equipment makes possible the uninterrupted production in summer, or in localities where the climate is unfavorable, of those materials which are affected by temperature or humidity, or both. Or, dehumidification will relieve excessive temperature and moisture conditions which affect the employees.

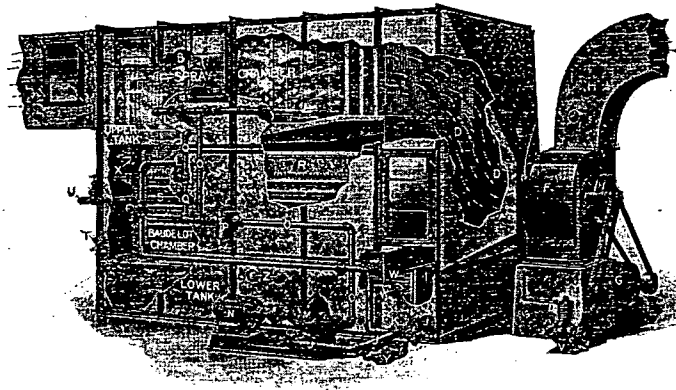
The application of Conditioned Air in Drying or Processing is becoming more and more important every day. Conditioned Air drying is a natural, efficient process, susceptible to accurate control

and remarkably flexible in its adaptability to given requirements. The most delicate products, both physically and chemically, can be processed or dried under automatic control, quickly and at minimum cost. For the more rugged products, where speed and cost are the principal factors, conditioned air drying or processing is, in nearly every instance, the most desirable and economical method available.

On account of the multiplicity of factors involved in a comprehensive explanation of our business, we publish, privately, a bi-monthly magazine, *The Weather Vein*, which relates, not too technically, the constantly lengthening story of Manufactured Weather and its industrial applications. We invite any interested person to become a "regular subscriber." The subscription price is your request.

In addition to *The Weather Vein* we have published a number of Bulletins describing Carrier Apparatus and certain of its specific applications. These Bulletins are at your disposal, upon your request.

We invite you to avail yourself of the opportunity to become familiar with the principles and practice of scientific air conditioning, through our publications. Manufactured Weather has proven an invaluable ally in scores of industries, and the list is growing rapidly.



Typical Carrier Self-Contained Dehumidifier. A—Distributor Plates. B—Sprays. C—Eliminator Plates. D—Outlet. E—Fan Connection. G—Fan Motor. H—Fan Outlet Connection to Duct System. I—Pump Suction Screen. J—Pump Suction Line. K—Three-way Mixing Valve. L—Line from Upper Tank to Three-way Valve. M—Pump. N—Pump Motor. O—Pump Discharge Line. P—Pot Strainer. Q—By-pass to Upper Tank for quick cooling at start. R—Drip Trough over Baudouin Coils. S—Baudouin Cooling Coils. T—Refrigerant Inlet. U—Refrigerant Outlet. V—Air Compressor for Automatic Control. W—Overflow from Lower Tank. X—Upper Tank Drain. Y—Lower Tank Drain to Sewer. Z—Fresh Water Connections for Make-up and Cleaning.

Air Conditioning

W. L. Fleisher & Co., Inc.

31 Union Square West

New York, N. Y.

Chicago, Ill., 1042 Wrigley Bldg.

Camden, N. J., Thorne and Copewood Sts.

Consulting and Contracting Industrial Engineers for
Air Conditioning and Drying

Fleisher-Sturtevant

AIR CONDITIONING AND DRYING SYSTEMS



Fleisher-Sturtevant Equipment

The Fleisher-Sturtevant air conditioning systems are designed to overcome the handicaps imposed on industry by variations in, or adverse climatic, weather or atmospheric conditions. They insure to the manufacturers that effect on materials and processes which can only be produced by ideal air characteristics, making his plant entirely independent of the seasons or the weather.

Whether the cure for such difficulties involves the creation of high or low temperature, and high or low humidities in any combination, dependable apparatus, a careful design and a broad basis of experience, is offered by the combined Fleisher and Sturtevant organizations.

All apparatus used is manufactured by the B. F. Sturtevant Co., the oldest, largest and one of the most experienced fan and air apparatus builders in this country. The highest type of service, both from the engineering and contracting viewpoint, is assured by W. L. Fleisher & Co., Inc.

Catalogs are ready for distribution, giving both the general details of the apparatus used, and also, for each specific industry, giving the particular advantages of such installations to that industry.

Sales Engineers are located in practically every principal city. Upon request they will call on manufacturers for consideration of their problems and to collect data for recommendations, estimates, and guarantees of results.

Air Diffusers

Knowles Mushroom Ventilator Co.

202-204 FRANKLIN STREET, NEW YORK

Knowles Air Diffusers
for Auditoriums of
THEATRES, CHURCHES, SCHOOLS

There is a Knowles Mushroom Ventilator or Air Diffuser for every condition requiring the uniform introduction or uniform exhausting of air from a church, theatre, or school auditorium. Details of three of the leading Knowles products are given below and the engineer who uses this equipment will find Knowles engineers ready to cooperate on any ventilating problem.

Notch Type Mushrooms.

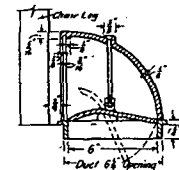
Are adjustable by merely raising and lowering the cap in recessed notches, and locking. They cannot be tampered with and are made with lugs for either wood or concrete floors. No set screws. Three outer bearings make them rigid.



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

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.



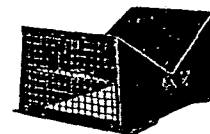
	Long	Wide	High	Lbs.	C. F. M. at 300 Vel.	Area Sq. Ft.
Small Size.....	8"	4 1/2"	4 1/2"	9 1/2	75	0.25
Large Size.....	8"	6"	6"	13	100	0.333

May also be made in any size to suit conditions.

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, Bottom Damper-type Mushrooms, and the famous Lever Lock Mushroom.

Send for NEW BOOKLET containing complete engineering data.

Reed Air Filter Co

Incorporated

Factory and General Offices

215-225 Central Avenue
LOUISVILLE, KY.NEW YORK OFFICE
50 CHURCH STREET
Reed Air
filters ALL MEDIA
BRANCH OFFICES
IN PRINCIPAL CITIES

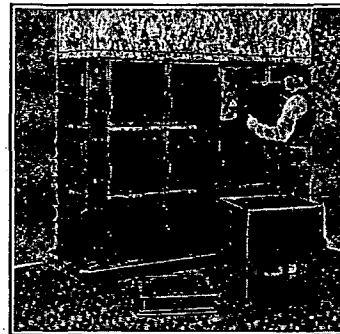
THE Reed System of Air Filtration provides a simple, economical and efficient method of supplying clean air for ventilation and industrial processes.

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.

CLEANING AND CHARGING

When dirty the cells are dipped in the cleaning tank, recharged with "Adhesine" and again put back into service.

Specifications	
Size,	20"x20"x4"
Capacity (Normal Rat.),	800 C. F. M.
Resistance,	0.25" to 0.30" W. G.
Efficiency,	97%
Velocity (recommended),	360 C. F. M.
Weight,	25 lb.



Removing Cell for Cleaning

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—Vent. Electrical Machinery.
- 110—Air Compressors.
- 111—Drying Operation and Bacteria Control.

MIDWEST AIR FILTERS
 INCORPORATED
100 EAST 45TH STREET
NEW YORK, N.Y. U.S.A.

BRANCHES

NEW YORK, N. Y.
BOSTON, MASS.
PHILADELPHIA, PA.
CLEVELAND, O.
COLUMBUS, O.INDIANAPOLIS, IND.
MINNEAPOLIS, MINN.
SAN FRANCISCO, CAL.
KANSAS CITY, MO.
PITTSBURGH, PA.CHICAGO, ILL.
RICHMOND, VA.
ST. LOUIS, MO.
DENVER, COLO.
DETROIT, MICH.SALT LAKE CITY, UTAH
MILWAUKEE, WIS.
SEATTLE, WASH.
DALLAS, TEXAS
MONTREAL, CANADA

Midwest Air Filters are made in types to fill every need for CLEAN AIR. Type U-2, however, illustrated below, meets all requirements in most general ventilating problems.

These filters are based on the unit principle, each unit consisting of a cell and a frame, completely interchangeable with the other cells and frames of an installation. Practically any requirements of space and capacity can be met by the flexibility of the system. Figure 1 shows a single unit Type U-2 and Figure 2 shows a typical installation.

Midwest Air Filters do not clog, but resume their original resistance after each easily accomplished cleaning.

Our engineering service is at your command.

SPECIFICATIONS

Size of Unit.....	20 x 20 x 4 in.
Capacity per unit.....	800 C. F. M.
Resistance.....	3/8 in. W. G. Approx.
Shipping weight per unit.....	40 lb.
Efficiency.....	Maximum dust content in cleaned air will not at any time, exceed 0.1 grain per 1000 cu. ft.

The **Midwest Super-Filter** is a new type for use where extremely clean air is essential. This filter makes possible a degree of cleanliness hitherto unattainable commercially and is guaranteed to allow a maximum dust content in the cleaned air of only 0.01 grain per 1000 cu. ft.

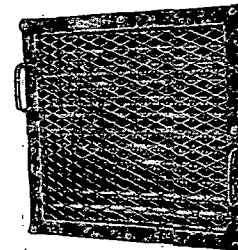


Fig. 1—Type U-2 Frame and Cell

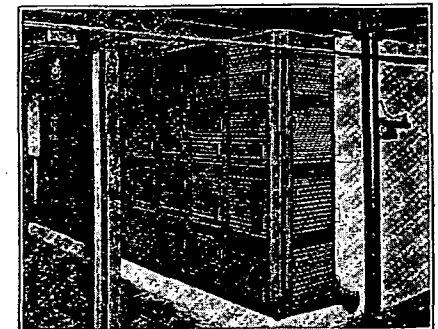


Fig. 2—Typical Installation

"X" LIQUID

REPAIRS LEAKS IN STEAM AND HOT WATER HEATING SYSTEMS AND AUTO RADIATORS, CRACKED CYLINDERS, WATER JACKETS

Made by

"X" LABORATORIES, 25 West 45th St., New York

Factories: Boston and Montreal

"X" Liquid repairs quickly and permanently all leaks in steam boilers (low or high pressure) hot water heaters and entire systems. Just pour it in. Used by over 30,000 heating contractors in the United States and Canada, the United States Government, General Electric, American Telephone and Telegraph, Standard Oil Co., etc. Over three million cans sold annually. Carried by ALL jobbers of Steamfitters Supplies. Fully guaranteed or money back.

Resists Any Steam Pressure

"X" Liquid is a pure colloidal solution which combines and circulates freely with the water in the boiler flowing out through every crack where the water leaks. Contact with the air and heat causes the Liquid to solidify making a permanent repair which will resist any steam pressure. It has repaired Stanley (Automobile) boilers.

"X" Boiler Liquid
Sold by all Jobbers

SIZES AND PRICES

Quart Cans..... \$6.00 Each
Half Gallon Cans..... \$10.00 Each

"X" finds and seals multitudinous hair cracks, leaky bolt heads and makes inside repairs which would be impossible to repair otherwise. Where cracks are very large, it is best to stuff with lead wool or tin foil to retard the flow.

Increases Thermal Efficiency

The use of "X" Liquid increases thermal boiler efficiency because it dissolves 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 in the boiler.



ABENDROTH BROTHERS

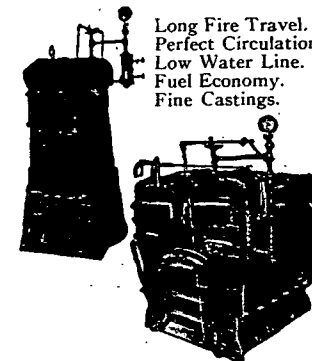
Estab. 1840

Port Chester, N. Y.

YORK HEATERS

"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
1201	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	275	16	38 1/2	2-2
19 Y S 3	350	19	39 1/2	2-2 1/2
20 Y S 3	450	20	42 1/4	2-2 1/2
22 Y S 3	550	22	45	2-3
25 Y S 3	700	25	47 1/4	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	.....	2-2 1/2
20 Y W 3	740	20	.....	2-2 1/2
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	43 1/2	2-2
19 Y S 4	375	19	44 1/2	2-2 1/2
20 Y S 4	475	20	48	2-2 1/2
22 Y S 4	575	22	50	2-3
25 Y S 4	750	25	53 1/4	2-3
28 Y S 4	965	28	54 1/2	2-4
16 Y W 4	500	16	.....	2-2
19 Y W 4	620	19	.....	2-2 1/2
20 Y W 4	780	20	.....	2-2 1/2
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	47 1/2	2-2
19 Y S 5	400	19	49 1/2	2-2 1/2
20 Y S 5	500	20	53 1/4	2-2 1/2
22 Y S 5	600	22	55	2-3
25 Y S 5	800	25	59 1/4	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	.....	2-2 1/2
20 Y W 5	825	20	.....	2-2 1/2
22 Y W 5	990	22	.....	2-3
25 Y W 5	1320	25	.....	2-3
28 Y W 5	1650	28	.....	2-4

YORK SQUARE SECTIONAL

Number	Rating	Grate Dimensions	Tapping Each Flow and Return
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	2-4
309	2,850	30x58	2-4
310	3,200	30x65	2-4
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	2-4
309	4,700	30x58	2-4
310	5,280	30x65	2-4
405	2,900	40x34	2-5
406	3,625	40x42 1/2	2-5
407	4,350	40x51	2-5
408	5,075	40x59 1/2	2-5
409	5,800	40x68	2-5
410	6,525	40x76 1/2	2-5
411	7,250	40x85	2-5
412	7,975	40x93 1/2	2-5
405	4,800	40x34	2-5
406	6,000	40x42 1/2	2-5
407	7,200	40x51	2-5
408	8,400	40x59 1/2	2-5
409	9,600	40x68	2-5
410	10,800	40x76 1/2	2-5
411	12,000	40x85	2-5
412	13,200	40x93 1/2	2-5

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.

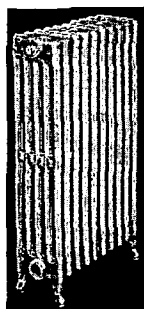
Ideal Boilers, American Radiators, Heating and Vacuum Cleaning Equipments

We present sample pages taken from various catalogs issued by us. The pages selected illustrate newer products, and in part suggest the efforts this Company puts forth to meet the demands of Engineers for utmost refinement in heating devices.

Catalogs containing valuable data for Engineers are being constantly issued or supplemented, such as the "Ideal Fitter" catalog (384 pages), Vento Data Book for Engineers (48 pages), American Wall Radiator Installation Book (48 pages), Heat Transmission Book (24 pages), Arcola Outfit Installation Book (24 pages), Lowering the High Cost of Cleaning Buildings Through Arco Wand Vacuum Cleaners catalog (12 pages), How to Run the Steam and Hot Water Boiler catalogs (12 pages), Specifications for Steam and Water Systems (8 pages), Ideal Gas Boiler Manuals (16 pages each), Drying of Lumber, Paint and Varnish catalog (48 pages), etc. May we not, therefore, request that Heating Engineers kindly keep their names on file at our nearest Sales Branch in order that latest technical catalogs may be mailed.

Faithfully,

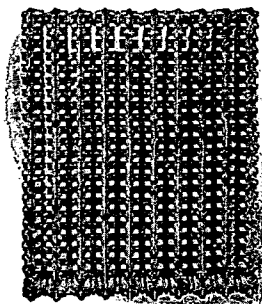
AMERICAN RADIATOR COMPANY



(Pat. Sept. 4, 1917,
May 10, 1921, July
19, 1921)

Illustrates (at left) the CORTO Radiator, of classic design. Its heating surface equals, or exceeds, the best; its water content is three-fourths of a pound per square foot of heating surface, or about one-half the contents of the usual form of radiator; and its condensed spacings permit of placing 80% more heating surface in a given area of floor space than with any other type of radiator.

Send for complete CORTO Radiator Catalog.

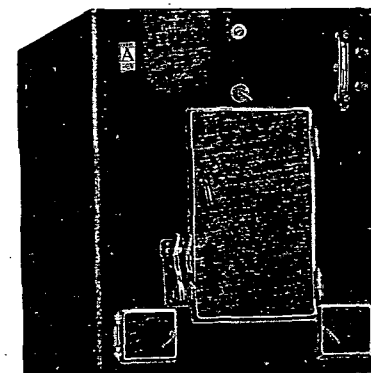


Front View of 10-Section VENTO Stack

Illustrates (at right) the VENTO Cast-Iron Hot Blast Heaters, now the standard, at home and abroad, for the heating of moving air.

Made in 40, 50 and 60 in. Narrow pattern, and in 30, 40, 50, 60 and 72 in. Regular pattern.

Please ask for special and complete catalog: "Engineers Data on VENTO Heaters."

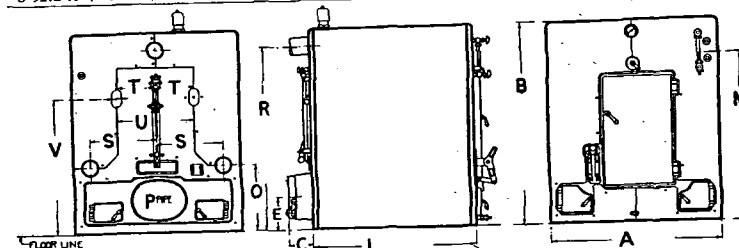


IDEAL Type "A" Heat Machines

IDEAL Type "A" Boilers are made in two series, ranging in Steam from 1,000 to 6,000 sq. ft., and in Water from 1,600 to 9,600 sq. ft. They specially lend themselves to installation in battery form. IDEAL Boiler ratings conform with the rating formula of the A. S. H. & V. E. Code 1919.

RATINGS AND DATA

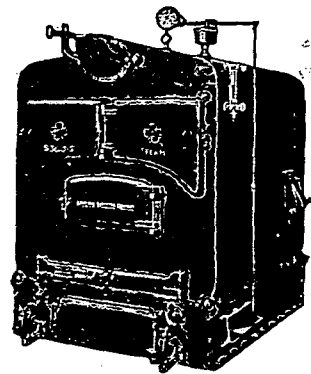
Number of Boiler	Steam Rating Sq. Ft.	Number of Boiler	Water Rating Sq. Ft.	Grate Area Sq. Ft.	Fuel Capacity Lbs.	Total Length "L" Ins.	Outlets No. and Size	Inlets No. and Size	Chimney	
									Size Ins.	Height Ft.
S-2204-A	1000	W-2204-A	1600	2.76	245	26	1-5	2-5	12x12	35
S-2205-A	1250	W-2205-A	2000	3.68	328	32	1-5	2-5	12x16	35
S-2206-A	1500	W-2206-A	2400	4.60	411	38	1-5	2-5	12x16	35
S-2207-A	1750	W-2207-A	2800	5.52	494	44	1-5	2-5	12x16	40
S-2208-A	2000	W-2208-A	3200	6.44	577	50	1-5	2-5	12x16	45
S-2209-A	2250	W-2209-A	3600	7.36	660	56	1-5	2-5	12x16	45
S-3205-A	2500	W-3205-A	4000	6.22	660	36	1-6	2-6	16x16	40
S-3206-A	3000	W-3206-A	4800	7.77	825	43	1-6	2-6	16x16	40
S-3207-A	3500	W-3207-A	5600	9.32	990	50	1-6	2-6	16x20	45
S-3208-A	4000	W-3208-A	6400	10.87	1155	57	1-6	2-6	16x20	45
S-3209-A	4500	W-3209-A	7200	12.42	1320	64	1-6	2-6	20x20	50
S-3210-A	5000	W-3210-A	8000	13.97	1485	71	1-6	2-6	20x20	50
S-3211-A	5500	W-3211-A	8800	15.52	1650	78	1-6	2-6	20x20	55
S-3212-A	6000	W-3212-A	9600	17.07	1815	85	1-6	2-6	20x20	55



DIMENSIONS—MEASUREMENTS IN INCHES

BOILER	A	B	C	E	M	O	P	R	S	T	U	V
S or W-2204-A to 2209-A.....	41 1/2	61 3/4	8 1/4	8 3/4	50	19 3/4	12	56	15 3/4	9 1/8	18 1/4	41
S or W-3205-A to 3212-A.....	57 1/2	69	10 3/4	11 1/4	56 3/4	23	18	63 3/4	22 3/4	13 3/8	26 3/4	57

S or W-2204-A to 2209-A Boiler has 12" Round Smoke Pipe Collar.
S or W-3205-A to 3212-A Boiler has Oval Smoke Pipe Collar for 18" pipe.

**IDEAL Smokeless Boilers**

(Furnished With or Without Ideal Metallic Jacket)

IDEAL Smokeless Boilers are made in series, ranging in Steam from 2000 to 17,750 sq. ft., and in Water from 8250 to 28,500 sq. ft. They specially lend themselves to installation in battery form. IDEAL Boiler ratings conform with the rating formula of the A. S. H. & V. E. Code 1919.

RATINGS AND DATA

Steam										Water									
Number of Boiler	Rating Steam Sq. Ft.	Gross Area Sq. Ft.	Total Length In.	Outlets Number and Size	Inlets Number and Size	Chimney Size (Sea Level)	Chimney Height, Ft.	Number of Boiler	Rating Water Sq. Ft.	Gross Area Sq. Ft.	Total Length In.	Outlets Number and Size	Inlets Number and Size	Chimney Size (Sea Level)	Chimney Height, Ft.	Number of Boiler	Rating Water Sq. Ft.	Gross Area Sq. Ft.	Total Length In.
S-2906-S	2,000	6.05	36	1-5	2-4	12x16	40	W-2906-S	3,250	6.05	36	1-5	2-4	12x16	40	W-2906-S	3,250	6.05	36
S-2907-S	2,400	7.25	42	1-5	2-4	16x16	40	W-2907-S	3,900	7.25	42	1-5	2-4	16x16	40	W-2907-S	3,900	7.25	42
S-2908-S	2,800	8.47	48	1-5	2-4	16x16	45	W-2908-S	4,550	8.47	48	1-5	2-4	16x16	45	W-2908-S	4,550	8.47	48
S-2909-S	3,200	9.68	54	2-5	2-4	16x20	50	W-2909-S	5,200	9.68	54	2-5	2-4	16x20	50	W-2909-S	5,200	9.68	54
S-2910-S	3,600	10.89	60	2-5	2-4	16x20	55	W-2910-S	5,850	10.89	60	2-5	2-4	16x20	55	W-2910-S	5,850	10.89	60
S-2911-S	4,000	12.10	66	2-5	2-4	20x20	60	W-2911-S	6,500	12.10	66	2-5	2-4	20x20	60	W-2911-S	6,500	12.10	66
S-3607-S	3,800	9.00	42	2-6	2-4	16x20	50	W-3607-S	6,200	9.00	42	2-6	2-4	16x20	50	W-3607-S	6,200	9.00	42
S-3608-S	4,450	10.50	48	2-6	2-4	20x20	50	W-3608-S	7,300	10.50	48	2-6	2-4	20x20	50	W-3608-S	7,300	10.50	48
S-3609-S	5,100	12.00	54	2-6	2-4	20x20	55	W-3609-S	8,400	12.00	54	2-6	2-4	20x20	55	W-3609-S	8,400	12.00	54
S-3610-S	5,750	13.50	60	2-6	2-4	20x20	55	W-3610-S	9,500	13.50	60	2-6	2-4	20x20	55	W-3610-S	9,500	13.50	60
S-3611-S	6,400	15.00	66	2-6	2-4	20x20	60	W-3611-S	10,600	15.00	66	2-6	2-4	20x20	60	W-3611-S	10,600	15.00	66
S-3612-S	7,050	16.50	72	2-6	2-4	20x24	60	W-3612-S	11,700	16.50	72	2-6	2-4	20x24	60	W-3612-S	11,700	16.50	72
S-3613-S	7,700	18.00	78	2-6	2-4	20x24	65	W-3613-S	12,800	18.00	78	2-6	2-4	20x24	65	W-3613-S	12,800	18.00	78
S-3614-S	8,350	19.50	84	2-6	2-4	20x24	70	W-3614-S	13,900	19.50	84	2-6	2-4	20x24	70	W-3614-S	13,900	19.50	84
S-3615-S	9,000	21.00	90	2-6	2-4	24x24	75	W-3615-S	15,000	21.00	90	2-6	2-4	24x24	75	W-3615-S	15,000	21.00	90
S-4807-S	9,000	21.60	68 1/2	3-6	4-4	24x24	70	W-4807-S	14,500	21.60	68 1/2	3-6	4-6	24x24	70	W-4807-S	14,500	21.60	68 1/2
S-4808-S	10,250	25.20	79 1/4	3-6	4-4	24x28	75	W-4808-S	16,500	25.20	79 1/4	3-6	4-6	24x28	75	W-4808-S	16,500	25.20	79 1/4
S-4809-S	11,500	28.80	90	3-6	4-4	24x28	80	W-4809-S	18,500	28.80	90	3-6	4-6	24x28	80	W-4809-S	18,500	28.80	90
S-4810-S	12,750	28.80	100 1/4	3-6	4-4	24x28	85	W-4810-S	20,500	28.80	100 1/4	3-6	4-6	24x28	85	W-4810-S	20,500	28.80	100 1/4
S-4811-S	14,000	28.80	111 1/2	4-6	4-4	28x28	95	W-4811-S	22,500	28.80	111 1/2	4-6	4-6	28x28	95	W-4811-S	22,500	28.80	111 1/2
S-4812-S	15,250	28.80	122 1/4	4-6	4-4	28x28	100	W-4812-S	24,500	28.80	122 1/4	4-6	4-6	28x28	100	W-4812-S	24,500	28.80	122 1/4
S-4813-S	16,500	32.40	133	4-6	4-4	28x32	105	W-4813-S	26,500	32.40	133	4-6	4-6	28x32	105	W-4813-S	26,500	32.40	133
S-4814-S	17,750	32.40	143 1/4	4-6	4-4	28x32	110	W-4814-S	28,500	32.40	143 1/4	4-6	4-6	28x32	110	W-4814-S	28,500	32.40	143 1/4

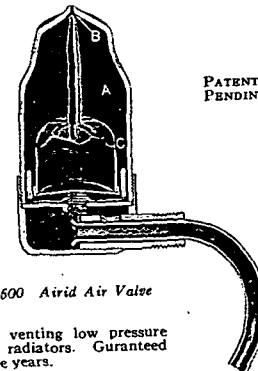
*Two 3 1/4-in. and two 4-in. †Four 3 1/4-in. and two 4-in.

Guarantee

We guarantee that all Ideal Boilers will develop their stated capacities when tested in accordance with the standard testing code of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS (Revisions of 1919) and when fired with hard coal of 13,000 B.t.u. heat value per pound. For detailed information see page 85 of the Ideal Fitter of April 1, 1922.

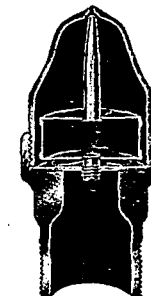
Selection of Proper Size Boiler

For determining proper size of boiler for a given installation a careful study is recommended of pages 247 to 251 inclusive of the same edition of the Ideal Fitter.

PATENTS
PENDING

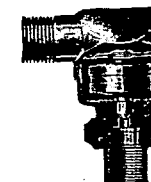
No. 600 Airid Air Valve

For venting low pressure steam radiators. Guaranteed for five years.

PATENT
PENDING

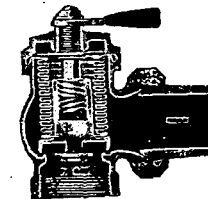
No. 815 Ideal Quick Vent

All metal. Very sensitive. For venting mains, long runs of pipe, indirect stacks, drop risers, etc. Either 1/4" or 3/8" connection.

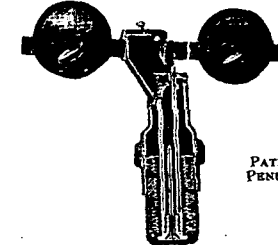
PATENT
PENDING

No. 817 Vento Vent

For use on Vento Heaters and Blast Coils.

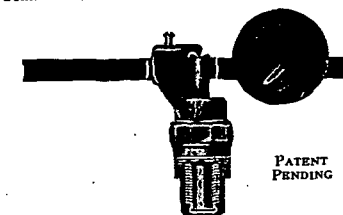
PATENTS
PENDINGIdeal Super Packless Radiator Valve
(No. 878)

No packing of any kind is used. Opens with one turn.

PATENTS
PENDING

Arco Water Regulator (No. 800)

For damper control of Hot Water Heating Boilers. Range 100° to 220° F. Length of Bulb 2 1/4 inches. Connection, 2 inches.

PATENT
PENDING

Arco Junior Water Regulator (No. 801)

For damper control on Hot Water Supply Boilers. Length of bulb, 2 inches. Connection, 1 1/4 inches. Range 130° to 180°.



PATENT PENDING

Arco Tank Regulator (Nos. 826-828)

Range 140° to 180° F. For use on steam pressures up to 15 lbs.

Send for complete catalog of Ideal Heating Specialties

Boilers

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 with-



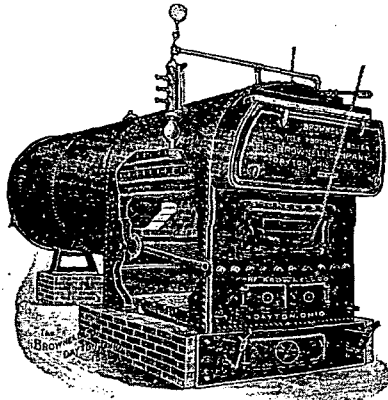
out smoke. Brownell Firebox Boilers are mechanically correct and insure long life. Brownell Heating Boilers have generous and properly designed fireboxes, permitting complete combustion and high efficiency.

Brownell ratings are very conservative, only the parts of

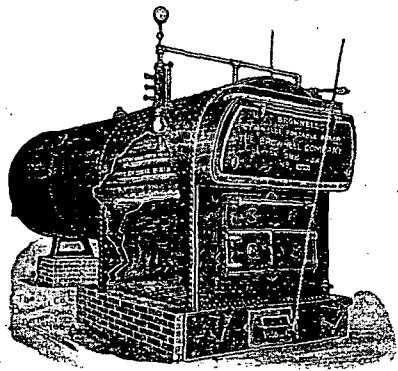
boiler below the normal water level and coming in actual contact with the hot gases being considered as effective heating surface.

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.

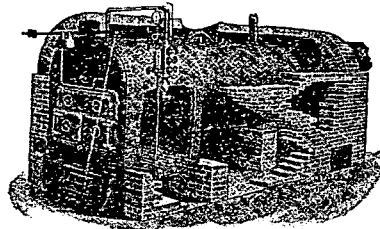
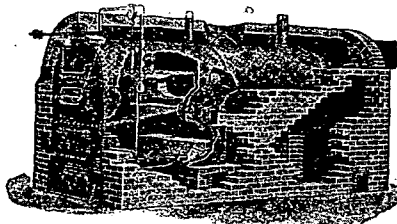
Brownell Firebox Heating Boilers are regularly built according to the A. S. M. E. Code for 15 lb. working pressure but will be furnished for pressure up to 100 lb. at an increased cost.



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-6Brownell Brick-set Firebox Boiler—Smokeless Type
Bulletin B-6

The Brownell Co.

Boilers

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	6500	7000	7500	8000	8500	9000	9500	10000	10500	11000
Capacity—Water, Sq. Ft.	4100	4800	5800	6600	7400	8300	9100	9900	11600	13200	15700	18200	21500	24800	28500	32000	35000	38000
Approximate Weight	6900	7400	8300	9000	9800	10600	11300	12100	14100	15900	17300	19600	21000	23000	24800	27100	29000	30000
Diam. of Boiler, In.	48	48	48	54	54	60	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	26	28	30	32	34	34	36	36	40	40
Diam. Stack, In.	20	20	20	22	22	22	24	24	24	26	28	30	32	32	34	34	38	38
Min. Height Stack, Ft.	30	30	30	34	34	34	38	38	38	40	44	46	50	50	52	52	56	56
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	34	36	36	40	42	46	46	48	54	54
Min. 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	7000	7500	8000	8500	9000	9500	10000	10500	11000	11500
Capacity—Water, Sq. Ft.	5000	5800	6600	7400	8300	9100	9900	10700	12400	14000	16500	18800	21100	24400	27900	33000	40000	50000
Approximate Weight	7800	8600	9300	10400	11100	11900	13300	15300	16900	17800	20000	21900	24000	25500	27900	28000	35000	41000
Diam. of Boiler, In.	48	48	48	54	54	60	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	15-9	16-1	16-6	17-9	16-6	17-8	18-8	20-1	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.	30	30	30	34	34	34	38	38	40	40	44	46	50	50	52	52	56	56
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	100

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	2300	2600	3000	3500	4000	4500	5000	5500	6000	7000	8000	10000	12000	14000
Capacity—Water, Sq. Ft.	1500	1700	2000	2300	2800	3300	3800	4300	5000	5800	6600	7400	8100	9000	10000	11000	12000	13000	14000	15000
Approx. Shipping Weight	2800	3000	3200	3600	4200	4800	5200	5600	6000	7000	7800	8600	9400	10000	11000	12000	13000	14000	15000	16000
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 Overall, 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	18-0	16-0	18-0	16-0	18-0	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	4	4	4	4	4	5	5	5	5	5	6	6	6	8
Size of Return, In.	2 1/2	3	3	3	3	3	3	4	4	4	4	5	5	5	5	5	6	6	6	8
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	22	22	24	24	28	32	32	32	32	36	36	36	36
Diam. Stack, In.	12	12	14	14	16	18	20	22	22	22	22	26	30	30	30	30	30	34	34	34
Min. Height Stack, Ft.	40	40	40	40	40	45	45	45	45	50	50	50	55	55	55	60	60	60	60	60
Diam. Breeching, 2 Boilers, In.	20	20	20	22	22	22	24	24	24	26	26	28	30	30	32	34	36	36	38	40
Diam. Stack, 2 Boilers, In.	18	18	18	20	20	20	22	22	22	24	24	26	28	28	30	32	34	34	36	38
Min. Height Stack, 2 Boilers, Ft.	50	50	50	50	50	50	50	50	50	55	55	60	60	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	21000	23000	26400
Approximate Shipping Weight	6100	6700	7200	8400	9100	9800	12300	13600	16000	19400	21000	24000	24300	28000
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	19-4	20-4
Heating Surface, Sq. Ft.	309	359	409	448	509	563	643	736	851	987	1074	1204	1303	1468
Size of Steam, In.	6	6	6	6	6	6	7	7	7	8	8	8	8	8
Size of Return, In.	4	4	4	4	4	4	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	22	24	24	24	27	27	30	30	34	34	36	38
Diam. Stack, In.	20	20	20	22	22	22	24	24	28	28	32	32	34	36
Min. Height 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	60	70	70	70	75	80	80	80

Boilers (Gas Fired)

THE BRYANT HEATER & MFG. COMPANY

Factory, 952 E. 72nd St.



CLEVELAND, OHIO

BRANCH OFFICES

PITTSBURGH, PA., East End Trust Bldg., Penn and Hiland Ave.; CINCINNATI, OHIO, 421 Union Trust Bldg.; CANTON, OHIO, 1607 Shorb Ave.; PHILADELPHIA, PA., Bourse Bldg.; SAN FRANCISCO, CAL., 710 Polk St.; BOSTON, MASS., 126 High St.; BUFFALO, N. Y., Erie County Bank Bldg.; NEW YORK, N. Y., 212 Livingston St., Brooklyn; CHICAGO, ILL., 218 S. Wabash Ave.; DENVER, COLO., 1425 Sixteenth St.; TOLEDO, OHIO, 449 Nicholas Bldg.; ST. LOUIS, MO., 1515 Olive St.; BALTIMORE, MD., 1116 Lexington Bldg.

Products

Bryant Gas Boilers for Hot Water, Steam or Vapor Heat.

Bryant Hot Water Storage Systems.

Bryant Low Pressure Steam Generator.

General Description of Boiler—

A patented boiler of tubular, sectional construction having an individual burner for each section. Embodies thermostatic control and other automatic regulating devices. Gives 84½ per cent efficiency with natural or manufactured gas.

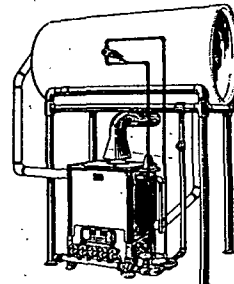
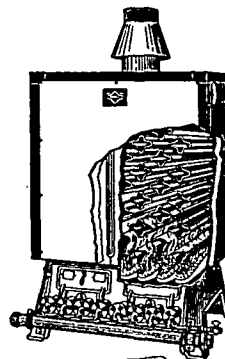
Constructed of cast iron with heavy base which serves as foundation.

Heat is quickly transmitted through thin walls of liberally proportioned tubes; staggered tubes give a long heat travel; scientifically designed burners afford perfect combustion; tubes easily accessible for cleaning, if desired.

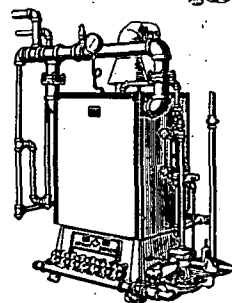
General Description of Hot Water Storage System—A rugged system suited for all places requiring a large supply of hot water on instant notice. Boiler is controlled by automatic devices, and maintains a tank, full of hot water at all times. Has ample capacity to handle peak loads or sustained heavy demands.

Bryant Service—Bryant representatives go anywhere. Apply for information at any of the above branch offices or communicate with headquarters.

Bryant Boiler, Showing Interior Construction



6-A-2 Storage System (above)



7-S-3 Steam Boiler. Used in Indirect Systems.

THE BRYANT HEATER & MFG. COMPANY

Boilers (Gas Fired)

Ratings and Dimensions of Bryant Gas Boilers

Steam Boiler No.		Water Boiler No.		Dimensions, Inches											
Sections Type Tappings	Rating	Sections Type Tappings	Rating	A	B	C	D	E	F	G	H	J	K	L	
3-S-2	200	3-C-2	320	47	5	15 3/4	28 1/2	29	29 3/4	22	12 1/2	2	18	13 1/2	
4-S-2	265	4-C-2	425	47	5	18 3/4	31 3/4	29	29 3/4	22	12 1/2	2	18	13 3/4	
5-S-2	335	5-C-2	535	47	5	21 3/4	34 3/4	29	29 3/4	22	12 1/2	2	18	13 3/4	
3-S-3	400	3-C-3	640	65	5	17 3/4	30 3/2	37	46	36	15 3/4	3	26 3/4	21 1/2	
4-S-3	560	4-C-3	895	66	6	20 3/4	33 3/4	37	46	36	15 3/4	3	26 3/4	21 1/2	
5-S-3	720	5-C-3	1150	66	6	23 3/4	37 3/4	37	46	36	15 3/4	3	26 3/4	21 1/2	
6-S-3	880	6-C-3	1410	66	6	26 3/4	41 3/4	37	46	36	15 3/4	3	26 3/4	21 1/2	
7-S-3	1040	7-C-3	1665	67	7	29 3/4	44 1/4	37	46	36	15 3/4	3	26 3/4	21 1/2	
8-S-3	1200	8-C-3	1920	67	7	33	47 3/4	37	46	36	15 3/4	3	26 3/4	21 1/2	
9-S-3	1500	9-C-3	2400	66 1/2	8	40 3/4	54 3/4	37	47 3/4	37	15 3/4	4	26 3/4	21 1/2	
11-S-3	1880	11-C-3	3010	67	8	47 3/4	63 3/4	37 1/4	47 3/4	37	15 3/4	4	26 3/4	21 1/2	
13-S-3	2260	13-C-3	3620	67	8	54 3/4	70 3/4	37 1/4	47 3/4	37	15 3/4	4	26 3/4	21 1/2	
15-S-3	2640	15-C-3	4220	67 1/2	9	61 3/4	77 3/4	37 1/4	47 3/4	37	15 3/4	4	26 3/4	21 1/2	
17-S-3	3020	17-C-3	4830	67 1/2	9	69 3/4	86	37 1/4	47 3/4	37	15 3/4	4	26 3/4	21 1/2	
19-S-3	3400	19-C-3	5440	67 1/2	9	76 3/4	93 3/4	37 1/4	47 3/4	37	15 3/4	4	26 3/4	21 1/2	
21-S-3	3780	21-C-3	6050	67 1/2	9	83 3/4	100 3/4	37 1/4	47 3/4	37	15 3/4	4	26 3/4	21 1/2	
23-S-3	4160	23-C-3	6660	68	10	90 3/4	107 3/4	37 1/4	47 3/4	37	15 3/4	4	26 3/4	21 1/2	
25-S-3	4540	25-C-3	7260	68	10	98 3/4	115	37 1/4	47 3/4	37	15 3/4	4	26 3/4	21 1/2	
27-S-3	4920	27-C-3	7870	68 1/2	11	105 3/4	122 3/4	37 1/4	47 3/4	37	15 3/4	4	26 3/4	21 1/2	
29-S-3	5300	29-C-3	8480	68 1/2	11	112 3/4	129 3/4	37 1/4	47 3/4	37	15 3/4	4	26 3/4	21 1/2	
31-S-3	5680	31-C-3	9090	68 1/2	11	119 3/4	136 3/4	37 1/4	47 3/4	37	15 3/4	4	26 3/4	21 1/2	
33-S-3	6060	33-C-3	9700	68 1/2	11	127 3/4	143 3/4	37 1/4	47 3/4	37	15 3/4	4	26 3/4	21 1/2	
35-S-3	6440	35-C-3	10300	68 1/2	11	134 3/4	151 3/4	37 1/4	47 3/4	37	15 3/4	4	26 3/4	21 1/2	
37-S-3	6820	37-C-3	10910	69	12	141 3/4	158 3/2	37 1/4	47 3/4	37	15 3/4	4	26 3/4	21 1/2	
39-S-3	7200	39-C-3	11520	69	12	148 3/4	165 3/4	37 1/4	47 3/4	37	15 3/4	4	26 3/4	21 1/2	
41-S-3	7580	41-C-3	12330	69	12	156 3/4	173	37 1/4	47 3/4	37	15 3/4	4	26 3/4	21 1/2	

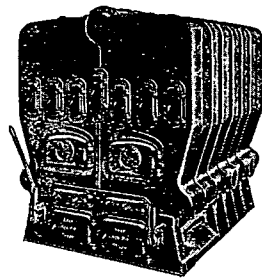
Capacities of Bryant Hot Water Storage Systems

Boiler H. P.	Available B.t.u.	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

Burnham Boiler Corporation

Irvington, N. Y.

Makers of Low Pressure Cast Iron Boilers



Twin Section for heavy duty work. Sections and grates both being twins, can pass through small opening. No rights and lefts to sections. Three men can set it up.

Burnham Square Sectional boilers are based on the principle that a long fire travel (correctly proportioned) reduces fuel bills. The hot gases go back and forth three times the length of the boiler, on each side of the boiler, before they are led to the smoke box opening.

Because of the individual side flue openings, each section absorbs an equal amount of heat.

Burnham steam boilers have such a low water line that they can be used in shallow cellars. They are so constructed that the size of the steam dome is not sacrificed.

Every operating part is handy in front of the boiler.

Every flue has a separate clean-out door.

TWIN SECTIONAL FOR HEAVY DUTY Steam Boilers

Number	Grate Area Sq. Ft.	No. and Size of Outlets and Inlets	No. and Size of Safety Valve	Rating Sq. Ft.
S-50-6	19.27	3-5"	3"	6,250
S-50-7	22.92	3-5"	3 1/2"	7,425
S-50-8	26.56	4-5"	3 1/2"	8,600
S-50-9	30.20	4-5"	3 1/2" & 2"	9,775
S-50-10	33.85	5-5"	3 1/2" & 2"	10,950
S-50-11	37.5	5-5"	3 1/2" & 3"	12,125
S-50-12	41.14	5-5"	3 1/2" & 3"	13,300

Water Boilers

Number	Grate Area Sq. Ft.	Size Supply Tap-pings	Size Return Tap-pings	Rating Sq. Ft.
W-50-6	19.27	4-5"	4-5"	10,300
W-50-7	22.92	4-5"	4-5"	12,250
W-50-8	26.56	5-5"	5-5"	14,200
W-50-9	30.20	5-5"	5-5"	16,150
W-50-10	33.85	5-5"	5-5"	18,100
W-50-11	37.5	6-5"	6-5"	20,050
W-50-12	41.14	6-5"	6-5"	22,000

SQUARE SECTIONAL Steam Boilers

Number	Grate Area Sq. Ft.	Size Supply Tap-pings	Size Return Tap-pings	Rating Sq. Ft.
S-18-4	3.00	1-3/4"	1-3/4"	750
S-18-5	3.94	2-3/4"	2-3/4"	950
S-18-6	4.88	2-3/4"	2-3/4"	1,150
S-18-7	5.81	2-3/4"	2-3/4"	1,350
S-24-5	5.17	2-4"	2-4"	1,350
S-24-6	6.42	2-4"	2-4"	1,700
S-24-7	7.67	2-4"	2-4"	2,050
S-24-8	8.92	2-4"	2-4"	2,400
S-30-5	6.46	2-4"	2-4"	1,750
S-30-6	8.02	2-4"	2-4"	2,250
S-30-7	9.58	2-4"	2-4"	2,750
S-30-8	11.15	3-4"	2-4"	3,250
S-30-9	12.71	3-4"	2-4"	3,750
S-36-6	9.88	2-4"	2-4"	2,850
S-36-7	11.75	3-4"	2-4"	3,500
S-36-8	13.63	3-4"	2-4"	4,150
S-36-9	15.50	3-4"	2-4"	4,700
S-36-10	17.38	4-4"	2-4"	5,350
S-36-11	19.25	4-4"	2-4"	6,000

Water Boilers

Number	Grate Area Sq. Ft.	Size Supply Tap-pings	Size Return Tap-pings	Rating Sq. Ft.
W-18-4	3.00	2-3/4"	2-3/4"	1,250
W-18-5	3.94	2-3/4"	2-3/4"	1,575
W-18-6	4.88	2-3/4"	2-3/4"	1,900
W-18-7	5.81	3-3/4"	3-3/4"	2,225
W-24-5	5.17	2-4"	2-4"	2,225
W-24-6	6.42	2-4"	2-4"	2,800
W-24-7	7.67	2-4"	2-4"	3,375
W-24-8	8.92	3-4"	3-4"	3,950
W-30-5	6.46	2-4"	2-4"	2,900
W-30-6	8.02	2-4"	2-4"	3,715
W-30-7	9.58	3-4"	3-4"	4,530
W-30-8	11.15	3-4"	3-4"	5,345
W-30-9	12.71	4-4"	4-4"	6,160
W-36-6	9.88	3-4"	3-4"	4,700
W-36-7	11.75	3-4"	3-4"	5,775
W-36-8	13.63	4-4"	4-4"	6,850
W-36-9	15.50	4-4"	4-4"	7,925
W-36-10	17.38	5-4"	5-4"	9,000
W-36-11	19.25	5-4"	5-4"	10,075



General Boilers Company

Manufacturers of

Pacific Steel Heating Boilers, Pacific Circulating Tanks

Waukegan, Illinois

PACIFIC SMOKELESS STEAM BOILERS

Catalog Number	Net Rating	Height Water Line, Inches	Dimensions Overall, Inches	Diameter Stack, Inches One Boiler	Minimum Height Stack, Ft.	Grate Dimensions, Inches	Heating Surface, Sq. Ft.	Diameter Smoke Con-nection, Inches	Space at Front for Drawing Tubes	Size of Outlet Inches	Size of Return Inches
604	850	60	39 x 49	11	45	21 x 23	73.0	12	34	3	2
605	1000	60	39 x 55	11	45	21 x 27	87.0	12	40	3	2
606	1150	60	39 x 61	11	45	21 x 31	100.0	12	46	3	2
607	1300	60	39 x 67	11	45	21 x 35	114.0	12	52	3	2
608	1450	60	39 x 73	11	45	21 x 35	122.0	12	58	3	2
609	1800	64	43 x 67	13	50	25 x 35	152.0	14	52	4	2 1/2
610	2300	64	43 x 79	13	50	25 x 43	189.0	14	64	4	2 1/2
611	2800	68	47 x 81	15	55	29 x 43	234.0	16	64	5	3
612	3300	68	47 x 93	15	55	29 x 47	279.0	16	76	5	3
613	3900	68	50 x 94	17	60	31 x 47	318.0	18	77	5	3
614	4500	68	50 x 106	17	60	31 x 51	372.0	18	89	5	3
615	5000	75	58 x 96	17	60	37 x 47	392.0	18	77	6	3
616	5500	75	58 x 102	17	65	37 x 51	415.6	18	83	6	3
617	5800	75	58 x 108	17	65	37 x 51	457.6	18	89	6	3
618	6500	81	63 x 96	22	65	43 x 55	508.5	24	77	7	4
619	7500	81	63 x 108	22	70	43 x 63	594.8	24	89	7	4
620	8300	81	63 x 114	22	70	43 x 67	637.5	24	95	7	4
621	9000	89	71 x 112	24	70	50 x 55	708.7	26	89	8	4
622	10000	89	71 x 124	24	75	50 x 59	809.5	26	101	8	4
623	12000	99	78 x 113	28	75	54 x 67	864.5	30	89	8	4
624	14000	99	78 x 125	28	75	54 x 71	988.8	30	101	8	4
625	15500	106	86 x 129	30	85	66 x 67	1183.8	32	101	8	5
626	18000	106	86 x 141	30	85	66 x 71	1332.9	32	113	8	5
627	20000	119	96 x 145	33	100	78 x 67	1500.0	36	114	10	6
628	22500	119	96 x 157	33	100	78 x 71	1665.0	36	126	10	6
629	25000	119	96 x 169	33	100	78 x 75	1830.0	36	138	10	6

PACIFIC DIRECT DRAFT STEAM BOILERS

Catalog Number	Net Rating	Height Water Line, Inches	Dimensions Overall, Inches	Diameter Stack, Inches	Minimum Height Stack, Ft.	Grate Dimensions, Inches	Heating Surface, Sq. Ft.	Diameter Smoke Con-nection, Inches	Space at Front for Drawing Tubes	Size of Outlet Inches	Size of Return Inches
204	700	60	39 x 49	11	40	21 x 23	73.0	12	34	3	2
205	825	60	39 x 55	11	40	21 x 27	87.0	12	40	3	2
206	950	60	39 x 61	11	40	21 x 31	100.0	12	46	3	2
207	1075	60	39 x 67	11	40	21 x 35	114.0	12	52	3	2
208	1200	60	39 x 73	11	40	21 x 35	122.0	12	58	3	2
209	1500	64	43 x 67	13	45	25 x 35	152.0	14	52	4	2 1/2
210	1900	64	43 x 79	13	45	25 x 43	189.0	14	64	4	2 1/2
211	2350	68	47 x 81	15	50	29 x 43	234.0	16	64	5	3
212	2750	68	47 x 93	15	50	29 x 47	279.0	16	76	5	3
213	3200	68	50 x 94	17	55	31 x 47	318.0	18	77	5	3
214	3700	68	50 x 106	17	55	31 x 51	372.0	18	89	5	3
215	4100	75	58 x 96	17	55	37 x 47	392.0	18	77	6	3
216	4500	75	58 x 102	17	60	37 x 51	415.6	18	83	6	3
217	4800	75	58 x 108	17	60	37 x 51	457.6	18	89	6	3
218	5300	81	63 x 96	22	60	43 x 55	508.5	24	77	7	4
219	6200	81	63 x 108	22	65	43 x 63	594.8	24	89	7	4
220	6700	81	63 x 114	22	65	43 x 67	637.5	24	95	7	4
221	7500	89	71 x 112	24	65	50 x 55	708.7	26	89	8	4
222	8500	89	71 x 124	24	70	50 x 59	809.5	26	101	8	4
223	10000	99	78 x 113	28	70	54 x 67	864.5	30	89	8	4
224	11500	99	78 x 125	28	70	54 x 71	988.8	30	101	8	4
225	13000	106	86 x 129	30	75	66 x 67	1183.8	32	101	8	5
226	15000	106	86 x 141	30	75	66 x 71	1332.9	32	113	8	5
227	17000	119	96 x 145	33	90	78 x 67	1500.0	36	114	10	6
228	19000	119	96 x 157	33	90	78 x 71	1665.0	36	126	10	6
229	21000	119	96 x 169	33	90	78 x 75	1830.0	36	138	10	6

Pacific Boilers are so constructed that 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.

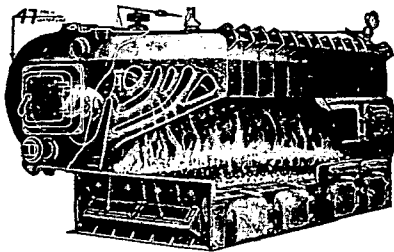
Continental Heater Corporation

Dunkirk, N. Y.

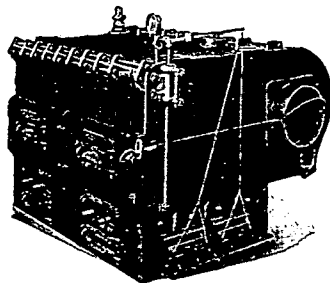
MANUFACTURERS OF CAST IRON BOILERS AND RADIATORS

Continental Low Water Line Boilers

Smokeless and Regular Types

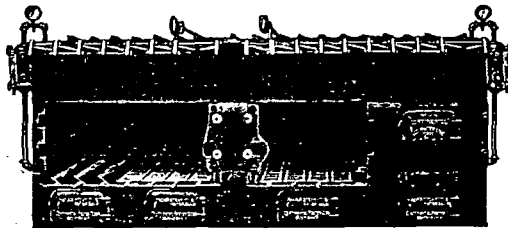


Interior View



No. 410S—Single Series (Regular)

Continental Double Series Boiler



Double Series Boiler

Many engineers, architects and heating contractors will recognize the Continental as the boiler which during the past 10 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.

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.

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	39 1/2	8x12	40
....	26	900	1,500	4.85	3	42	39 1/2	12x12	40
....	27	1,100	1,850	5.82	3	49	39 1/2	12x12	40
....	28	1,300	2,200	6.80	3	56	39 1/2	12x12	40

30 Series Water Line 43 Inches—Height of Flow 48 Inches

530	35	1,200	2,000	5.83	4	35	54 1/2	12x12	40
630	36	1,600	2,650	7.29	4	42	54 1/2	12x12	40
730	37	2,000	3,300	8.75	4	49	54 1/2	12x12	40
830	38	2,400	4,000	10.21	4	56	54 1/2	12x12	40
930	39	2,800	4,650	11.67	4	63	54 1/2	12x16	40
1030	310	3,200	5,300	13.13	4	70	54 1/2	12x16	45
1130	311	3,600	6,000	14.59	4	77	54 1/2	12x16	45
1230	312	4,000	6,650	16.05	4	84	54 1/2	16x16	45

40 Series Water Line 47 Inches—Height of Flow 54 Inches

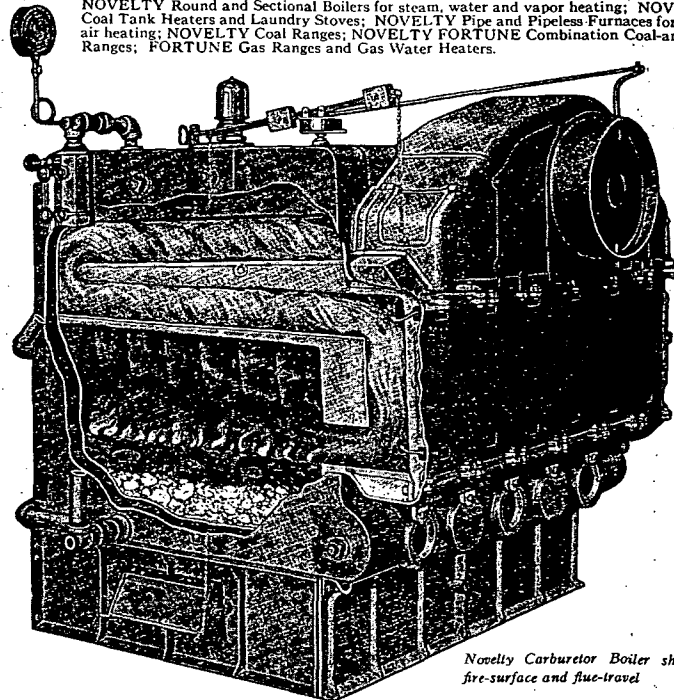
640	46	2,500	4,150	9.72	5	42	79	12x16	50
740	47	3,200	5,300	11.66	5	49	79	12x16	50
840	48	3,900	6,450	13.60	5	56	79	16x16	50
940	49	4,600	7,600	15.54	5	63	79	16x20	55
1040	410	5,300	8,750	17.48	5	70	79	16x20	55
1140	411	6,000	9,900	19.43	5	77	79	20x20	55
1240	412	6,700	11,100	21.35	5	84	79	20x20	60
1340	413	7,400	12,250	23.32	5	91	79	24x24	65
1440	414	8,100	13,400	25.27	5	98	79	24x28	65
1540	415	8,800	14,550	27.22	5	105	79	28x28	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
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

No.	Rating Sq. Ft. Steam	Rating Sq. Ft. Water	Size of Grate Inches	Grate Area Sq. Ft.	Overall Dimensions, Inches		Supply Outlets Inches	Return Inlets Inches	Smoke Outlets Inches
					Width	Depth			
3-30	1300	2150	30x18 1/2	3.85	36	54	1-4	1-4	9
4-30	1800	3000	30x27 3/8	5.76	45	55	2-4	2-4	12
5-30	2300	3800	30x36 1/2	7.65	54	56	2-4	2-4	14
6-30	2900	4650	30x45 3/8	9.56	63	56	3-4	3-4	16
7-30	3500	5450	30x55	11.45	72	57	3-4	3-4	16
8-30	4200	6300	30x64 1/8	13.36	81	57	4-4	4-4	13
4-40	2600	4300	40x27 3/8	7.68	45	64	2-4	2-4	12
5-40	3700	6100	40x36 1/4	10.21	54	66	2-4	2-4	14
6-40	4600	7600	40x45 3/8	12.75	63	66	3-4	3-4	16
7-40	5500	9100	40x55	15.28	72	67	3-4	3-4	16
8-40	6500	10750	40x64 1/2	17.81	81	67	4-4	4-4	18
9-40	7800	12900	40x73 1/4	20.35	90	70	4-4	4-4	20
10-40	9000	14850	40x82 3/8	22.88	99	70	5-4	5-4	20
11-40	10200	16850	40x91 1/2	25.42	108	72	5-4	5-4	22
12-40	11500	19000	40x100 3/8	27.88	117	72	5-4	5-4	22
13-40	12600	20800	40x109 1/4	30.50	126	72	5-4	5-4	25
14-40	13800	22800	40x118 3/8	33.04	135	75	6-4	6-4	25
15-40	15000	24750	40x128	35.58	144	75	6-4	6-4	25
16-40	16500	27250	40x137 3/8	38.12	153	75	7-4	7-4	25
17-40	18000	29700	40x146 1/4	40.66	162	72	7-4	7-4	2-20
18-40	19500	32200	40x155 3/8	43.20	171	72	8-4	8-4	2-20
19-40	22000	36300	40x164 1/2	45.74	180	72	8-4	8-4	2-20
20-40	24000	39600	40x173 3/8	48.28	189	72	8-4	8-4	1-20 1-22

Height of water line 50 inches. 3, 4 and 5-section boilers have one fire-door; 6, 7, 8, 9 and 10-section have two fire-doors; 11, 12 and 13-section have four fire-doors; 14, 15 and 16-section have five fire-doors; and 17, 18, 19 and 20-section have six fire-doors.

NOVELTY CARBURETOR (Side-feed) SECTIONAL BOILERS

This Novelty Carburetor Boiler has separate chambers connected to the rear of each section of the boiler. By means of air-slots at top and bottom of each carburetor, air is drawn in which furnishes oxygen for mixing with the smoke and unburned gases. After the smoke and gases have come in contact with the extensive, over-hanging, direct heating surface in the firebox of the boiler, they are drawn into the carbureting chamber. They mix with the oxygen from the air brought in at the rear and are instantly ignited and break into flames.

In other words, after combustion takes place in the firebox of the boiler, the smoke and gases, instead of passing up into the flue within the boiler, as in the regular type, enter the carburetor at the rear of each section, where they are mixed with air and ignited. They immediately enter the lower flue in a hot, red flame at an unusually high temperature and pass to the front of the boiler, where they enter the upper flue still in a red flame, and then return to the rear of the boiler. These flues are surrounded by water so that this part of the boiler, which is flue surface in other boilers, becomes prime heating surface in the NOVELTY Carburetor Boiler.

The smoke and gases which usually pass into the chimney and are wasted, are thoroughly consumed. At least 15 per cent more heat units are liberated in the NOVELTY Carburetor Boiler than is possible in the regular surface feed boiler of any make. No adjustment of air intake is necessary. Rate of combustion determines amount of air required.

Burns Hard or Soft Coal—In the NOVELTY Carburetor Boiler there is a big saving in burning hard coal, regardless of the size, as well as soft coal. The cheaper grades and sizes of hard coal are made to yield as many heat units as the larger and more expensive sizes.

Where soft coal is used, about 80 per cent of the volatile matter (which analysis shows to be very high in heat value) is thoroughly consumed.

The Fundamental Side Feed Principle is maintained in the NOVELTY Carburetor Boiler the same as in the regular Novelty Sectional Boiler. As a section is added, grate surface, fire surface, carbureting chamber and flue surface are increased in equal proportion giving every size, from the smallest (made for homes) to the largest (made for schools, churches, apartments, office buildings and public buildings), a balance which is not possible with the end feed type.

Low Water Line—The low water line, only 50 in. in all sizes, saves excavating and saves space. The distance from the fire-door to back of firebox is only 40 in. in the largest boiler.

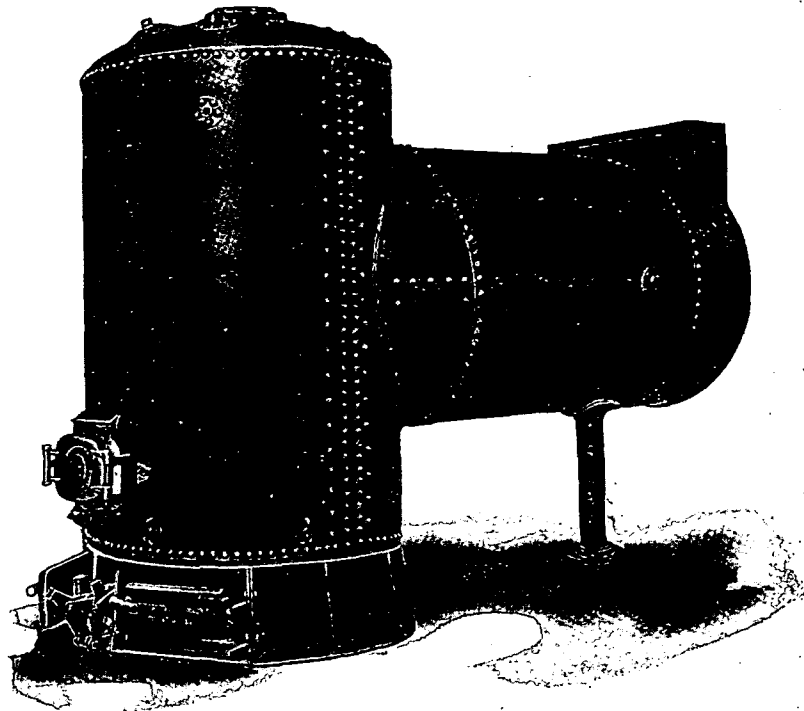
Fitzgibbons Boiler Co., Inc.

ESTABLISHED 1886

Works: OSWEGO, N. Y.

GENERAL OFFICES: 47 West 42nd Street, New York City

Fitzgibbons Power and Heating Boilers, 30 to 350 H. P., for 150, 125, 100 and 15 lbs. working pressure. Built to A. S. M. E. Boiler Code. Adapted to Bituminous, Semi-Bituminous, Anthracite and Oil Fuel. Compact. Accessible. Do not require Brick Setting.



150 H. P. FITZGIBBONS BOILER

Specifications—Heating Boiler—15 lbs. W. S. P.

Number	23	24	25	26	27	29	30	31	32	33	34	35
Horse Power	40	50	60	70	80	100	125	150	175	200	225	250
Steam Rating, sq. ft.	4500	5400	6400	7500	8500	11000	13500	16500	19000	22000	25000	28000
Length (feet and inches)	9-4	10-6	10-9	12-2	12-4	13-7	13-11	15-1	15-5	16-2	17-5	18-2
Height (feet and inches)	8-3	8-6	8-11	9-2	9-9	10-1	10-8	11-0	11-11	12-1	12-2	12-6
Water-line (feet and inches)	7-1	7-4	7-8	7-11	8-5	8-8	9-2	9-4	10-1	10-4	10-4	10-8
Diameter Vertical Cylinder	4-1	4-5	4-8	4-10	5-1	5-5	5-11	6-3	6-7	6-9	6-11	7-3
Diameter Horizontal Cylinder	3-5	3-8	3-11	4-1	4-4	4-7	5-1	5-3	5-7	5-9	5-9	6-1
Clearance at Rear	4-8	5-7	5-7	6-10	6-10	7-9	7-8	8-7	8-7	8-11	10-1	10-7

The Fitzgibbons "Ontario" Boiler attains its high operating economy from utilizing the well-known design of the Fitzgibbons Boiler. Built in the same Works, with the same care, by the same mechanics and under the same engineers as the Power Boilers.

Design: Internally fired. Compact. Entirely self-contained. No brick work required. High combustion chamber. Free water circulation. Ample steam space insuring dry steam.

Construction: Built entirely of certified boiler steel according to the A. S. M. E. Boiler Code for low pressure steam and hot water heating.

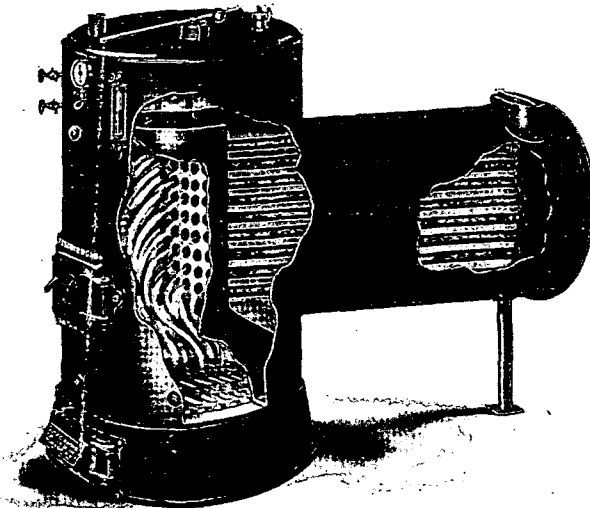
Combustion: Contains a specially proportioned fire box with high combustion chamber.

Economy: Its high economy is due primarily to design of combustion chamber, efficient round grate and rapid circulation.

Safety: Fusible plug in crown sheet directly over the fire, protecting the boiler in case of low water.

Accessibility: All parts of the interior of boiler can easily and quickly be cleaned or examined.

Labor Saving: The entire boiler is in one piece or unit and tested at the Works, just as it is to be installed.



FITZGIBBONS "ONTARIO" BOILER for low pressure Steam and Hot Water Heating

Specifications—15 lbs. W. S. P.

Number of Boiler	H 12	H 16	H 20	H 24	H 28	H 32	H 36	Number of Boiler	H 12	H 16	H 20	H 24	H 28	H 32	H 36
Steam Rating	600	800	1000	1200	1400	1600	1800	Height Cast Iron Stand	28 1/2	28 1/2	28 1/2	27 1/2	27 1/2	28	28
Hot Water Rating	1000	1300	1600	1900	2200	2500	2800	Width Smoke Uptake	6 1/2	6 1/2	6 1/2	7 1/2	7 1/2	8 1/2	8 1/2
Diameter Vertical Shell	29	29	33	33	36	36	36	Length Smoke Uptake	15 1/2	15 1/2	15 1/2	17 1/2	17 1/2	20 1/2	20 1/2
Height Bare Boiler	52 1/4	52 1/4	52 1/4	52 1/4	52 1/4	57	57	Clearance Flue Door	21	21	21	23	23	27	27
Length Bare Boiler	60 1/4	72 1/4	84 1/4	77 1/4	89 1/4	81 1/4	93 1/4	Steam Outlet	4	4	4	4 1/2	4 1/2	5	5
Diameter Horizontal Shell	21	21	21	23	23	27	27	Return	2 1/2	2 1/2	2 1/2	3	3	3	3
Floor to Water-line	56	56	56	56	56	60 1/4	60 1/4	Safety Valve	1	1	1 1/4	1 1/4	1 1/4	1 1/2	1 1/2
Diameter Fire Box	24	24	24	28	28	31	31	Diameter Smoke Pipe	10	10	10	12	12	14	14
Diameter Cast Iron Base	33 1/2	33 1/2	33 1/2	37 1/2	37 1/2	40 1/2	40 1/2	Approx. Sq. Ft. Covering	48	54	60	62	68	76	84
Overall Height	65 1/4	65 1/4	65 1/4	70	70	70	70	Approx. Shipping Weight	1800	2000	2200	2400	2600	2800	3000
Overall Length	70	82	94	87	99	91	103								

Ratings are based on 2 lb. 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.

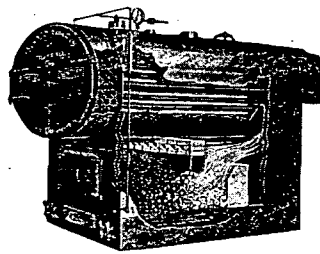
HEGGIE-SIMPLEX BOILER COMPANY

JOILET, ILLINOIS

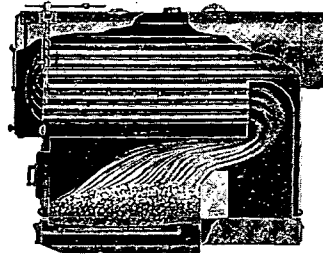
General Sales Office, 1909 Conway Bldg., CHICAGO

Cleveland Toledo Cincinnati Columbus Detroit
 Denver Oklahoma City Milwaukee Memphis
 St. Louis Charlotte, N. C. New York Minneapolis

SIMPLEX STEEL HEATING BOILERS



With Smoke Burning Arch



Straight Draft Type

These Boilers Will Heat All Radiation Shown by Their Capacity

SIMPLEX combines both firebox and double return tubular types of boilers into one. *Providing:* An unusually large direct firebox heating surface. Double return tubular flues which force long gas travel and insure thorough utilization of heat. A smoke-burning arch which forces soot and gases to ignite through contact with the burning fuel. A large combustion chamber in the rear of the firebox which insures thorough combustion before gases are allowed to pass into the flues. A single body of water, in direct contact with every heated surface, that circulates freely around the tubes and firebox, unimpeded by pipe connections.

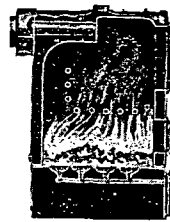
SIMPLEX BOILERS burn any fuel—COAL, OIL, GAS or WOOD. They burn smokelessly and save 25% to 40% in consumption. Occupy only 2/3 the floor space ordinarily needed. Come in one piece (except base) ready for setting—without rivets, pipe connecting or bricking. There are no laps to break and leak, no ordinary iron castings to crack and no brick work to leak air and spoil draft control.

SIMPLEX BOILERS are electric arc welded, built according to A. S. M. E. Code—of flange steel plate. Working pressure 15 lb. Tested to 100 lb. Hydrostatic pressure. Fully guaranteed.

SIMPLEX WATER HEATING GARBAGE BURNERS

The back and forth flue travel, together with the complete manner in which the water surrounds every heated surface in SIMPLEX HEATERS produce savings of 30% to 60% in fuel.

Catalog Number.....	35	36	37	38	39	40	41	42
Capacity, Gallons per Hour.....	600	800	1000	1200	1500	1800	2200	2600
Height Over-all.....In.	60	60	60	66	66	68	68	68
Dimensions of Floor Space Required.....In.	29x26	29x32	29x39	36x39	36x46	41x41	41x47	41x53
Dimensions Over-all.....In.	28x31	28x37	28x44	36x44	36x50	41x44	41x51	41x58
Dimensions of Lower Grates.....In.	22x20	22x26	22x33	28x33	28x38	33x32	33x38	38x44
Size Flow and Return.....In.	2 1/2	2 1/2	2 1/2	2 1/2	3	3	4	4
Diameter of Smoke Pipe.....In.	10	10	10	11	11	12	12	12
Approximate Shipping Weight.....	1750	2000	2250	2450	3000	3300	3700	4000



Note how water circulates through tubes forming garbage grate; ample grate area; simplicity of construction.



SPECIFICATIONS, SIMPLEX STEEL HEATING BOILERS

No. of Boiler.....	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118
Capacity, Steam.....	850	1000	1150	1300	1600	1900	2200	2600	3000	3500	4000	4500	5000	5500	6000	6500	7000	7500
Water.....	1400	1650	1900	2100	2650	3100	3600	4300	4900	5750	6550	7400	8200	9000	9850	10700	11500	12300
Weight—Base Boiler.....	1613	1791	1877	2042	2372	2724	2939	3448	3730	4557	4832	5323	5501	5785	6094	6828	7103	7479
—Base Only.....	259	276	290	277	319	370	361	402	444	436	457	478	518	538	550	559	580	601
—Grates Only.....	401	401	401	470	470	470	649	649	649	998	998	998	1164	1164	1164	1537	1537	1537
—Steam Trim.....	33	33	33	33	33	33	34	34	34	37	37	37	37	37	37	45	45	45
—Firing Tools.....	24	24	24	24	24	24	26	26	26	29	29	29	29	29	29	36	36	36
—Total.....	2320	2525	2625	2872	3321	3621	4009	4559	4883	6057	6351	6865	7249	7553	7874	9005	9301	9698
Boiler Horsepower.....	8.5	10	11.5	13	16	19	22	26	30	35	40	45	50	55	60	65	70	75
—Width.....	27	27	27	30	30	30	34	34	34	40	40	40	47	47	47	52	52	52
—Length.....	52	58	64	58	70	82	79	91	103	92	98	104	101	107	113	109	115	121
Width Firebox.....	22	22	22	25	25	25	29	29	29	34	34	34	41	41	41	46	46	46
Length.....	31	37	43	37	49	61	55	67	79	66	72	78	72	78	84	78	84	90
Grate Area.....	4.4	4.4	4.4	5.67	5.67	5.67	7.88	7.88	7.88	10.66	10.66	10.66	12.87	12.87	12.87	16.52	16.52	16.52
Diam. Breaching.....	14	14	14	18	18	18	20	20	20	22	22	22	24	24	24	26	26	26
—Stack.....	12	12	12	16	16	16	18	18	18	20	20	20	22	22	22	24	24	24
Height.....	40	40	40	50	50	50	55	55	55	60	60	60	65	65	65	70	70	70
Diam. Breaching 2 Boilers.....	20	20	20	26	26	26	28	28	28	30	30	30	34	34	34	38	38	38
—Stack 2 Boilers.....	18	18	18	24	24	24	26	26	26	28	28	28	32	32	32	34	34	34
Height * 2.....	50	50	50	60	60	60	65	65	65	70	70	70	75	75	75	80	80	80
Size Steam Opening.....	4	4	4	4	4	4	6	6	6	6	6	6	8	8	8	8	8	8
—Return.....	2	2	2	2	2	2	3	3	3	3	3	3	4	4	4	4	4	4
—Safety Valve.....	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	2	2	2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	3	3	3
Diam. Flues.....	3	3	3	3	3	3	3	3	3	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2
Sq. Ft. Boiler Covering Required.....	45	50	55	55	65	75	80	90	100	100	104	110	116	126	132	140	147	154
Height Water Line.....	55	55	55	58	58	58	62	62	62	69	69	69	72	72	72	77	77	77

No. of Boiler.....	119	120	121	122	123	124	125	126	127	128	129	130	131
Capacity, Steam.....	8500	10000	11000	12000	13000	14500	15500	16500	18500	20000	22000	25000	28000
Water.....	13950	16400	18050	19700	21300	23800	25400	27100	30350	32800	36100	41000	45900
Weight—Base Boiler.....	8426	8733	11115	11549	12021	13556	14120	14656	16492	17771	22041	23619	25197
—Base Only.....	626	667	1019	1047	1087	1092	1126	1160	1188	1256	1276	1344	1412
—Grates Only.....	1770	1770	1859	1859	1859	2269	2269	2269	2573	2573	2933	2933	2933
—Steam Trim.....	45	45	51	51	51	55	55	55	64	64	72	72	72
—Firing Tools.....	36	36	36	36	36	39	39	39	45	45	45	45	45
—Total.....	10903	11251	14080	14542	15054	17011	17609	18179	20362	21709	26367	28013	29659
Boiler Horsepower.....	85	100	110	120	130	145	155	165	185	200	220	250	280
—Width.....	57	57	63	63	63	70	70	70	78	78	84	84	84
—Length.....	121	133	123	129	135	129	135	141	141	153	153	165	177
Width Firebox.....	51	51	57	57	57	63	63	63	72	72	77	77	77
Length.....	90	102	96	102	96	102	108	108	114	114	126	138	138
Grate Area.....	20.61	20.61	22.95	22.95	22.95	28.21	28.21	28.21	35.51	35.51	37.68	37.68	37.68
Diam. Breaching.....	28	28	30	30	30	34	34	34	38	38	42	42	42
—Stack.....	26	26	28	28	28	32	32	32	36	36	40	40	40
Height.....	75	75	75	75	75	80	80	80	90	90	100	100	100
Diam. Breaching 2 Boilers.....	40	40	44	44	44	50	50	50	54	54	56	56	56
—Stack 2 Boilers.....	36	36	40	40	40	46	46	46	50	50	54	54	54
Height * 2.....	85	85	85	85	85	90	90	90	100	100	110	110	110
Size Steam Opening.....	8	8	10	10	10	10	10	10	12	12	12	12	12
—Return.....	4	4	5	5	5	5	5	5	6	6	6	6	6
—Safety Valve.....	3	3	3 1/2	3 1/2	3 1/2	4	4	4	4 1/2	4 1/2	4 1/2	4 1/2	4 1/2
Dia. Flues.....	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	4	4	4	4	4
Sq. Ft. Boiler Covering Required.....	165	180	180	190	197	205	215	222	240	260	280	310	340
Height Water Line.....	80	80	92	92	92	95	95	95	104	104	111	111	111

INTERNATIONAL HEATER COMPANY

Makers of Heating Apparatus

Utica, N. Y.

NEW YORK CHICAGO CLEVELAND NASHUA, N. H.
 Broadway and 57th St. 1933-35 Wentworth Ave. 1441 Davenport Ave., N.E. 110 Chestnut St.

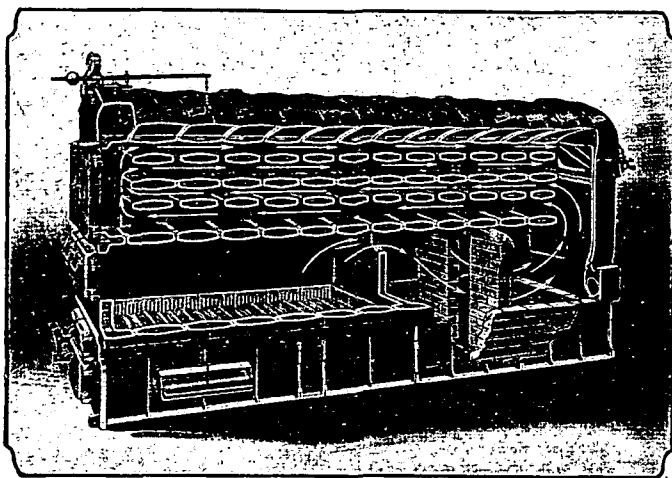
ECONOMY BOILERS

On the following pages we present condensed data on the INTERNATIONAL ECONOMY 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 Boiler Code 1919; 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 with no 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 to burn any fuel used for heating purposes; as soft coal, hard coal including buckwheat on large installations, coke, oil and gas. It is built on the *Kent Wing Wall principle* so that the smokeless feature is entirely outside of the fire box and practically independent of the fireman. It has no special grates or arches in the fire box, holds several hours' supply of coal and requires the least possible attention. Auxiliary air is always under control—an important feature that promotes fuel economy.



Cut-Away View of No. 140-47 Economy Smokeless Boiler

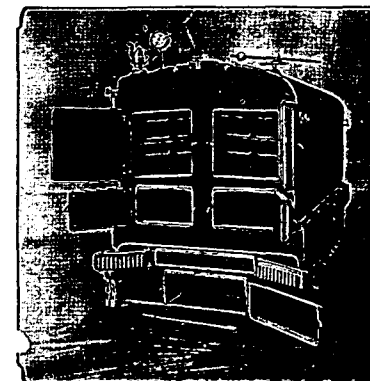
INTERNATIONAL HEATER COMPANY

SECTIONAL MEASUREMENTS

Regular and Smokeless Steam Sizes

Series	Height of Water Line, Inches	Height to Supply Outlet, Inches	Add to Height for Trimming, Feet	Length of Smoke Box, Inches	Width of Boiler, Including Trimming, Inches	Height from Floor to Center of Return Tappings, Inches	Height of Fire Box to Crown, Inches	Height Grates to Middle of Feed Door, Inches	Size of Smoke Flue, Inches	Size of Feed Doors, Inches
*19	44	53	9	6	35	18	22	16	9	9x14
26	47	57	11	7 1/2	40	19	22	16	10	9x17
31	50	62 1/2	11	7 3/4	45	19 1/2	24	18	12	9x17
38	54	68	11	8 1/4	52	20	26	18	16	11x21
47	59	73	12	8 3/4	61	21 1/2	26	18	20	2-10x17

*19 in. series for hard coal only.



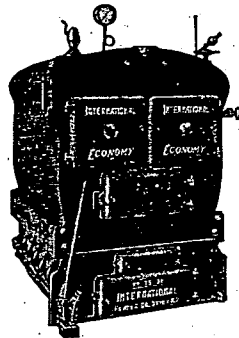
47 in. Series Economy Smokeless Boiler Showing Access for Cleaning

Ratings and Dimensions

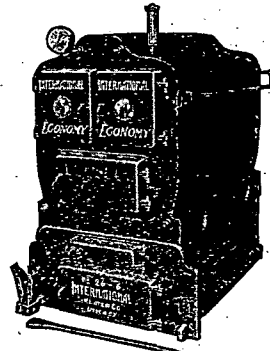
ECONOMY SMOKELESS BOILERS

Number	Rating	Coal Capacity Pounds	Evaporative Power	Dimensions Overall Inches	Tappings		Number	Rating	Coal Capacity Pounds	Evaporative Power	Dimensions Overall Inches	Tappings	
					Supply	Return						Supply	Return
80-26	2200	375	9.3	40x69	3-3/4	2-3/4	110-38	5800	1135	9.75	52x93	3-5	2-5
81-26	2400	425	9.3	40x74	3-3/4	2-3/4	111-38	6100	1225	9.75	52x98	3-5	2-5
90-26	2500	460	9.3	40x77	3-3/4	2-3/4	120-38	6350	1285	9.75	52x101	3-5	2-5
91-26	2700	510	9.3	40x82	3-3/4	2-3/4	130-38	6900	1285	9.75	52x109	3-5	2-5
100-26	2800	545	9.3	40x85	3-3/4	2-3/4	140-38	7450	1285	9.75	52x117	3-5	2-5
110-26	3100	545	9.3	40x93	3-3/4	2-3/4	150-38	8000	1435	9.75	52x125	3-5	2-5
							160-38	8550	1435	9.75	52x133	3-5	2-5
							170-38	9100	1435	9.75	52x141	3-5	2-5
80-31	2850	480	9.3	45x69	3-4	2-4	90-47	8300	1250	10	61x93	3-6	2-6
81-31	3100	545	9.3	45x74	3-4	2-4	100-47	9300	1500	10	61x103	3-6	2-6
90-31	3250	590	9.3	45x77	3-4	2-4	110-47	10300	1500	10	61x113	3-6	2-6
91-31	3500	655	9.3	45x82	3-4	2-4	120-47	11300	1500	10	61x123	4-6	2-6
100-31	3650	700	9.3	45x85	3-4	2-4	130-47	12300	1750	10	61x133	4-6	2-6
101-31	3900	765	9.3	45x90	3-4	2-4	140-47	13300	1750	10	61x143	4-6	2-6
110-31	4050	810	9.3	45x93	3-4	2-4	150-47	14300	1750	10	61x153	4-6	2-6
120-31	4450	810	9.3	45x101	3-4	2-4	160-47	15300	1750	10	61x163	4-6	2-6
130-31	4850	920	9.3	45x109	3-4	2-4	170-47	16300	1750	10	61x173	4-6	2-6
140-31	5250	920	9.3	45x117	3-4	2-4	180-47	17300	2000	10	61x183	4-6	2-6
150-31	5650	920	9.3	45x125	3-4	2-4	190-47	18300	2000	10	61x193	4-6	2-6
							200-47	19300	2000	10	61x203	4-6	2-6
							210-47	20300	2000	10	61x213	4-6	2-6
90-38	4700	835	9.75	52x77	3-5	2-5							
91-38	5000	925	9.75	52x82	3-5	2-5							
100-38	5250	985	9.75	52x85	3-5	2-5							
101-38	5550	1075	9.75	52x90	3-5	2-5							

INTERNATIONAL HEATER COMPANY



No. 90-38 Steam Pattern



No. 26-6 Water Pattern

ECONOMY SECTIONAL BOILERS

Steam						Water					
Number	Rating	Coal Capacity Pounds	Evaporative Power	Dimensions Overall Inches	Tappings Supply Return	Number	Rating	Coal Capacity Pounds	Dimensions Overall Inches	Tappings Supply Return	
35-19	700	195	9.6	35x32	2-3"	19-35	1150	195	33x32	1-3"	2-3"
4-19	825	225	9.6	35x35	2-3"	19-4	1325	225	33x35	1-3"	2-3"
45-19	975	265	9.6	35x40	2-3"	19-45	1600	265	33x40	2-3"	2-3"
5-19	1100	295	9.6	35x43	2-3"	19-5	1825	295	33x43	2-3"	2-3"
4-26	1000	290	9.3	40x37	2-3 1/2"	26-4	1650	290	36x37	2-3 1/2"	2-3 1/2"
45-26	1200	340	9.3	40x41	2-3 1/2"	26-45	1975	340	36x41	2-3 1/2"	2-3 1/2"
5-26	1300	375	9.3	40x45	2-3 1/2"	26-5	2150	375	36x45	2-3 1/2"	2-3 1/2"
55-26	1500	425	9.3	40x49	2-3 1/2"	26-55	2475	425	36x49	2-3 1/2"	2-3 1/2"
6-26	1600	460	9.3	40x53	2-3 1/2"	26-6	2650	460	36x53	2-3 1/2"	2-3 1/2"
5-31	1650	480	9.3	45x45	2-4"	31-5	2725	480	42x45	2-4"	2-4"
55-31	1900	545	9.3	45x49	2-4"	31-55	3125	545	42x49	2-4"	2-4"
6-31	2050	590	9.3	45x53	2-4"	31-6	3375	590	42x53	2-4"	2-4"
65-31	2300	645	9.3	45x57	2-4"	31-65	3800	645	42x57	2-4"	2-4"
7-31	2450	705	9.3	45x61	2-4"	31-7	4050	705	42x61	2-4"	2-4"
75-31	2700	770	9.3	45x65	2-4"	31-75	4450	770	42x65	2-4"	2-4"
8-31	2850	825	9.3	45x69	2-4"	31-8	4700	825	42x69	2-4"	2-4"
85-31	3100	890	9.3	45x73	2-4"	31-85	5125	890	42x73	2-4"	2-4"
5-38	2500	685	9.75	52x45	2-5"	38-5	4125	685	48x45	2-5"	2-5"
55-38	2800	770	9.75	52x50	2-5"	38-55	4625	770	48x50	2-5"	2-5"
6-38	3050	835	9.75	52x53	2-5"	38-6	5025	835	48x53	2-5"	2-5"
65-38	3350	920	9.75	52x58	2-5"	38-65	5525	920	48x58	2-5"	2-5"
7-38	3600	985	9.75	52x61	2-5"	38-7	5950	985	48x61	2-5"	2-5"
75-38	3900	1070	9.75	52x66	2-5"	38-75	6450	1070	48x66	2-5"	2-5"
8-38	4150	1135	9.75	52x69	2-5"	38-8	6850	1135	48x69	2-5"	2-5"
85-38	4450	1220	9.75	52x74	2-5"	38-85	7350	1220	48x74	2-5"	2-5"
9-38	4700	1285	9.75	52x77	2-5"	38-9	7750	1285	48x77	2-5"	2-5"
95-38	5000	1370	9.75	52x82	2-5"	38-95	8250	1370	48x82	2-5"	2-5"
10-38	5250	1455	9.75	52x85	2-5"	38-10	8650	1455	48x85	2-5"	2-5"
105-38	5550	1520	9.75	52x90	2-5"	38-105	9150	1520	48x90	2-5"	2-5"
11-38	5800	1585	9.75	52x93	2-5"	38-11	9550	1585	48x93	2-5"	2-5"
6-47	5300	1250	9.5	61x63	2-6"	47-6	8750	1250	59x63	2-6"	2-6"
7-47	6300	1500	9.5	61x73	2-6"	47-7	10400	1500	59x73	2-6"	2-6"
8-47	7300	1750	9.5	61x83	2-6"	47-8	12050	1750	59x83	2-6"	2-6"
*B9-47	8300	2000	9.5	61x93	2-6"	*B47-9	13700	2000	59x93	2-6"	2-6"
9-47	8300	2000	9.5	61x93	2-6"	47-9	13700	2000	59x93	2-6"	2-6"
*B10-47	9300	2250	9.5	61x103	2-6"	*B47-10	15350	2250	59x103	2-6"	2-6"
10-47	9300	2250	9.5	61x103	2-6"	47-10	15350	2250	59x103	2-6"	2-6"

*Bridgwall Section, limiting Grate to Convenient length for hand firing.

INTERNATIONAL HEATER COMPANY

ECONOMY ROUND BOILERS

These Boilers are designed to meet the most rigid demands for economical heating. Tested and rated according to the A. S. H. & V. E. Boiler Code 1919.

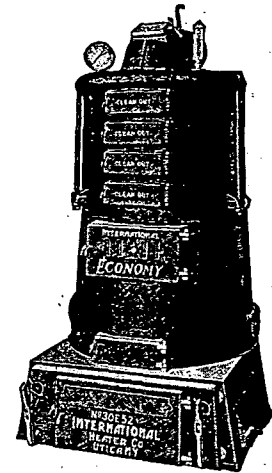
The carburetor principle of combustion is embodied in the design, also the positive cross fire travel, an exclusive feature of Economy Round Boilers.

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 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 1296-G for additional data.

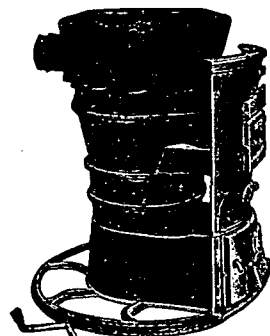


Economy Round Boiler

Ratings and Dimensions ECONOMY ROUND BOILERS

Steam						Water					
Number	Rating	Coal Capacity Pounds	Evaporative Power	Tappings Supply and Return	Height to Flow Outlet Inches	Number	Rating	Coal Capacity Pounds	Tappings Supply and Return	Height to Flow Outlet Inches	
3-E-16	350	114	8.2	1-2 1/2"	45	16-E-3	575	114	1-2 1/2"	40 1/2	
4-E-16	375	114	9.0	1-2 1/2"	49	16-E-4	625	114	1-2 1/2"	44 1/2	
5-E-16	400	114	9.7	1-2 1/2"	53	16-E-5	650	114	1-2 1/2"	48 1/2	
3-E-18	425	142	8.2	1-2 1/2"	45	18-E-3	700	142	1-2 1/2"	40 1/2	
4-E-18	475	142	9.0	1-2 1/2"	49	18-E-4	775	142	1-2 1/2"	44 1/2	
5-E-18	500	142	9.7	1-2 1/2"	53	18-E-5	825	142	1-2 1/2"	48 1/2	
2-E-21	450	170	8.2	2-2 1/2"	46 1/2	21-E-2	750	170	2-2 1/2"	42 1/2	
3-E-21	525	170	9.0	2-2 1/2"	50 1/2	21-E-3	875	170	2-2 1/2"	46 1/2	
4-E-21	575	170	9.7	2-2 1/2"	54 1/2	21-E-4	950	170	2-2 1/2"	50 1/2	
2-E-24	550	220	8.2	2-3"	47 1/2	24-E-2	900	220	2-3"	43 1/2	
3-E-24	650	220	9.0	2-3"	52 1/2	24-E-3	1075	220	2-3"	48	
4-E-24	725	220	9.7	2-3"	56 1/2	24-E-4	1200	220	2-3"	52 1/2	
5-E-24	775	220	10.3	2-3"	61 1/2	24-E-5	1275	220	2-3"	57	
2-E-27	700	275	8.2	2-3 1/2"	50	27-E-2	1150	275	2-3 1/2"	45 1/2	
3-E-27	825	275	9.0	2-3 1/2"	54 1/2	27-E-3	1375	275	2-3 1/2"	50 1/2	
4-E-27	925	275	9.7	2-3 1/2"	59 1/2	27-E-4	1550	275	2-3 1/2"	55	
5-E-27	1000	275	10.3	2-3 1/2"	64 1/2	27-E-5	1650	275	2-3 1/2"	59 1/2	
2-E-30	1025	385	8.2	2-4"	52 1/2	30-E-2	1675	385	2-4"	48	
3-E-30	1200	385	9.0	2-4"	58	30-E-3	2000	385	2-4"	53 1/2	
4-E-30	1350	385	9.7	2-4"	63 1/2	30-E-4	2225	385	2-4"	58 1/2	
5-E-30	1475	385	10.3	2-4"	68 1/2	30-E-5	2400	385	2-4"	63 1/2	
Outside Diameter at Base.....						16"	18"	21"	24"	27"	30"
Height, Floor to Center, Return Tappings.....						22 1/2"	25 1/2"	29"	32"	35"	39"
Size of Smoke Flue.....						7"	7"	9"	9"	10"	10"
Extreme Width of Firepot Section.....						22 1/4"	23"	26 1/4"	28 1/4"	32 1/4"	35"

INTERNATIONAL HEATER COMPANY



Carton Furnace

INTERNATIONAL CARTON FURNACE

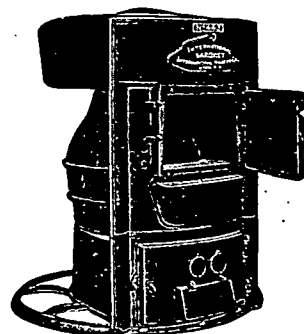
The **International Carton Furnace** is a sturdy, powerful heater made entirely of heavy cast iron with but five principal castings used in its assemblage.

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.

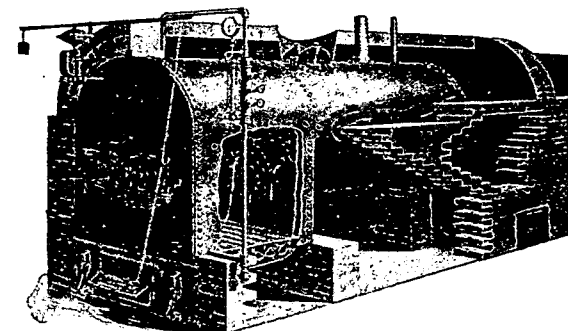
Send for Bulletins 1505 and 4010-G.

KEWANEE BOILER COMPANY

Kewanee, Illinois

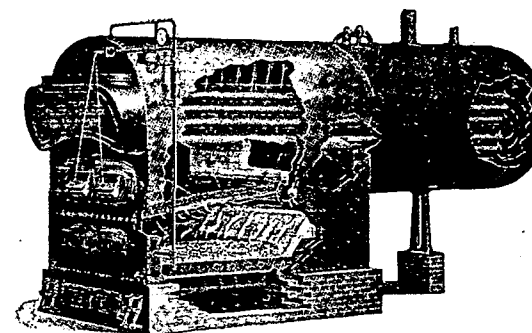
BRANCHES IN ALL PRINCIPAL CITIES

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.

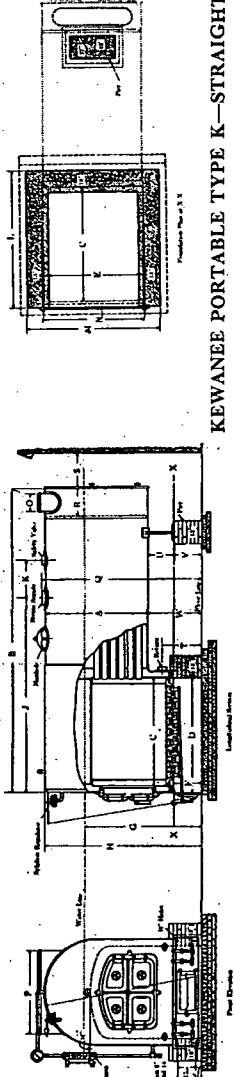
Kewanee Boilers are built of steel according to the rules of construction adopted by the *American Society of Mechanical Engineers*, known as the *A. S. M. E. Boiler Code*.

Ratings

The rated capacity of Kewanee Boilers, as printed in this book, 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 the required temperature.

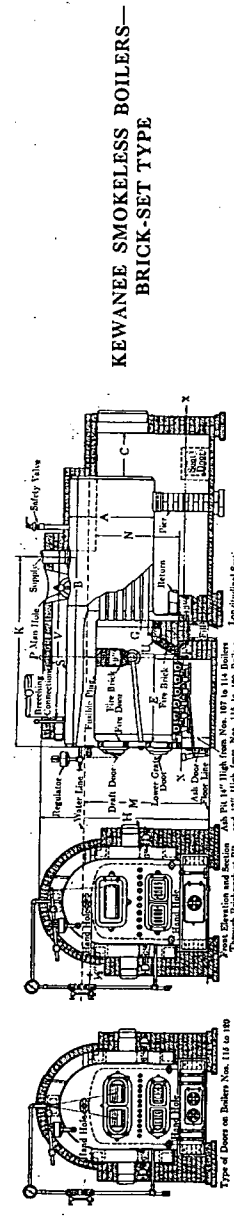
The ratings are based on a standard for steam of 2 lb. pressure at the boiler, and for water on a mean temperature of 180 deg. fahr. as the water leaves the boiler.



KEWANEE PORTABLE TYPE K—STRAIGHT DRAFT

Number of Boiler	1K	2K	3K	4K	5K	6K	8K	9K	10K	11K	12K	13K	14K	15K	16K	17K	18K	19K	20K
Capacity, Steam	850	1000	1150	1300	1450	1600	1850	2100	2350	2600	2850	3100	3350	3600	3850	4100	4350	4600	4850
Heating Surface	44	54	64	74	84	94	104	114	124	134	144	154	164	174	184	194	204	214	224
Area of Upper Grate	4.4	5.4	6.4	7.4	8.4	9.4	10.4	11.4	12.4	13.4	14.4	15.4	16.4	17.4	18.4	19.4	20.4	21.4	22.4
Diameter of Boiler	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Length of Boiler Overall	7.10	8.10	9.10	10.10	11.10	12.10	13.10	14.10	15.10	16.10	17.10	18.10	19.10	20.10	21.10	22.10	23.10	24.10	25.10
Diameter of Stack	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
Height of Stack	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
Diameter of Stack, Two Boilers	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
Height of Stack, Two Boilers	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
Size of Steam Opening	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Size of Safety Valve	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2
Length of Grate	26	32	38	44	50	56	62	68	74	80	86	92	98	104	110	116	122	128	134
Length of Ash-pit	33	39	45	51	57	63	69	75	81	87	93	99	105	111	117	123	129	135	141
Width of Ash-pit	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Height of Water-line	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
Height of Safety Valve	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26
Location of Safety Valve	4.0	4.8	5.6	6.4	7.2	8.0	8.8	9.6	10.4	11.2	12.0	12.8	13.6	14.4	15.2	16.0	16.8	17.6	18.4
Location of Foundation	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60	63	66
Width of Foundation	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
Center to Center Bolts in Ash-pit Front	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
Length of Breaching Connection	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43
Length of Steam Supply	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16
Depth of Steam Supply	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
Minimum Space Required at Rear	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
Height of Return	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29
Floor Line to Bottom of Cylinder	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19
Req'd at Front to Draw Tubes	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32
Req'd at Rear to Draw Tubes	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39
Number of Common Brick	68	77	85	91	106	120	135	149	157	177	197	200	235	275	314	331	343	358	366
Outside Surface to Be Covered	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45

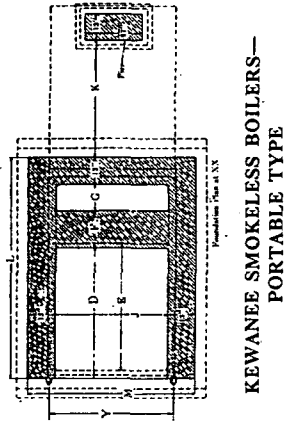
*Foundations not included. Full height back stand furnished with all boilers, no pier, see Letter W. Boilers No. 1K to No. 12K are furnished with cast iron base.



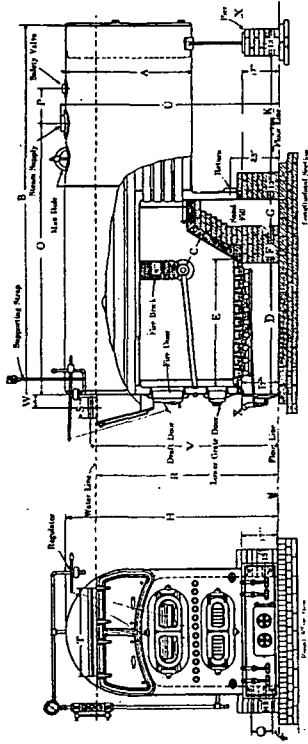
KEWANEE SMOKELESS BOILERS—BRICK-SET TYPE

Number of Boiler	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
Capacity, Steam	1600	2000	2300	2600	2900	3100	3400	3700	4000	4300	4600	4900	5200	5500	5800	6100	6400
Heating Surface	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200
Area of Upper Grate	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0	19.0	20.0
Diameter of Boiler	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36
Length of Boiler Overall	8.7	10.2	11.7	13.2	14.7	16.2	17.7	19.2	20.7	22.2	23.7	25.2	26.7	28.2	29.7	31.2	32.7
Diameter of Stack	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
Height of Stack	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
Diameter of Stack, Two Boilers	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Height of Stack, Two Boilers	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
Size of Steam Opening	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Size of Return	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Size of Safety Valve	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2
Length of Grate	26	32	38	44	50	56	62	68	74	80	86	92	98	104	110	116	122
Length of Ash-pit	33	39	45	51	57	63	69	75	81	87	93	99	105	111	117	123	129
Width of Ash-pit	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Height of Water-line	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
Height of Safety Valve	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26
Location of Safety Valve	4.0	4.8	5.6	6.4	7.2	8.0	8.8	9.6	10.4	11.2	12.0	12.8	13.6	14.4	15.2	16.0	16.8
Location of Foundation	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
Width of Foundation	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
Center to Center Bolts in Ash-pit Front	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
Length of Breaching Connection	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43
Length of Steam Supply	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16
Depth of Steam Supply	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
Minimum Space Required at Rear	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
Height of Return	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29
Floor Line to Bottom of Cylinder	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19
Req'd at Front to Draw Tubes	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32
Req'd at Rear to Draw Tubes	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39
Number of Common Brick	68	77	85	91	106	120	135	149	157	177	197	200	235	275	314	331	343
Outside Surface to Be Covered	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45

*Foundations not included.



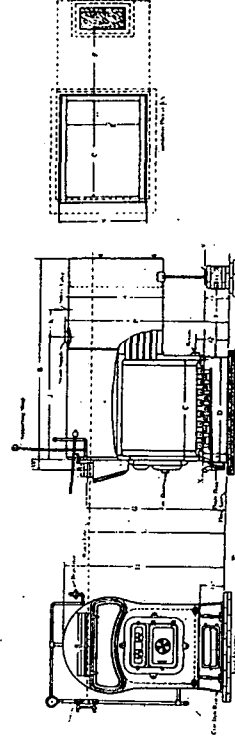
KEWANEE SMOKELESS BOILERS—PORTABLE TYPE



Number of Boiler	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324
Capacity, Steam.....	3000	3500	4000	4500	5000	5500	6000	6500	7500	8500	10000	12000	14000	16000	18000	20000	25000	30000
Heating Surface.....	297	352	391	445	495	546	592	643	721	773	912	1053	1204	1316	1458	1549	2074	2629
Area of Upper Grate.....	8.8	10.1	11.4	12.9	14.7	16.5	18.1	20.0	21.4	23.5	27.7	31.5	35.9	39.6	43.6	47.8	64.1	81.4
Diameter of Boiler.....	40	48	54	60	66	72	78	84	96	108	126	144	162	180	204	228	300	360
Diameter of Stack.....	20	24	28	32	36	40	44	48	56	64	76	88	100	112	126	144	180	216
Height of Stack.....	50	55	60	65	70	75	80	85	90	95	105	115	125	135	145	155	200	240
Height of Stack, Two Boilers.....	28	33	38	43	48	53	58	63	68	73	83	93	103	113	123	133	170	200
Height of Stack, Two Boilers.....	23	28	33	38	43	48	53	58	63	68	78	88	98	108	118	128	160	190
Size of Steam Opening.....	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	8	10
Size of Return Valve.....	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Distance Required to Open Rear Flue Doors.....	26	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22
E—Length of Grate.....	9	10	11	12	13	14	15	16	17	18	20	22	24	26	28	30	36	42
C—Header to Bridge Wall.....	38	44	50	56	62	68	74	80	86	92	108	124	140	156	172	188	240	288
D—Length of Ash-pit.....	29	35	41	47	53	59	65	71	77	83	99	115	131	147	163	179	232	280
K—Rear Wall to Pier.....	37	43	49	55	61	67	73	79	85	91	107	123	139	155	171	187	240	288
M—Width of Ash-pit.....	61	65	70	75	80	85	90	95	100	105	120	135	150	165	180	195	250	300
N—Width of Foundation.....	61	65	70	75	80	85	90	95	100	105	120	135	150	165	180	195	250	300
U—Height of Boiler.....	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85
V—Height of Water-line.....	71	71	71	71	71	71	71	71	71	71	71	71	71	71	71	71	71	71
R—Height of Breaching Connection.....	5-11	5-11	5-11	5-11	5-11	5-11	5-11	5-11	5-11	5-11	5-11	5-11	5-11	5-11	5-11	5-11	5-11	5-11
Q—Location Supply Valve.....	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
W—Connection to Front of Boiler.....	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
T—Length of Breaching Connection.....	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36
H—Rear Wall to Draw Tubes.....	8-11	8-11	8-11	8-11	8-11	8-11	8-11	8-11	8-11	8-11	8-11	8-11	8-11	8-11	8-11	8-11	8-11	8-11
Req'd at Front to Draw Tubes.....	7-7	7-7	7-7	7-7	7-7	7-7	7-7	7-7	7-7	7-7	7-7	7-7	7-7	7-7	7-7	7-7	7-7	7-7
Req'd at Rear to Draw Tubes.....	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
Number Common Brick.....	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113
Number Fire-brick.....	149	149	149	149	149	149	149	149	149	149	149	149	149	149	149	149	149	149
Outside Surface to be Covered.....	149	149	149	149	149	149	149	149	149	149	149	149	149	149	149	149	149	149

*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.....	2500	2900	3300	3700	4000	4500	5000	5500	6000	7000	8000	9500	11000	13000	15000	17500	20000	25000
Heating Surface.....	276	326	366	406	446	496	546	596	646	746	846	996	1146	1346	1546	1746	2046	2546
Area of Grate.....	9.6	11.0	12.4	13.8	15.2	16.6	18.0	19.4	20.8	24.2	28.6	33.0	37.4	41.8	46.2	50.6	64.0	78.4
Diameter of Boiler.....	48	54	60	66	72	78	84	90	96	108	120	132	144	156	168	180	216	252
Diameter of Stack.....	20	24	28	32	36	40	44	48	52	60	68	76	84	92	100	108	132	156
Height of Stack.....	50	55	60	65	70	75	80	85	90	95	105	115	125	135	145	155	200	240
Height of Stack, Two Boilers.....	28	33	38	43	48	53	58	63	68	73	83	93	103	113	123	133	170	200
Height of Stack, Two Boilers.....	23	28	33	38	43	48	53	58	63	68	78	88	98	108	118	128	160	190
Size of Steam Opening.....	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	8	10
Size of Return Valve.....	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Distance Required to Open Rear Flue Doors.....	26	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22
E—Length of Grate.....	9	10	11	12	13	14	15	16	17	18	20	22	24	26	28	30	36	42
C—Header to Bridge Wall.....	38	44	50	56	62	68	74	80	86	92	108	124	140	156	172	188	240	288
D—Length of Ash-pit.....	29	35	41	47	53	59	65	71	77	83	99	115	131	147	163	179	232	280
K—Rear Wall to Pier.....	37	43	49	55	61	67	73	79	85	91	107	123	139	155	171	187	240	288
M—Width of Ash-pit.....	61	65	70	75	80	85	90	95	100	105	120	135	150	165	180	195	250	300
N—Width of Foundation.....	61	65	70	75	80	85	90	95	100	105	120	135	150	165	180	195	250	300
U—Height of Boiler.....	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85
V—Height of Water-line.....	71	71	71	71	71	71	71	71	71	71	71	71	71	71	71	71	71	71
R—Height of Breaching Connection.....	5-11	5-11	5-11	5-11	5-11	5-11	5-11	5-11	5-11	5-11	5-11	5-11	5-11	5-11	5-11	5-11	5-11	5-11
Q—Location Supply Valve.....	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
W—Connection to Front of Boiler.....	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
T—Length of Breaching Connection.....	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36
H—Rear Wall to Draw Tubes.....	8-11	8-11	8-11	8-11	8-11	8-11	8-11	8-11	8-11	8-11	8-11	8-11	8-11	8-11	8-11	8-11	8-11	8-11
Req'd at Front to Draw Tubes.....	7-7	7-7	7-7	7-7	7-7	7-7	7-7	7-7	7-7	7-7	7-7	7-7	7-7	7-7	7-7	7-7	7-7	7-7
Req'd at Rear to Draw Tubes.....	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
Number Common Brick.....	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113
Number Fire-brick.....	149	149	149	149	149	149	149	149	149	149	149	149	149	149	149	149	149	149
Outside Surface to be Covered.....	149	149	149	149	149	149	149	149	149	149	149	149	149	149	149	149	149	149

*Foundations not included. †If space is available at front, it is not necessary at rear, and vice-versa.

Boilers

Molby Boiler Company

INCORPORATED

41 East 42nd Street, New York

Plant: Lansdale, Pa.

New Molby Magazine-Feed, Downdraft-Crossdraft Smokeless Boilers with adjustable side grate for burning cheap anthracite



The New Molby will heat home—large apartment house—or commercial building—having a good chimney, just as successfully and just as easily with low priced small coal as ordinary boilers burning the expensive sizes.

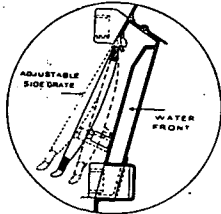
Side grate easily adjusted for small coal or large coal.

The New MOLBY is easy to operate, is self feeding, and gives a steady, even heat over long periods with low-priced No. 1 Buckwheat Anthracite. Also burns sized free-burning bituminous with proper chimney draft. Also coke. Magazines need re-filling only once every 12 hrs. Cast iron sectional construction throughout.

Ratings are based on the assumption that a good grade of No. 1 Buckwheat Anthracite is to be used and that the chimney is of such area, height and tightness as to produce the required draft; also that the boiler, mains and connections shall be covered with an insulating material. These ratings, under the same conditions, may be used for sized soft coal, of the free-burning and non-caking variety.

Should larger sizes of good grades of Anthracite be used, a given boiler—other conditions being the same—would burn with equal efficiency, 20 per cent more coal. Thus, when such larger sizes are regularly used, the ratings shown are increased 20 per cent.

The boiler is built throughout in accordance with the codes of the American Society of Mechanical Engineers and the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.



SIZES, CAPACITIES, DIMENSIONS AND PRICES OF NEW MOLBY BOILERS

STEAM						STEAM AND WATER							WATER				
Number	Steam Vapor	Water Line	Returns	Steam Rating	List Price	Size—Inches						Approximate Shipping Weight	Number	Water Cipher	Returns	Water Rating	List Price
						Height	Width	Length	Smoke Pipe	Outlets	Chimney Flue						
26" Series																	
S-4025	Adageo	48	2-3	500	\$280	54	41	39½	10	2-3	8x12	1890	W-4026	Domo	2-3	850	\$320
S-5026	Addio	48	2-3	675	340	54	41	42	10	2-3	8x12	2230	W-5026	Daseo	2-3	1125	330
S-6026	Admito	48	2-3	850	400	54	41	48½	10	2-3	8x12	2580	W-6026	Doffo	2-3	1400	390
S-7025	Adzo	48	2-3	1025	460	54	41	55	10	2-3	12x12	2925	W-7026	Doveo	2-3	1700	450
S-8026	Adelo	48	2-3	1200	520	54	41	61½	10	2-3	12x12	3300	W-8026	Docko	2-3	2000	510
31" Series																	
S-4031	Bugo	54	2-3	1000	470	62½	61	37½	14	2-4	8x12	3320	W-4031	Edamo	2-4	1650	470
S-5031	Buffo	54	2-3	1350	580	62½	61	44	14	2-4	12x12	3820	W-5031	Edgeo	2-4	2250	580
S-6031	Bullo	54	2-3	1700	667	62½	61	50½	14	2-4	12x12	4290	W-6031	Edito	2-4	2850	667
S-7031	Buno	54	2-3	2050	814	62½	61	56½	14	2-4	12x16	4690	W-7031	Edicto	2-4	3425	814
S-8031	Bufo	54	2-3	2400	904	62½	61	63½	14	2-4	12x16	5100	W-8031	Edeno	2-4	4000	904
S-9031	Buoyo	54	2-4	2750	984	62½	61	69½	14	3-4	16x16	5510	W-9031	Educoo	3-4	4575	984
S-10031	Bungo	54	2-4	3100	1064	62½	61	75½	14	3-4	16x16	5930	W-10031	Eduzo	3-4	5150	1064
47" Series																	
S-5047	Calco	61	2-4	2550	960	80	75½	50½	14	2-4	12x16	5990	W-5047	Flusco	2-4	4250	960
S-6047	Calfo	61	2-4	3200	1120	80	75½	59	14	2-4	16x16	7150	W-6047	Fledo	2-4	5325	1120
S-7047	Caro	61	2-4	3850	1280	80	75½	67½	16	3-4	16x16	8310	W-7047	Flipo	3-4	6400	1280
S-8047	Carpso	61	2-4	4500	1440	80	75½	76	16	3-4	16x20	9500	W-8047	Flowo	3-4	7500	1440
S-9047	Caseo	61	2-4	5150	1600	80	75½	84½	18	3-4	16x20	10650	W-9047	Flungo	3-4	8575	1600
S-10047	Cadio	61	3-4	5800	1760	80	75½	93	18	4-4	20x20	11840	W-10047	Flusho	3-5	9650	1760
S-11047	Cabo	61	3-4	6450	1940	80	75½	101½	18	4-4	20x20	13000	W-11047	Flinto	3-5	10725	1940
S-12047	Cando	61	3-4	7100	2100	80	75½	110	18	4-4	20x24	14150	W-12047	Flato	3-5	11800	2100
S-13047	Camo	61	3-4	7750	2260	80	75½	118½	18	4-4	20x24	15320	W-13047	Fleigo	3-5	12925	2260

Note.—In ordering 26-in. boilers state whether you wish same fitted up with right hand or left hand end to the chimney. Length includes Smoke Box.

Equipment.—Each steam boiler is equipped with a full set steam trimmings (26 in. series, 1 pressure regulator; 31 in. and 47 in. series, 2 pressure regulators).

Water boilers are furnished with two water temperature regulators, except 26 in. series which are equipped with one. A complete set of firing and cleaning tools, together with instruction books for setting up and operation, accompany each boiler.

Boilers

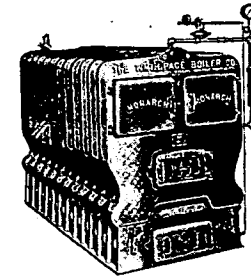
THE WM. H. PAGE BOILER CO.

GENERAL OFFICE: 58 West 40th Street, NEW YORK

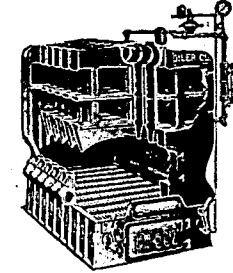
Branches: 123 Beverly Street, Boston,
Rose Building, Cleveland

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	Rating* Sq. Ft. Steam	Rating* Sq. Ft. Water	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	1400	22x20	3.06	60 1/2	39 1/4	52	35	34	41	2-3	10
605	1075	1775	22x26 3/4	4.03	60 1/2	39 1/4	52	35	40 3/4	41	2-3	10
606	1300	2150	22x32 1/4	5.00	60 1/2	39 1/4	52	35	46 1/4	41	2-3	10
607	1525	2525	22x39 3/4	5.98	60 1/2	39 1/4	52	35	53 1/4	41	2-3	10
608	1750	2900	22x45 1/2	6.95	60 1/2	39 1/4	52	35	59 1/2	41	2-3	10
504	1600	2650	28x24 1/4	4.82	73	45 1/4	64 1/2	41	43 1/4	51	2-5	13
505	2050	3400	28x33 3/4	6.45	73	45 1/4	64 1/2	41	52	51	2-5	13
506	2500	4125	28x41 1/2	8.07	73	45 1/4	64 1/2	41	60 3/4	51	2-5	13
507	2950	4875	28x49 3/4	9.70	73	45 1/4	64 1/2	41	68 1/4	51	2-5	13
508	3400	5600	28x58 1/4	11.32	73	45 1/4	64 1/2	41	77 1/4	51	2-5	13
509	3850	6350	28x66 3/4	12.96	73	45 1/4	64 1/2	41	85 1/4	51	2-5	13
510	4300	7100	28x66 3/4	14.58	73	45 1/4	64 1/2	41	93 1/4	51	2-5	13
511	4750	7850	28x66 3/4	16.21	73	45 1/4	64 1/2	41	102 1/4	51	2-5	13
512	5200	8600	28x66 3/4	17.84	73	45 1/4	64 1/2	41	110 3/4	51	2-5	13
405	3400	5600	40x33 3/4	9.20	81	59 1/4	72 1/2	55	52	58	2-5	21
406	4200	6925	40x41 1/2	11.52	81	59 1/4	72 1/2	55	60 3/4	58	2-5	21
407	5000	8250	40x49 3/4	13.85	81	59 1/4	72 1/2	55	68 1/4	58	2-5	21
408	5800	9575	40x58 1/4	16.18	81	59 1/4	72 1/2	55	77 1/4	58	2-5	21
409	6600	10900	40x66 3/4	18.50	81	59 1/4	72 1/2	55	85 1/4	58	2-5	21
410	7400	12200	40x75	20.82	81	59 1/4	72 1/2	55	93 1/4	58	2-5	21
411	8200	13525	40x83 3/4	23.13	81	59 1/4	72 1/2	55	102 1/4	58	3-5	21
412	9000	14850	40x91 3/4	25.50	81	59 1/4	72 1/2	55	110 3/4	58	3-5	21
413	9800	16175	40x91 3/4	27.81	81	59 1/4	72 1/2	55	119	58	3-5	21
414	10600	17500	40x91 3/4	30.14	81	59 1/4	72 1/2	55	127 1/4	58	3-5	21
415	11400	18800	40x91 3/4	32.47	81	59 1/4	72 1/2	55	135 1/4	58	3-5	21
416	12200	20125	40x91 3/4	34.79	81	59 1/4	72 1/2	55	144 3/4	58	3-5	21

* Monarch boilers are built in conformity with the Boiler Code of the American Society of Mechanical Engineers; and ratings as given are conservatively made in accordance with the Standard Formula of the American Society of Heating and Ventilating Engineers—derived from careful and exhaustive tests which proved their safety—and are based on a standard of 2 lb. pressure maintained at the boiler for steam and 180 degrees for hot water.

† Bridgwall sections are furnished for shortening grates. Grate areas as given above are for entire length of boilers, but unless otherwise ordered bridgwall section will be shipped with boilers larger than 509 and 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.

Branches

NEW YORK, 47 W. 42nd Street
PHILADELPHIA, 121 N. Broad Street
BALTIMORE, 2622 Frisby Street
WASHINGTON, 1228 H Street

RICHMOND, 1538 E. Cary Street
PITTSBURGH, 1402 Arrott Building
CLEVELAND, 6308 Kinsmam Road
CINCINNATI, Suite 826-827 Union Central Building

Plants

JOHNSTOWN, PA.

NEW CASTLE, PA.

TRENTON, N. J.

Warehouses

NEW YORK

NEW ROCHELLE

BALTIMORE

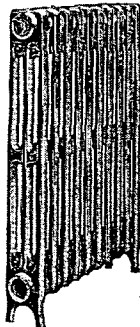
WASHINGTON

RICHMOND

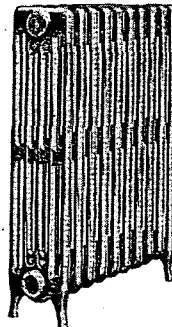
CLEVELAND

Manufacturers

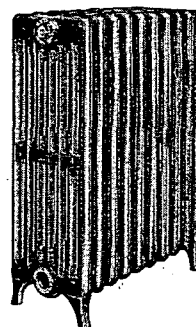
National Smokeless, Novus Upright and Sectional, Acme Round, Radium Gas and Hot Water Supply Boilers, also Aero and Premo Radiators.



Three-Column



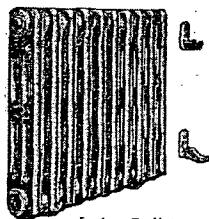
Five-Column



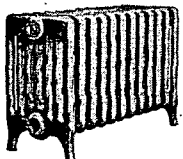
Seven-Column

Patents Applied For

AERO RADIATORS



Legless Radiator



Window Radiator

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.

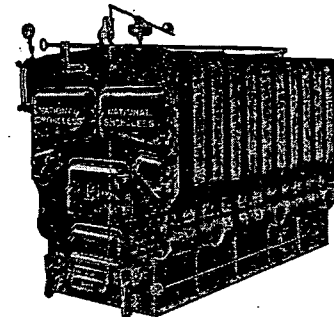
All radiators are vented for both steam and hot water. One vent is plugged. Any Aero Radiator can be used for either steam, hot water or vapor.

Aero Radiators are made in three patterns—Three, Five and Seven Column. A total of 16 heights composes the entire line.

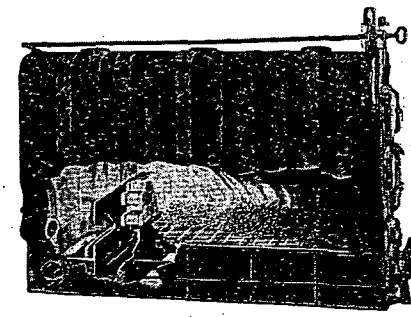
Roughing-in measurements are standard. All sections measure 2 1/4 in. from center to center.

The Three-Column pattern is 5 1/2 in. wide, the Five-Column pattern 8 3/4 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	Outlet No. and Size	Smoke Pipe	
25-9	2525	4175	9	5	6.11	3.48	49	57 1/4	65 1/2	36 1/2	40 1/2	74 1/2	27 1/2	60 1/2	3-4"	12
25-10	2825	4675	10	6	7.27	3.48	49	57 1/4	65 1/2	36 1/2	40 1/2	81 1/2	27 1/2	67 1/2	3-4"	12
25-11	3125	5175	11	7	8.43	3.48	49	57 1/4	65 1/2	36 1/2	40 1/2	88 1/2	27 1/2	74 1/2	3-4"	12
25-12	3425	5675	12	8	9.59	3.48	49	57 1/4	65 1/2	36 1/2	40 1/2	95 1/2	27 1/2	81 1/2	3-4"	12
31-9	3625	5975	9	5	8.55	5.07	52	61	71 1/4	50	54	79 1/2	33 1/2	65 1/2	3-5"	15
31-10	4050	6675	10	6	10.24	5.07	52	61	71 1/4	50	54	88 1/2	33 1/2	74 1/2	3-5"	15
31-11	4475	7375	11	7	11.93	5.07	52	61	71 1/4	50	54	95 1/2	33 1/2	81 1/2	3-5"	15
31-12	4900	8075	12	8	13.62	5.07	52	61	71 1/4	50	54	103 1/2	33 1/2	89 1/2	3-5"	15
31-13	5325	8775	13	9	15.31	5.07	52	61	71 1/4	50	54	110 1/2	33 1/2	96 1/2	3-5"	15
36-9	5125	8475	9	5	11.50	6.75	60 1/4	70	78 1/4	56	60	87 1/2	41 1/2	73 1/2	3-5"	16
36-10	5750	9500	10	6	13.75	6.75	60 1/4	70	78 1/4	56	60	95 1/2	41 1/2	81 1/2	3-5"	16
36-11	6375	10,525	11	7	16.00	6.75	60 1/4	70	78 1/4	56	60	104 1/2	41 1/2	90 1/2	3-5"	16
36-12	7000	11,550	12	8	18.25	6.75	60 1/4	70	78 1/4	56	60	112 1/2	41 1/2	98 1/2	3-5"	16
36-13	7625	12,575	13	9	20.50	6.75	60 1/4	70	78 1/4	56	60	121 1/2	41 1/2	107 1/2	4-5"	16
36-14	8250	13,600	14	9	20.50	9.50	60 1/4	70	78 1/4	56	60	129 1/2	41 1/2	115 1/2	4-5"	16
36-15	8875	14,625	15	10	22.75	9.50	60 1/4	70	78 1/4	56	60	137 1/2	41 1/2	123 1/2	4-5"	16
36-16	9500	15,650	16	10	22.75	12.25	60 1/4	70	78 1/4	56	60	146 1/2	41 1/2	132 1/2	4-5"	16
48-9	9200	15,100	9	5	18.23	10.65	68	80	89	67	71	109 1/2	53 1/2	89 1/2	3-6"	20
48-10	10,325	16,950	10	6	21.78	10.65	68	80	89	67	71	119 1/2	53 1/2	99 1/2	3-6"	20
48-11	11,450	18,800	11	7	25.33	10.65	68	80	89	67	71	130 1/2	53 1/2	110 1/2	4-6"	20
48-12	12,575	20,650	12	8	28.88	10.65	68	80	89	67	71	141 1/2	53 1/2	121 1/2	4-6"	20
48-13	13,700	22,500	13	9	32.43	10.65	68	80	89	67	71	151 1/2	53 1/2	131 1/2	4-6"	20
48-14	14,825	24,350	14	9	32.43	14.20	68	80	89	67	71	162 1/2	53 1/2	142 1/2	5-6"	20
48-15	15,950	26,200	15	10	35.98	14.20	68	80	89	67	71	173 1/2	53 1/2	153 1/2	5-6"	20
48-16	17,075	28,050	16	10	35.98	17.75	68	80	89	67	71	183 1/2	53 1/2	163 1/2	5-6"	20



Syph-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.

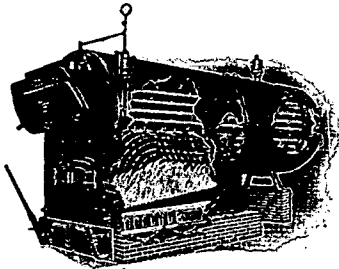
The volume of preheated air necessary to burn smoke varies with the state of combustion. The air should be gradually decreased and cut off almost completely during a period of about 20 minutes from the time fuel is charged. Unless this is done the preheated air has a tendency to chill rather than increase the gas temperatures and the boiler efficiency and evaporation is decreased.

The Syph-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.
 BOSTON, MASS., 66 Broadway
 PITTSBURGH, PA., 1116 House Bldg.
 ATLANTA, GA., 50 S. Forsyth St.
 BALTIMORE, MD., Dukehart Bldg., McComas and Race Sts.

CHICAGO, ILL., 308-19 W. Jackson Blvd.
 KANSAS CITY, MO., 410 E. 43rd St.
 HOUSTON, TEXAS, 410 Union National Bank Bldg.
 LOS ANGELES, CALIF., 1003 Union Bank Bldg.
 DENVER, COLO., 1521 Fifteenth St.
 BUFFALO, N. Y., 220 Delaware Ave.



"Oil City" Direct Draft Boiler

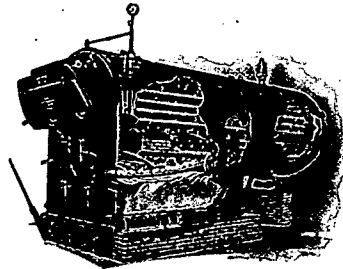
"OIL CITY" low pressure boilers are offered to the trade as the last word in "Heating Economy" comprising in one unit all the elements of a modern plant for steam or hot water heating, especially adapted for Schools, Office Buildings, Hotels, Churches, Club Houses, Hospitals or for any purpose where 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.



"Oil City" Smokeless Boiler

All parts of the boiler are made accessible for cleaning by the use of man-holes, 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.

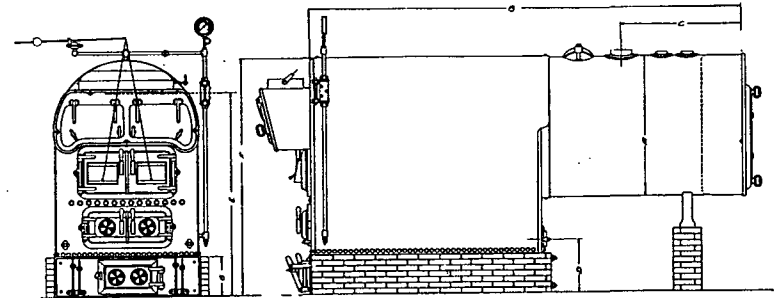
Equipment—Equipment with all boilers includes, in addition to complete set of shaking grates, all the necessary castings, safety valves, steam gauge, water column, etc., required for a complete installation.

In General—In addition to the foregoing, the object of the OIL CITY BOILER WORKS is to furnish a boiler that has embodied in it the best features of modern construction and free from the recognized faults.

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	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224
CAPACITY - STEAM	36 P.	3200	3200	3200	3200	3200	3200	3200	3200	3200	3200	3200	3200	3200	3200	3200	3200	3200
CAPACITY - WATER	36 P.	3200	3200	3200	3200	3200	3200	3200	3200	3200	3200	3200	3200	3200	3200	3200	3200	3200
BOILER DIMETER	A	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48
BOILER LENGTH	C	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4
FEET TO OUTLET	D	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4
FLOOR TO RETURN	E	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4
FLOOR TO WATER LINE	F	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4
HEIGHT OVER BOILER	G	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4
HEIGHT FROM PIT	H	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4
SIZE OUTLET	I	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
SIZE RETURN	J	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
SIZE SMOKE OUTLET	K	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4
DATA BREACHING - ONE BOILER	L	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22
DATA BREACHING - TWO BOILERS	M	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
DATA STACK - ONE BOILER	N	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
DATA STACK - TWO BOILERS	O	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
HEIGHT STACK - ONE BOILER	P	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
HEIGHT STACK - TWO BOILERS	Q	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
FEET TO OPEN REAR DOORS	R	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26

"Oil City" Direct Draft Type

NUMBER OF BOILER	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224
CAPACITY - STEAM	36 P.	3200	3200	3200	3200	3200	3200	3200	3200	3200	3200	3200	3200	3200	3200	3200	3200	3200
CAPACITY - WATER	36 P.	3200	3200	3200	3200	3200	3200	3200	3200	3200	3200	3200	3200	3200	3200	3200	3200	3200
BOILER DIMETER	A	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48
BOILER LENGTH	C	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4
FEET TO OUTLET	D	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4
FLOOR TO RETURN	E	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4
FLOOR TO WATER LINE	F	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4
HEIGHT OVER BOILER	G	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4
HEIGHT FROM PIT	H	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4
SIZE OUTLET	I	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
SIZE RETURN	J	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
SIZE SMOKE OUTLET	K	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4
DATA BREACHING - ONE BOILER	L	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22
DATA BREACHING - TWO BOILERS	M	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
DATA STACK - ONE BOILER	N	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
DATA STACK - TWO BOILERS	O	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
HEIGHT STACK - ONE BOILER	P	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
HEIGHT STACK - TWO BOILERS	Q	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
FEET TO OPEN REAR DOORS	R	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26

Boilers and Heating Specialties

Pierce, Butler & Pierce Mfg. Corp.

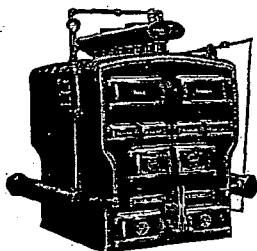
41 East 42nd St. NEW YORK CITY

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.	Sec- tions	Length	BOILER AND HEADERS		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.	
			Width	Height							Steam Boilers	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 1/4	12x12	35	1400	2325
266	6	63	51	64 1/2	47 1/8	2-4	2-4	11 1/4	12x16	35	1750	2900
267	7	71	51	64 1/2	47 1/8	2-4	2-4	11 1/4	12x16	40	2100	3475
268	8	79	51	64 1/2	47 1/8	2-4	2-4	11 1/4	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 1/4	16x16	45	2600	4300
406	6	63	66 1/2	69 1/4	51	2-5	2-5	15 1/4	16x20	45	3250	5375
407	7	71	66 1/2	69 1/4	51	2-5	2-5	15 1/4	16x20	50	3900	6450
408	8	79	66 1/2	69 1/4	51	2-5	2-5	15 1/4	20x20	50	4550	7500
409	9	87	66 1/2	69 1/4	51	2-5	2-5	15 1/4	20x20	55	5200	8600
4010	10	95	66 1/2	69 1/4	51	2-5	2-5	15 1/4	20x20	55	5850	9650
4011	11	103	66 1/2	69 1/4	51	2-5	2-5	15 1/4	20x20	60	6500	10725
4012	12	111	66 1/2	69 1/4	51	2-5	2-5	15 1/4	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	6000	10725
468	8	84	79	82	55 1/4	2-6	2-6	19 1/4	24x24	75	6600	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)

Boilers

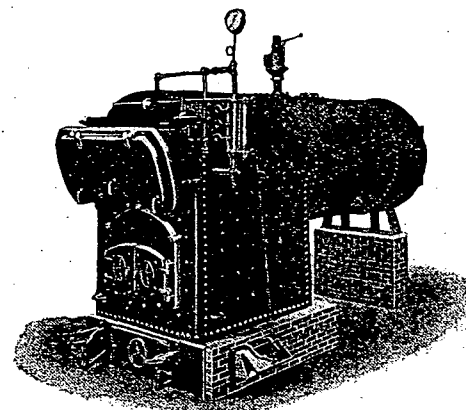
Ames Iron Works

Division of

Pierce, Butler & Pierce Manufacturing Corporation

OSWEGO, N. Y.

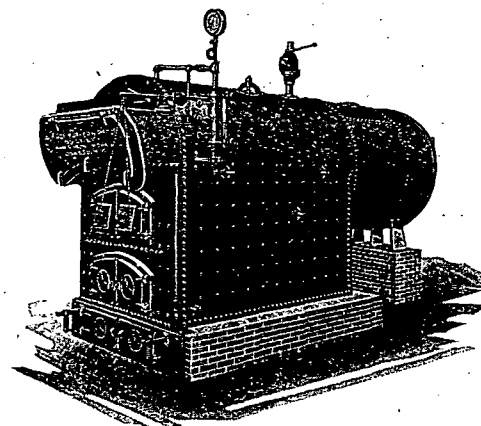
We are builders of highest grade steel plate fire tube boilers for Steam Power and Heating purposes. All boilers being built to conform to A. S. M. E. requirements.



Ames Firebox Heating Boiler with Plain Furnace

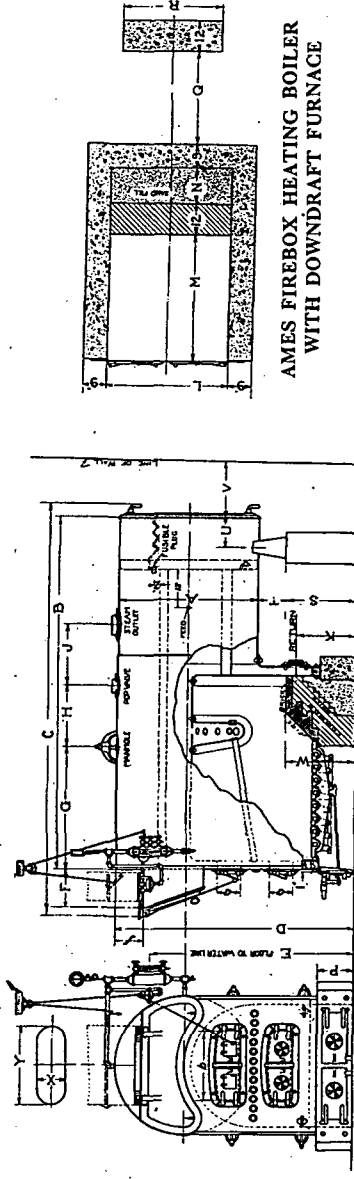
The large number of Firebox Heating boilers we have built in the past to meet the exacting requirements of Architects and Engineers who put service above cost has established a precedent for Ames Boilers to such an extent that we have now standardized on the sizes shown on the two following pages on which information is given that will be found of value in providing location and space in building.

When selecting size boiler for your requirements you will understand that our ratings are safe and conservative.



Ames Firebox Heating Boiler with Down draft Furnace

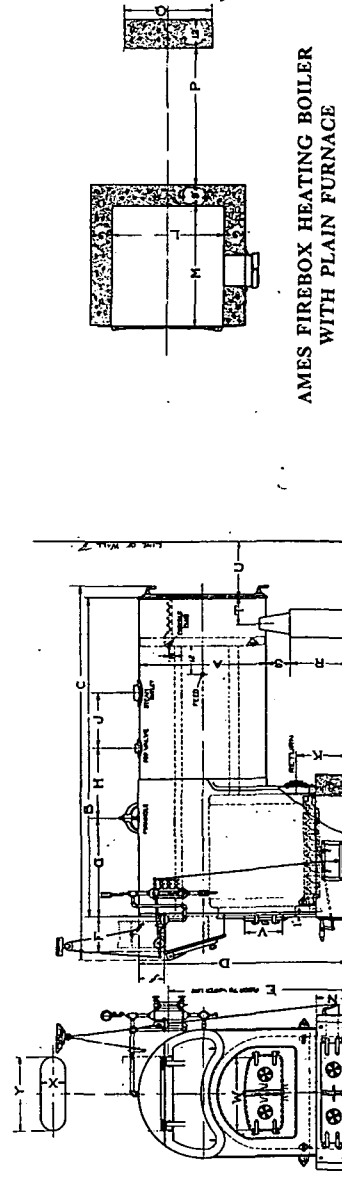
SEE THE TWO FOLLOWING PAGES FOR DIMENSIONS

AMES FIREBOX HEATING BOILER
WITH DOWNDRAFT FURNACE

Number of Size	905	908	910	912	913	914	915	916	918	920	923	925	927	930	933	937
Capacity Steam Radiation	2625	4100	5200	6100	6500	7500	8200	9000	10250	12000	13500	15250	16000	18000	20000	23500
Heating Surface	4000	6173	7900	9222	9822	11718	12652	14381	16662	19099	21544	24088	25530	28074	30518	35062
Grate Area, A. S. M. E. Rating	13.5	15.3	20.0	22.2	23.0	28.1	28.8	30.8	35.7	40.8	45.7	50.6	53.7	58.6	63.5	72.2
Size Steam Outlet	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Size Return	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
A—Diameter Shell	42	48	54	54	54	60	60	60	60	60	66	66	66	72	72	72
B—Length Over All	10-3	12-1	13-6	13-3	13-9	14-9	15-5	16-5	17-5	18-11	19-2	19-8	19-8	20-8	21-4	22-2
C—Length Top Shell	78	84	92	92	92	98	98	98	98	98	104	104	104	114	114	114
D—Height Top Shell	66	72	78	78	78	86	86	86	86	86	86	86	86	96	96	96
E—Height Water Line	66	72	78	78	78	86	86	86	86	86	86	86	86	96	96	96
F—Location Manhole	30	36	36	36	36	36	36	36	36	36	36	36	36	48	48	48
G—Location Pop Valve	30	36	36	36	36	36	36	36	36	36	36	36	36	48	48	48
H—Location Steam Valve	30	36	36	36	36	36	36	36	36	36	36	36	36	48	48	48
J—Location Steam Outlet	30	36	36	36	36	36	36	36	36	36	36	36	36	48	48	48
K—Location Return	30	36	36	36	36	36	36	36	36	36	36	36	36	48	48	48
L—Width Ashpit	20	20	22	22	22	22	22	22	22	22	22	22	22	22	22	22
M—Length Ashpit	42	48	54	54	54	60	60	60	60	60	66	66	66	72	72	72
N—Width Sand Fill	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
O—Location Rear Pier	30	36	36	36	36	36	36	36	36	36	36	36	36	48	48	48
R—Height Rear Pier	28	28	28	28	28	28	28	28	28	28	28	28	28	36	36	36
S—Height Rear Stand	8	8	8	8	8	8	8	8	8	8	8	8	8	12	12	12
T—Height Rear Stand	10	10	10	10	10	10	10	10	10	10	10	10	10	12	12	12
U—Location Rear Stand	10	10	10	10	10	10	10	10	10	10	10	10	10	12	12	12
V—Height Bridge Wall	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52
W—Height Stack Base	24	31	37	37	37	37	37	37	37	37	37	37	37	41	41	41
Y—Length Stack Base	24	31	37	37	37	37	37	37	37	37	37	37	37	41	41	41
Z—Top Smoke Box to Top Shell	10 1/2	13 1/2	13 1/2	13 1/2	13 1/2	12 1/4	12 1/4	12 1/4	12 1/4	12 1/4	13 1/4	13 1/4	13 1/4	18 1/2	18 1/2	18 1/2

*No manhole is provided in No. 905.

†This represents the distance from front head of boiler, and is the combination of distances G and H on above diagram.

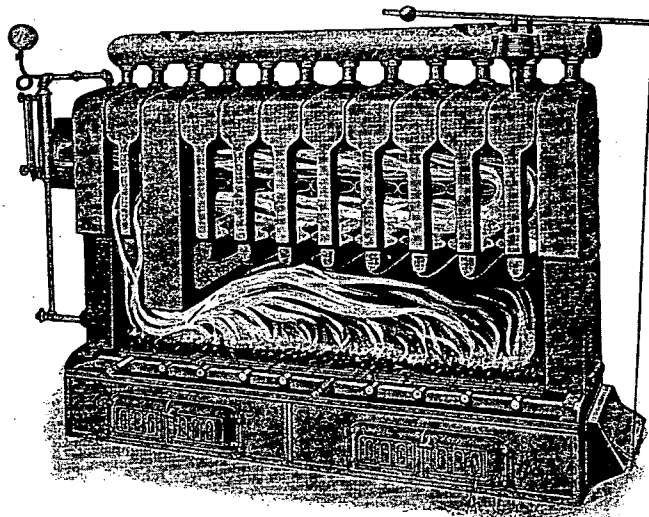
AMES FIREBOX HEATING BOILER
WITH PLAIN FURNACE

Number of Size	805	808	810	812	814	815	816	818	820	823	825	827	830	833	837	840
Capacity Steam Radiation	2500	4000	5150	6500	7200	8250	9000	10000	11500	13000	15000	16500	18000	20000	22500	25000
Heating Surface	3400	5173	6600	7900	8600	9822	10718	11718	13000	14500	16000	17500	19000	20500	22000	24500
Grate Area, A. S. M. E. Rating	10.5	12.2	16.0	18.0	20.0	22.5	24.7	27.5	30.0	33.0	36.0	38.8	41.6	44.4	47.2	50.0
Size Steam Outlet	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Size Return	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
A—Diameter Shell	42	48	54	54	54	60	60	60	60	60	66	66	66	72	72	72
B—Length Over All	10-3	12-1	13-6	13-3	13-9	14-9	15-5	16-5	17-5	18-11	19-2	19-8	19-8	20-8	21-4	22-2
C—Length Top Shell	78	84	92	92	92	98	98	98	98	98	104	104	104	114	114	114
D—Height Top Shell	66	72	78	78	78	86	86	86	86	86	86	86	86	96	96	96
E—Height Water Line	66	72	78	78	78	86	86	86	86	86	86	86	86	96	96	96
F—Location Manhole	30	36	36	36	36	36	36	36	36	36	36	36	36	48	48	48
G—Location Pop Valve	30	36	36	36	36	36	36	36	36	36	36	36	36	48	48	48
H—Location Steam Valve	30	36	36	36	36	36	36	36	36	36	36	36	36	48	48	48
J—Location Steam Outlet	30	36	36	36	36	36	36	36	36	36	36	36	36	48	48	48
K—Location Return	30	36	36	36	36	36	36	36	36	36	36	36	36	48	48	48
L—Width Ashpit	20	20	22	22	22	22	22	22	22	22	22	22	22	22	22	22
M—Length Ashpit	42	48	54	54	54	60	60	60	60	60	66	66	66	72	72	72
N—Width Sand Fill	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
O—Location Rear Pier	30	36	36	36	36	36	36	36	36	36	36	36	36	48	48	48
P—Height Rear Pier	28	28	28	28	28	28	28	28	28	28	28	28	28	36	36	36
R—Height Rear Stand	8	8	8	8	8	8	8	8	8	8	8	8	8	12	12	12
S—Height Rear Stand	10	10	10	10	10	10	10	10	10	10	10	10	10	12	12	12
T—Height Rear Stand	10	10	10	10	10	10	10	10	10	10	10	10	10	12	12	12
U—Location Rear Stand	10	10	10	10	10	10	10	10	10	10	10	10	10	12	12	12
V—Height Bridge Wall	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52
W—Height Stack Base	24	31	37	37	37	37	37	37	37	37	37	37	37	41	41	41
Y—Length Stack Base	24	31	37	37	37	37	37	37	37	37	37	37	37	41	41	41
Z—Top Smoke Box to Top Shell	10 1/2	13 1/2	13 1/2	13 1/2	13 1/2	12 1/4	12 1/4	12 1/4	12 1/4	12 1/4	13 1/4	13 1/4	13 1/4	18 1/2	18 1/2	18 1/2

*No manhole is provided in No. 805.

†This represents the distance from front head of boiler, and is the combination of distances G and H on above diagram.

Boilers



Cutaway View Showing Three Way Fire Travel of Up-Draft Smokeless Economic Type Boiler. Side Feed.

Number	No. Sections	Total Length, End to End In.	Total Width Over Header In.	Grate Area Sq. Ft.	Flow In.	Return In.	Rating	List Price Complete	Cipher	Chimney Size
EC-106	6	67	50	8.19	2-4	2-4	1750	\$630.00	Eccentric	12x16"
EC-107	7	74	50	9.54	3-4	3-4	2250	740.00	Eccentric	16x16"
EC-108	8	81	50	10.20	3-4	3-4	2750	845.00	Echelon	16x16"
EC-110	10	95	50	13.12	4-4	4-4	3250	960.00	Echo	16x16"
EC-111	11	102	50	14.58	4-4	4-4	3650	1070.00	Ectozoa	16x20"
EC-112	12	109	50	16.60	4-4	4-4	4200	1190.00	Eclipse	16x20"

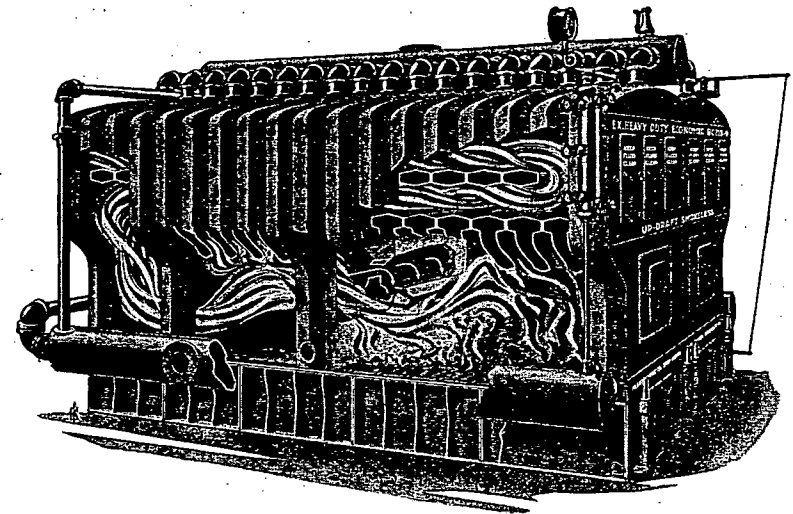
Height to top of header..... 70 in.
Water line..... 50 in.

Frank Prox Company

Boilers

PROX-"BC" Series Up-Draft Smokeless Boiler

Patent Pending



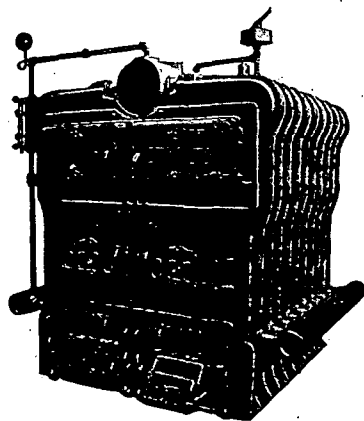
Up-Draft Smokeless Series No.	Length In.	Sq. Ft. Grate Surface	Flows, In.	Returns In.	Rating	List Price Complete	Cipher	Chimney Sizes, Round or Square
AC-207	78	15.9	2-5	4-4	4750	\$1350.00	Maut	20x60"
AC-208	85	18.1	2-5	4-4	5275	1448.00	Malon	20x60"
AC-209	92	22.2	2-5	4-4	5800	1582.00	Moke	24x60"
AC-210	99	22.2	3-5	4-4	6650	1674.00	Mespo	24x65"
AC-211	106	22.2	3-5	4-4	7325	1858.00	Mifo	24x70"
AC-212	113	22.2	3-5	4-4	7800	1980.00	Memo	24x70"
AC-213	120	22.2	3-5	4-4	8350	2063.00	Maga	24x70"
BC-210	108	22.2	1-8	4-4	8800	2166.00	Robe	24x80"
BC-211	115	22.2	1-8	4-4	9600	2366.00	Romb	24x80"
BC-212	122	22.2	1-8	4-4	10,400	2473.00	Rout	28x70"
BC-213	129	22.2	1-8	4-4	11,425	2678.00	Roter	28x70"
BC-214	136	25.4	2-8	4-4	12,000	2920.00	Roan	28x80"
BC-215	143	25.4	2-8	4-4	12,800	3120.00	Rodes	32x70"
BC-216	150	25.4	2-8	4-4	13,600	3320.00	Rozen	32x70"
BC-217	157	28.6	2-8	4-4	14,400	3520.00	Roww	32x70"
BC-218	164	28.6	2-8	4-4	15,200	3710.00	Rojop	32x80"
BC-219	171	31.7	2-8	4-4	16,000	3900.00	Roked	32x80"
BC-220	178	31.7	2-8	4-4	16,800	4100.00	Rongo	32x80"
BC-221	185	31.7	2-10	4-4	18,000	4345.00	Rello	32x85"
BC-222	192	35.0	2-10	4-4	19,200	4605.00	Rotar	32x85"
BC-223	199	35.0	2-10	4-4	20,400	4865.00	Roebie	32x85"
BC-224	206	38.1	2-10	4-4	21,600	5125.00	Roble	32x95"
BC-225	213	38.1	2-10	4-4	22,800	5385.00	Robust	32x95"

	A Series	B Series
Height to top of header.....	72 in.	80 in.
Water line.....	50 in.	55 in.
Size of smoke pipe.....	18 in.	24 in.
Height to center of smoke pipe.....	50 in.	55 in.
Total width over headers.....	93 in.	93 in.
Asbestos covering.....		

RICHMOND RADIATOR COMPANY

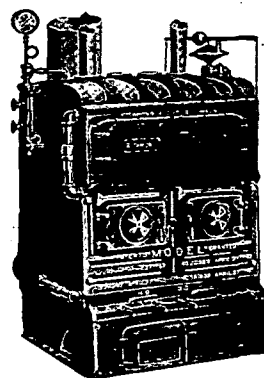
1480 Broadway, NEW YORK
460 Park Square Bldg., BOSTON
900 Kieth Bldg., CLEVELAND

217 E. Illinois St., CHICAGO
2241 N. American St., PHILADELPHIA
316 Fulton Bldg., PITTSBURGH



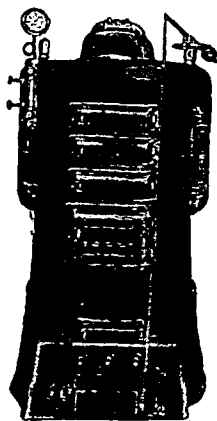
"RICHMOND" Sectional Boiler

Made in sizes: 4800 to 12000 sq. ft. for Steam; 7925 to 19800 sq. ft. for Hot Water.



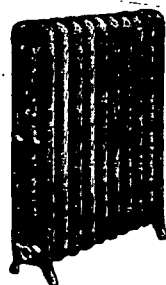
"MODEL" Sectional Boiler

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.



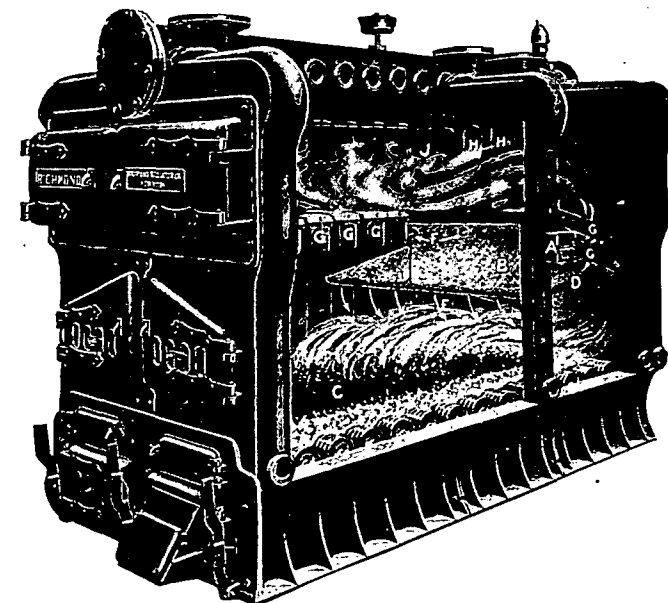
"RICHMOND" Radiators

Made in 1, 2, 3 and 7 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). | F—Gas escaping openings in upper part of fire arch. |
| B—Patented Heat Holding and Fire Resistent Fire Brick Arch. | G—Overhanging fire surfaces. |
| C—Coal and Fire on Primary Grate. | H—Flues in which products of combustion travel from rear to front of boiler. |
| D—Secondary Grate where unburned gases are consumed. | J—Flues in which products of combustion travel to rear of boiler. |
| E—Point at which oxygen is supplied for perfect combustion of gases. | |

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

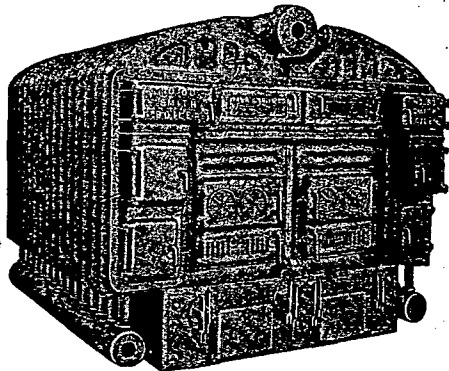
New York, 10 East 39th Street

Boston, 640 Main Street, Cambridge

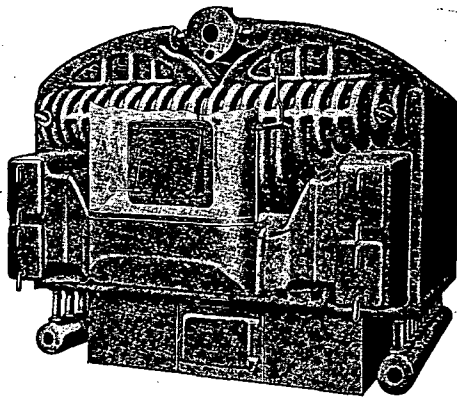
Cleveland, 1108 Webster Avenue, S.E.

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

The H. B. Smith Company

SMITH SMOKELESS BOILERS

For Anthracite Coal, Oil, Gas, Coke and all Bituminous Coals.

When Bituminous Coal contains over 22 1/4% volatile Oxygen Torch should be installed.

With Oxygen Torch

No. of Sections in Boiler	Nominal Size of Fire Pot, Inches		Total Length of Boiler Inches	Length at Foundation, Inches	Steam Rating, Feet	Water Rating, Feet
	Width	Length				
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	72	140	103	16,800	27,700
18	60	78	146	109	18,000	29,700
19	60	84	152	115	19,200	31,700
20	60	90	158	121	20,400	33,650

Additional Data Applying to Boilers Both With and Without Smokeless Furnace

Boiler No.	27	36	60
Width at foundation.....	35"	48 1/4"	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.....	13 1/4"	17"	26"
	round	round	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"
8	2	2	2	2
9	2	2	2	2
10	2	2	2	2
11	2	2	2	2
12	2	2	2	2
13	2	2	2	2
14	2	2	2	2
15	2	2	2	2
16	2	2	2	2
17	2	2	2	2
18	2	2	2	2
19	2	2	2	2
20	2	2	2	2

No. of Sections in Boiler	Nominal Size of Fire Pot, Inches		Total Length of Boiler, Inches	Length at Foundation, Inches	Steam Rating, Feet	Water Rating, Feet
	Width	Length				
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	66	89	74	3,300	5,450
13	27	72	95	80	3,600	5,950
14	27	78	101	86	3,900	6,425
15	27	84	107	92	4,200	6,925
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	66	93	74	4,800	7,925
13	36	72	99	80	5,300	8,750
14	36	78	105	86	5,800	9,575
15	36	84	111	92	6,300	10,400
16	36	90	117	98	6,800	11,225
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	90	140	103	16,800	27,700
18	60	96	146	109	18,000	29,700
19	60	102	152	115	19,200	31,700
20	60	108	158	121	20,400	33,650

NOTE—For additional data pertaining to these boilers, see table at bottom of opposite column.

Return Drums*

Steam Boilers
Outside diameter.....8 in.
Tapped for 2-in. lock-nut nipples.
Front ends tapped.....2 1/4 in.
Rear ends tapped.....5 in.
Undersides tapped.....1 1/4 in.

Fire Tools Furnished

Poker, hoe, slice bar, flue brush with handle and ash shovel.

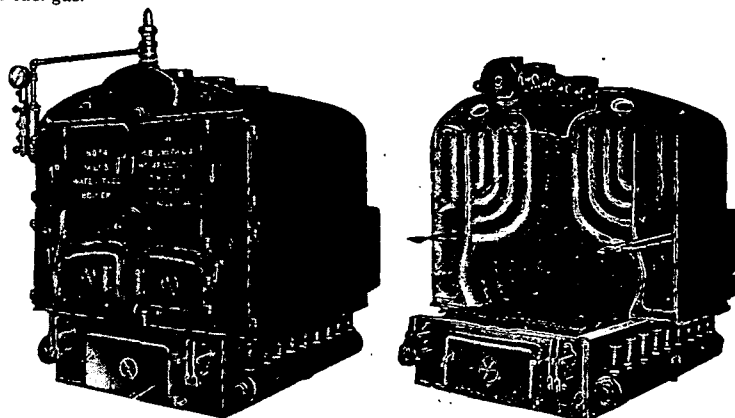
Trimings Furnished with Steam Boilers

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.



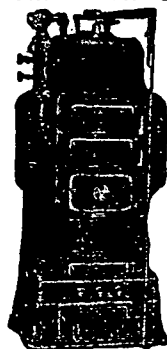
No. 44 Mills Steam Boiler

No. 44 Mills Boiler—Interior

Size of Boiler	Nominal Width Fire Pot Inches	Commercial Rating—Capacity in Sq. Ft.		Max. Allowable Working Pressure		
		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.

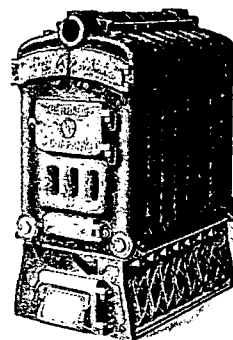
**Commercial Ratings**

Diam. of Fire Pot Inches	Steam	Water
	Rating Feet	Rating Feet
15 to 27	250 to 1000	425 to 1650

17 Hy-Test Boiler

For Hot Water Supply
A. S. M. E. Standard

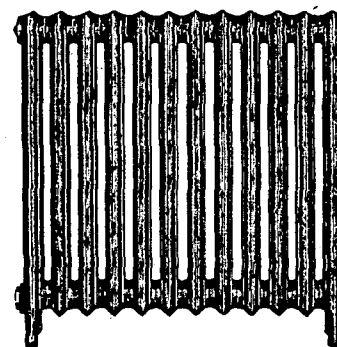
Maximum allowable working pressure, 120 lb. Open Tank; 80 lb. Closed Tank.

**Princess 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.

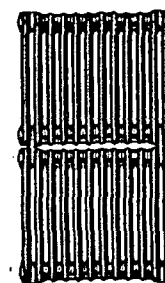
Princess Radiators are the standard radiators of The H. B. Smith Co. and are sold at regular list prices.



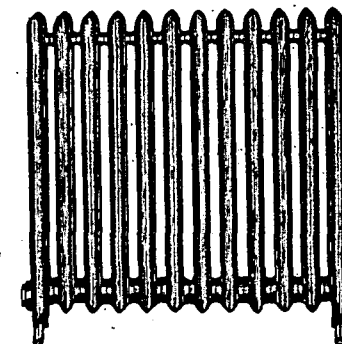
"Princess" Water Radiator

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

Boilers

Standard Heater Company Williamsport, Pa.

NEW YORK PHILADELPHIA BOSTON BALTIMORE BUFFALO
DETROIT CHICAGO DENVER DULUTH
Builders of Spencer Heaters

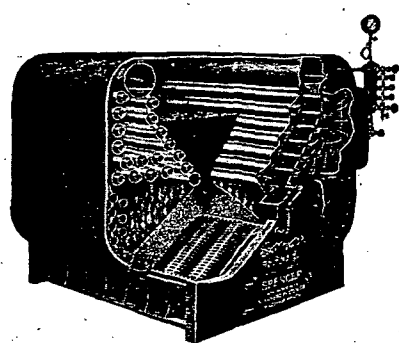
SPENCER HEATERS

Give uniform heat over long periods and use small size hard coal with least attention to the fire.

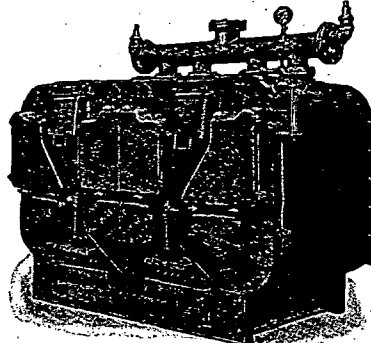
The magazine-feed feature is built into the heater and requires no adjustment. The magazine holds a supply of coal sufficient for 8 to 12 hours in severe weather or for a proportionately longer period in milder weather.

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 made in accordance with the A. S. H. & V. E. Code 1919 for testing low pressure boilers, using fresh mined No. 1 Buckwheat coal as fuel.



60 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 ₂ O	Size Chimney Flue
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"	107 1/2	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"	120 1/2	81	59	.26	18"x18"x60"
3-60	6,000	24.83	506	2-5"	1-4"	126 1/2	81	59	.27	18"x18"x65"
3-70	7,000	27.00	547	2-5"	1-4"	132 1/2	81	59	.28	18"x18"x70"
3-80	8,000	30.35	560	1-8"	1-4"	101 1/2	118 1/2	66	.27	20"x20"x65"
3-90	9,000	34.70	621	1-8"	1-4"	107 1/2	118 1/2	66	.28	20"x20"x65"
3-105	10,500	39.05	683	1-8"	1-4"	114	118 1/2	66	.29	22"x22"x65"
3-120	12,000	43.40	745	1-8"	1-4"	120 1/2	118 1/2	66	.30	24"x24"x70"
3-140	14,000	47.75	807	1-8"	1-4"	126 1/2	118 1/2	66	.32	24"x24"x70"
3-160	16,000	52.10	869	1-8"	1-4"	132 1/2	118 1/2	66	.34	24"x24"x70"

Heaters No. 3-45 to 3-160 are furnished with steel jackets and 1 1/2 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.

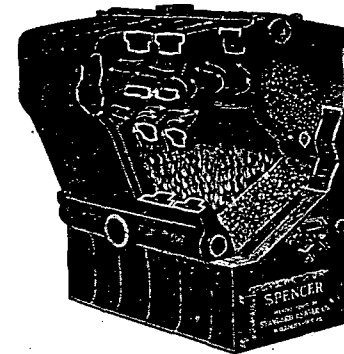
Standard Heater Company

Boilers

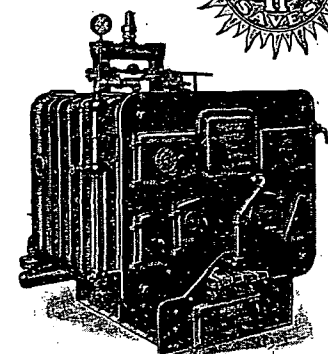
SPENCER HEATERS are adaptable for residences, apartment houses, churches, schools, public and commercial buildings, theatres, green houses, garages and all other types of buildings heated by low pressure steam, vapor, or hot water.

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.



16 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 ₂ O	Size Chimney Flue
154-S	375	2.29	1-4"	2-3"	33	33 1/2	49	0.16	8"x8"x30"
155-S	500	3.02	1-4"	2-3"	39 1/2	33 1/2	49	0.16	8"x8"x30"
156-S	625	3.78	1-4"	2-3"	47	33 1/2	49	0.17	10"x10"x35"
157-S	750	4.54	2-4"	4-3"	54	33 1/2	49	0.18	10"x10"x35"
158-S	900	5.30	2-4"	4-3"	62	33 1/2	49	0.20	10"x10"x40"
2-5	1,000	4.51	2-4"	2-4"	63 1/4	57 1/4	50	0.15	10"x10"x30"
2-6	1,300	5.64	2-4"	2-4"	70	57 1/4	50	0.17	10"x10"x35"
2-7	1,600	6.77	2-4"	2-4"	76 1/4	57 1/4	50	0.18	12"x12"x35"
2-8	2,000	7.90	2-4"	2-4"	82 1/2	57 1/4	50	0.19	12"x12"x35"
2-9	2,400	9.03	2-4"	2-4"	88 1/4	57 1/4	50	0.20	12"x12"x35"
2-10	2,800	10.16	2-4"	2-4"	95	57 1/4	50	0.21	12"x12"x40"
2-11	3,200	11.28	2-4"	2-4"	101 1/4	57 1/4	50	0.21	12"x12"x40"

SPENCER SECTIONAL WATER 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 ₂ O	Size Chimney Flue
15-4-W	600	2.29	1-4"	2-3"	33	33 1/2	49	0.16	8"x8"x30"
15-5-W	800	3.02	1-4"	2-3"	39 1/2	33 1/2	49	0.16	8"x8"x30"
15-6-W	1,000	3.78	1-4"	2-3"	47	33 1/2	49	0.17	10"x10"x35"
15-7-W	1,200	4.54	2-4"	4-3"	54	33 1/2	49	0.18	10"x10"x35"
15-8-W	1,400	5.30	2-4"	4-3"	62	33 1/2	49	0.20	10"x10"x40"
27-4-W	1,600	4.38	2-4"	2-4"	41 1/2	55 1/2	50	0.19	10"x10"x35"
27-5-W	2,100	5.84	2-4"	2-4"	49 1/2	55 1/2	50	0.20	10"x10"x40"
27-6-W	2,600	7.31	2-4"	2-4"	58	55 1/2	50	0.20	12"x12"x35"
2-6-W	2,100	5.64	2-4"	2-4"	70	57 1/4	50	0.17	10"x10"x35"
2-7-W	2,600	6.77	2-4"	2-4"	76 1/4	57 1/4	50	0.18	12"x12"x35"
2-8-W	3,200	7.90	2-4"	2-4"	82 1/2	57 1/4	50	0.19	12"x12"x35"
2-9-W	3,800	9.03	2-4"	2-4"	88 1/4	57 1/4	50	0.20	12"x12"x35"
2-10-W	4,500	10.16	2-4"	2-4"	95	57 1/4	50	0.21	12"x12"x40"
2-11-W	5,100	11.28	2-4"	2-4"	101 1/4	57 1/4	50	0.21	12"x12"x40"

Richardson & Boynton Company

260 Fifth Avenue
New York City

BRANCHES

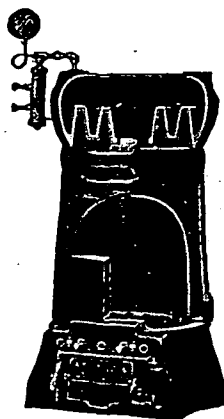
Boston
60 High Street

Chicago
3641 S. Ashland Avenue

Philadelphia
1308 Arch Street

Providence
58 Exchange Street

Rochester
Rockwood Street

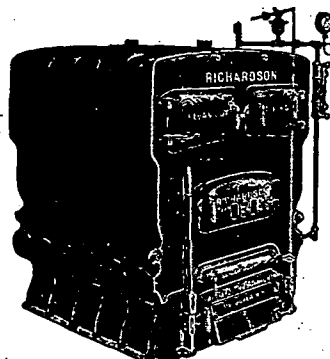


Richardson Round Boiler

RICHARDSON SECTIONAL BOILER

List Prices and Data

Boiler Number	8 Hr. Rating Sq. Ft. Steam	8 Hr. Rating Sq. Ft. Water	Center Area, Sq. Ft.	Height to Top Outlet, In.	Height Water- line, In.	Asphit. Inside, In.	No. Outlets and Size, In.	List Price Com- plete, Steam	List Price Com- plete, Water
255	1000	1600	4.57	55	48 1/2	27 1/2	x35 1/2	2-3/4	\$415.
256	1250	2000	5.70	55	48 1/2	27 1/2	x42 1/2	2-3/4	\$495.
257	1500	2400	6.83	55	48 1/2	27 1/2	x50	2-3/4	\$564.
258	1700	2800	7.97	55	48 1/2	27 1/2	x57 1/2	2-3/4	\$629.
355	1950	3125	7.85	63	56	39	x33 1/2	2-4	\$679.
356	2400	3850	9.81	63	56	39	x41 1/2	2-4	\$805.
357	2850	4575	11.75	63	56	39	x50	2-4	\$932.
358	3300	5300	13.70	63	56	39	x58 1/2	2-4	\$1,035.
359	3750	6025	15.65	63	56	39	x66 1/2	2-4	\$1,139.
427	3500	5600	13.82	66	60	45	x50	2-5	\$1,083.
428	4050	6500	16.11	66	60	45	x58 1/2	2-5	\$1,190.
429	4600	7400	18.40	66	60	45	x66 1/2	2-5	\$1,323.
4210	5150	8300	20.69	66	60	45	x74 1/2	2-5	\$1,432.
4211	5700	9200	22.98	66	60	45	x83	2-5	\$1,547.
536	6300	10000	18.94	82	70 1/2	55	x55	2-6	\$1,786.
537	7300	11600	22.68	82	70 1/2	55	x63 1/2	2-6	\$2,010.
538	8300	13200	26.40	82	70 1/2	55	x70 1/2	2-6	\$2,243.
539	9300	14800	30.12	82	70 1/2	55	x87 1/2	2-6	\$2,464.
5310	10300	16400	33.88	82	70 1/2	55	x98	2-6	\$2,707.



Richardson Sectional Boiler

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

NEW YORK OFFICE.....152 West 42nd St.
CHICAGO OFFICE.....53 W. Jackson Blvd.
BUFFALO OFFICE.....821-23 Marine Trust Bldg.

DETROIT OFFICE.....810 Peter Smith Bldg.
PITTSBURGH OFFICE.....Farmers Bank Bldg.
WASHINGTON OFFICE.....732 Woodward Bldg.

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.

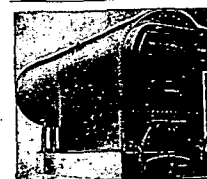
A large supply of material for all types of boilers is constantly carried and an adequate stock of completed TICOS and ACME FIREBOX Boilers is always ready for immediate shipment.

Thorough inspections and tests are constantly made during the construction and all workmanship and material is guaranteed first class in every respect.

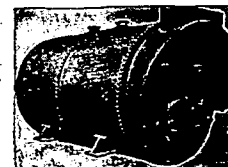
In addition to the line of TITUSVILLE Boilers illustrated herewith

we manufacture pneumatic and storage tanks of every description.

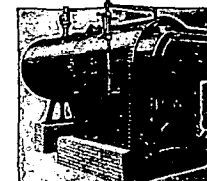
Descriptive bulletins will be sent on request.



Tico Smokeless Boiler



Titusville Standard Internal Fired Scotch Type Boiler



Tico Return Tubular Fire Box Boiler



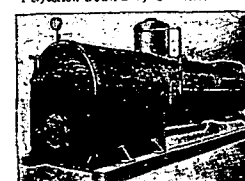
Titusville Vertical Tubular Boiler



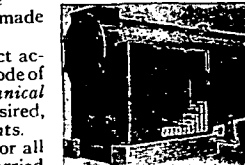
Titusville Standard Tubular Boiler and Seling



Perfection Down Draft Smokeless Boiler



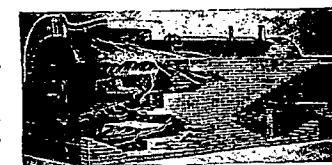
Titusville Open Bottom Locomotive Portable Boiler with Water Front



Titusville Perfection Boiler—Built in Sizes 25 H. P. to 200 H. P. from 15 lbs. to 150 lbs. Working Pressure



Titusville Jacketed Tubless Water Heater—for Heating Domestic Hot Water by Direct Circulation



Acme Smokeless Boiler—Brick Set Type for Steam and Hot Water Heating

Boilers

Utica Heater Company UTICA, New York

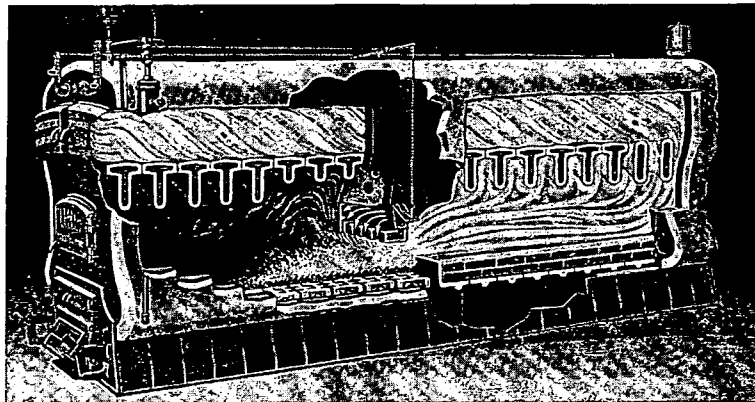
218-220 West Kinzie St.
CHICAGO, ILL.

707 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 protected 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.

Utica Heater Company

Boilers

Utica - Imperial SUPER - SMOKELESS Boilers

Made in Thirty-one Sizes for Steam and Hot Water; Capacity
1,200 to 17,000 Sq. Ft. Steam; 1,975 to 28,325 Sq. Ft. Hot Water

CAPACITIES AND DIMENSIONS OF UTICA-IMPERIAL SUPER-SMOKELESS BOILERS

Steam Boiler Number	Rating (Square Feet)	Water Boiler Number	Rating (Square Feet)	Grate Area (Sq. Ft.)	Size of Pit Under Ash Pit (Inches)	Size of Foundation (Inches)	Length of Boiler Overall (Inches)	Minimum Chimney Sizes*		
								Flue (Inches)	Height (Feet)	
								Square	Round	
S-245	1,200	W-245	1,975	4.88	35 x 24	39 1/2 x 29 1/2	59 1/4	12x12	12	40
S-246	1,500	W-246	2,475	6.10	43 x 24	47 1/2 x 29 1/2	67 1/2	12x12	12	40
S-247	1,800	W-247	2,975	6.10	43 x 24	55 1/2 x 29 1/2	73 1/2	14x14	14	45
S-248	2,100	W-248	3,475	7.32	51 x 24	65 x 29 1/2	82	14x14	14	50
S-249	2,400	W-249	3,975	7.32	51 x 24	73 1/2 x 29 1/2	90 1/4	14x14	14	55
S-335	2,000	W-335	3,325	6.95	35 x 33 1/2	39 1/2 x 39	60 1/4	16x16	15	40
S-336	2,500	W-336	4,175	8.68	43 x 33 1/2	47 1/2 x 39	67	16x16	15	40
S-337	3,000	W-337	5,000	10.42	51 x 33 1/2	55 1/2 x 39	77 1/4	16x16	15	40
S-338	3,500	W-338	5,825	12.15	60 x 33 1/2	65 x 39	83 1/2	18x18	16	50
S-339	4,000	W-339	6,675	13.89	68 x 33 1/2	73 1/2 x 39	91 1/4	18x18	16	50
S-3310	4,700	W-3310	7,850	15.63	77 x 33 1/2	81 1/2 x 39	100	20x20	20	55
S-405	2,750	W-405	4,575	9.25	35 x 44 1/2	39 1/2 x 52	65 1/4	18x18	18	50
S-406	3,500	W-406	5,825	11.57	43 x 44 1/2	47 1/2 x 52	73 1/2	18x18	18	50
S-407	4,750	W-407	7,075	13.88	51 x 44 1/2	55 1/2 x 52	81 1/4	18x18	18	50
S-408	5,000	W-408	8,325	16.19	60 x 44 1/2	65 x 52	90	20x20	20	55
S-409	5,750	W-409	9,575	18.51	68 x 44 1/2	73 1/2 x 52	98 1/4	20x20	20	55
S-4010	6,500	W-4010	10,825	20.82	77 x 44 1/2	81 1/2 x 52	106 1/2	20x20	20	60
S-4011	7,250	W-4011	12,075	23.13	84 1/2 x 44 1/2	90 1/2 x 52	112 1/4	22x22	22	60
S-4012	8,000	W-4012	13,325	23.13	89 x 44 1/2	99 x 52	121	22x22	22	65
S-4013	8,750	W-4013	14,575	23.13	89 x 44 1/2	107 1/2 x 52	129 1/4	22x22	22	70
S-4014	9,500	W-4014	15,825	23.13	89 x 44 1/2	115 1/2 x 52	137 1/2	22x22	22	75
S-4015	10,250	W-4015	17,075	23.13	89 x 44 1/2	123 1/2 x 52	145 1/4	22x22	22	75
S-4016	11,000	W-4016	18,325	23.13	89 x 44 1/2	132 x 52	154	22x22	22	80
S-4017	11,750	W-4017	19,575	23.13	89 x 44 1/2	140 1/2 x 52	162 1/4	24x24	24	80
S-4018	12,500	W-4018	20,825	23.13	89 x 44 1/2	148 1/2 x 52	170 1/2	24x24	24	80
S-4019	13,250	W-4019	22,075	23.13	89 x 44 1/2	156 1/2 x 52	178 1/4	24x24	24	85
S-4020	14,000	W-4020	23,325	23.13	89 x 44 1/2	165 x 52	187	24x24	24	90
S-4021	14,750	W-4021	24,575	23.13	89 x 44 1/2	173 1/2 x 52	195 1/4	24x24	24	100
S-4022	15,500	W-4022	25,825	23.13	89 x 44 1/2	181 1/2 x 52	203 1/2	26x26	26	100
S-4023	16,250	W-4023	27,075	23.13	89 x 44 1/2	189 1/2 x 52	211 1/4	26x26	26	100
S-4024	17,000	W-4024	28,325	23.13	89 x 44 1/2	198 x 52	220	26x26	26	100

Series.....	24	33	40	Series.....	24	33	40
Height to Top of Steam Trimmings.....	60"	72 1/2"	77 1/2"	Height of Ashpit.....	10"	10"	11"
Height to Top of Outlets.....	54"	64 1/2"	69"	Length of Smoke Box.....	20"	21 1/2"	28"
Height of Water Line.....	45 1/2"	53"	57"	Height to Center of Smoke Collar.....	40"	47"	51"
Width Including Trimmings.....	46"	53"	66"	Height to Bottom of Smoke Box.....	33 1/2"	39 1/2"	41"
Width Excluding Trimmings.....	34 1/2"	48"	58"	Height to Top of Smoke Box.....	46 1/2"	54 1/2"	61"
Width of Ashpit.....	29 1/2"	39"	52"	Size of Feed Door.....	9 1/4" x 15"	10" x 18"	12 1/2" x 24"

*These sizes apply only to single boilers. If two or more boilers are to be used, send for schedule of chimney sizes.

A Typical
Installation
Showing a
Battery of
Four SUPER-
SMOKELESS
BOILERS
With a Total
Boiler Capacity
of 38,000 Sq. Ft.

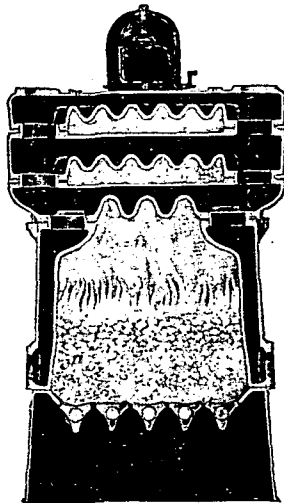


Weil-McLain

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.

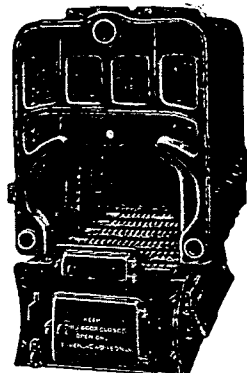
STEAM		WATER		Actual Diam. Grate and Fire Pot Inches (Both Steam and Hot Water)
Size Boiler	Rating Sq. Ft.	Size Boiler	Rating Sq. Ft.	
5-S-17	395	5-W-17	650	17
5-S-19	480	5-W-19	795	19
5-S-22	660	5-W-22	1090	22
5-S-25	865	5-W-25	1430	25
5-S-28	1065	5-W-28	1760	28
5-S-31	1350	5-W-31	2225	31
6-S-17	410	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
35-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
35-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.



No. 157

UNITED STATES RADIATOR CORPORATION

GENERAL OFFICES: DETROIT, MICHIGAN

Branch Offices in Principal Cities

Manufacturers of Capitol Boilers and United States Radiators

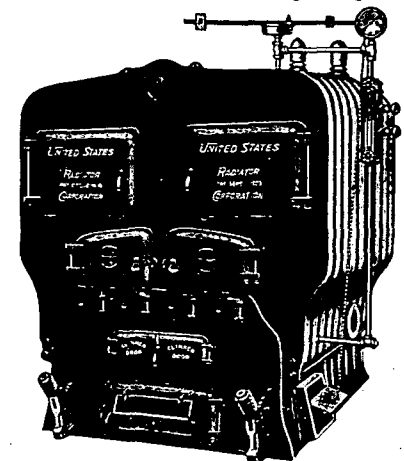
The Capitol Smokeless Boiler has been developed to meet a growing demand on the part of the public for boilers which will burn the bituminous coals of the United States without smoke. This demand has been brought about by the educational work of civic societies, which have taught the public to realize the destructive effect and the menace to health of soft coal smoke in our large cities, and, as a consequence, 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.

The UNITED STATES RADIATOR CORPORATION has developed a line of cast-iron boilers built upon the highly effective "wing-wall" principal which is well-known in power boilers where smokeless combustion is desired.

Capitol Smokeless Boilers contain a large fire box or furnace where bituminous coal is burned at a rapid rate of combustion. The air is admitted through the grates and fuel bed, with an auxiliary supply admitted at the front of the furnace, which mixes with the volatile gases distilled from the fuel bed.

These volatile gases pass from the furnace into a mixing chamber through two horizontal openings in the back or bridge wall of the furnace. This mixing chamber back of the furnace is formed by the bridge wall at the front and ignition walls or "wing-walls" of fire brick at the rear. The fire brick used in the ignition walls have a fusing temperature of 2700 deg. fahr. The temperature of the burning gases coming in contact with these ignition walls does not reach this fusing point by several hundred degrees so that the fire brick used in the ignition walls are practically indestructible. Because of the continuous volume of burning gases pouring from the furnace through the bridge wall 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.

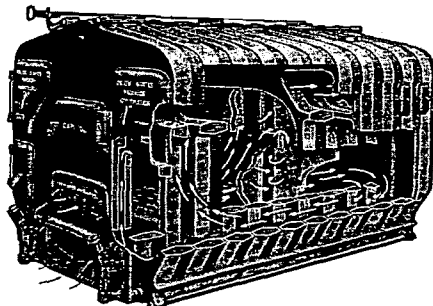
All the gases from the furnace must pass through this mixing chamber and while they enter the mixing chamber through two horizontal openings, their escape from the mixing chamber to the combustion chamber at the rear of the boiler is through a long vertical opening between the ignition walls, the area of which is slightly less than the area of the two horizontal openings into the mixing chamber. The effect of this



No. 511 Steam Boiler

arrangement is a congestion and intermixture of burning gases and auxiliary air within the mixing chamber in contact constantly with the ignition walls, which are maintained at a temperature above the ignition point of the gases.

The combustion of these gases is completed in the combustion chamber at the rear of the boiler where the temperature is but slightly lower than that of the mixing chamber and well above the burning point of these gases. From the combustion chamber the gases are rapidly cooled in the large flues, passing to the front of the boiler on each side (as shown in the illustration showing the Interior View) from which point they are returned to the smokehood through the return flues. The use of this mixing chamber with its ignition walls and the combustion chamber completely burns the volatile matter in the fuel before the gases are cooled below their burning point.

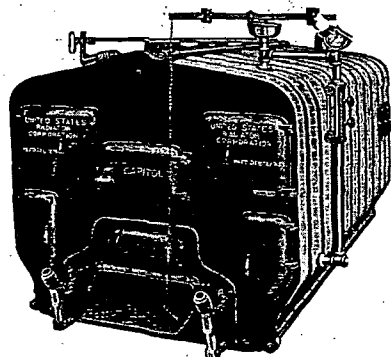


Interior View Showing Fire Travel
No. 411 Water Boiler

Capitol Smokeless Boilers are provided with an auxiliary air supply at the front of the furnace. This air supply does not come through the fire door as in many types of construction.

Air is admitted through passages at the front of the furnace leading from the ashpit to a point just above the level of the fuel bed; these air passages having an area sufficient to provide the necessary air which sweeps across the entire width of the furnace. This air passes from the boiler room to the furnace through the ashpit and the air passages and is therefore heated to a high temperature before passing into the furnace where it meets the volatile gases as they are distilled from the fuel bed.

The operation of these boilers is exceedingly simple. No skilled operator is necessary to obtain smokeless results. Any person who can throw coal into a boiler can operate them smokelessly, because no further attention is required.

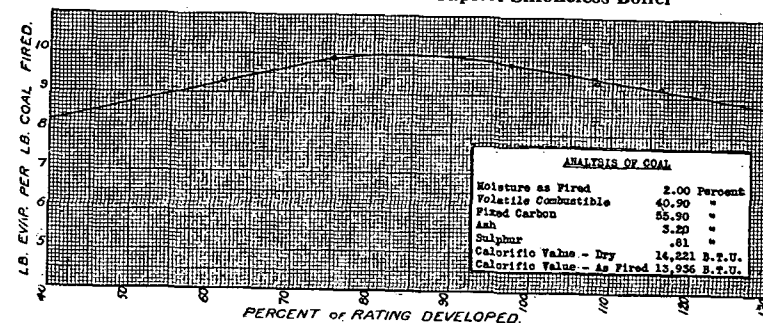


No. 411 Steam Boiler

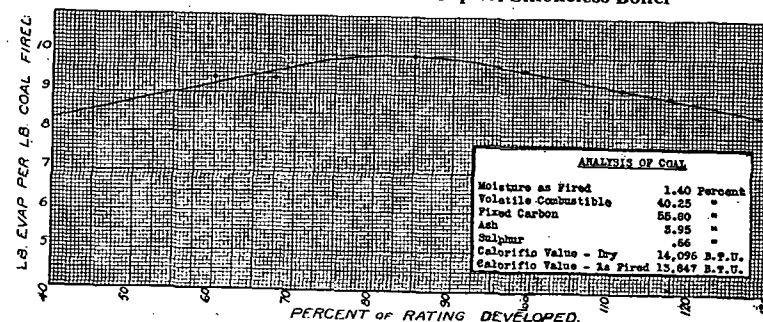
Capitol Smokeless Boilers will burn any of the bituminous coals of the United States including the lignites of the far West—burn them smokelessly, and within the requirements of any smoke ordinance of any city in the United States.

The typical performance curves shown illustrate the efficiency of Capitol Smokeless Boilers. Attention is called to the high volatile coal used in these tests. Capitol Smokeless Boilers burn these coals without smoke and with great economy.

Performance Curve for No. 411 Capitol Smokeless Boiler



Performance Curve for No. 511 Capitol Smokeless Boiler



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	Minimum Chimney Sizes	
	Steam	Water					Height, Feet	Dimensions, Inches
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	13.50	3-5"	55	20x20
411	4950	7920	49	12.47	14.70	3-5"	55	20x20
412	5500	8800	49	12.47	16.30	3-5"	55	20x20
413	6050	9680	49	14.63	17.70	3-5"	60	22x22
414	6600	10560	49	14.63	19.25	4-5"	60	24x24
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	28.80	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"	90	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 400 Series have two six inch inlets on rear of back section.
Dimensions, inclusive of trimmings: 400 Series, height 71 inches, width 75 inches.
500 Series, height 92 inches, width 82 inches.

CAPITOL SQUARE SECTIONAL BOILERS
Ratings and Dimensions

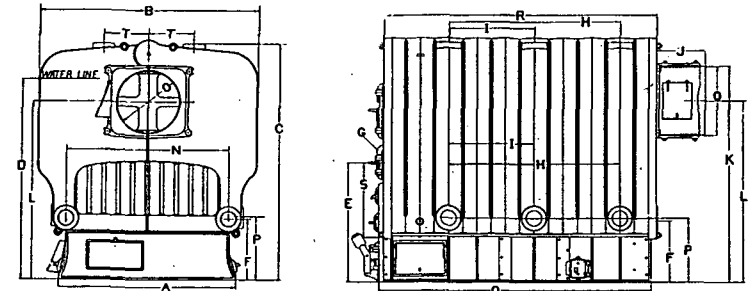
Size	Rating Sq. Ft.		Grate Area Sq. Ft.	Coal Capacity Cu. Ft.	Outlets and Inlets	Steam Boiler Dimensions			Minimum Chimney Sizes	
	Steam	Water				Height Water Line Inches	Height Inches Including Trimmings	Width Inches Including Trimmings	Diameter Inches	Height Feet
184	400	650	1.88	2.33	2-3"	40 1/2	61 1/2	36 3/4	8x8	35
185	550	910	2.63	3.17	2-3"	40 1/2	61 1/2	36 3/4	8x12	35
186	700	1170	3.38	4.01	2-3"	40 1/2	61 1/2	36 3/4	8x12	35
187	850	1430	4.13	4.84	2-3"	40 1/2	61 1/2	36 3/4	8x12	40
204	600	1000	2.59	4.36	2-3 1/2"	46 1/2	66 1/2	45	8x12	35
205	800	1300	3.48	5.85	2-3 1/2"	46 1/2	66 1/2	45	8x12	35
206	1000	1650	4.37	7.34	2-3 1/2"	46 1/2	66 1/2	45	12x12	35
207	1200	2000	5.26	8.83	3-3 1/2"	46 1/2	66 1/2	45	12x12	40
255	1100	1825	5.66	8.37	2-4"	49	70 1/2	51	8x12	40
256	1350	2225	7.08	10.45	2-4"	49	70 1/2	51	8x12	40
257	1600	2650	8.50	12.53	3-4"	49	70 1/2	51	12x12	40
258	1850	3050	9.92	14.62	3-4"	49	70 1/2	51	12x12	45
G276	1350	2230	5.32	7.93	2-4"	45 1/2	68 1/2	50 3/4	12x12	40
G277	1650	2720	6.55	9.65	2-4"	45 1/2	68 1/2	50 3/4	12x12	40
G278	1950	3200	7.78	11.37	3-4"	45 1/2	68 1/2	50 3/4	12x12	45
G279	2250	3700	9.01	13.09	3-4"	45 1/2	68 1/2	50 3/4	12x12	45
235	1900	3150	7.28	11.01	2-4"	55	78	58 1/4	12x16	40
236	2350	3900	9.11	13.75	2-4"	55	78	58 1/4	12x16	45
237	2800	4650	10.94	16.49	3-4"	55	78	58 1/4	16x16	45
238	3250	5450	12.77	19.22	3-4"	55	78	58 1/4	16x16	50
239	3700	6150	14.61	21.96	3-4"	55	78	58 1/4	16x16	50
240	4150	6900	16.44	24.70	4-4"	55	78	58 1/4	16x16	60
WN276	4550	7475	15.25	24.66	3-5"	66	92	82	20x24	50
WN277	5475	9000	18.29	29.67	3-5"	66	92	82	24x24	55
WN278	6400	10,525	21.33	34.68	3-5"	66	92	82	24x24	60
WN279	7325	12,050	24.37	39.69	4-5"	66	92	82	24x24	60
WN280	8250	13,575	27.41	44.71	4-5"	66	92	82	24x28	65
WN281	9175	15,100	30.45	49.66	4-5"	66	92	82	28x28	70
WN282	10,100	16,625	33.49	54.61	4-5"	66	92	82	28x28	70
WN283	11,025	18,150	36.53	59.56	5-5"	66	92	82	28x32	75
WN284	11,950	19,675	39.57	64.51	5-5"	66	92	82	32x32	80

CAPITOL SEMI-SMOKELESS BOILERS

SS237	2800	4650	10.94	16.49	3-4"	55	78	58 1/4	16x16	45
SS238	3250	5450	12.77	19.22	3-4"	55	78	58 1/4	16x16	50
SS239	3700	6150	14.61	21.96	3-4"	55	78	58 1/4	16x16	55
SS240	4150	6900	16.44	24.70	4-4"	55	78	58 1/4	16x16	60
SS241	4600	7600	18.27	27.44	4-4"	55	78	58 1/4	16x20	60
SS277	5475	9000	18.29	29.67	3-5"	66	92	82	24x24	55
SS278	6400	10,525	21.33	34.68	3-5"	66	92	82	24x24	60
SS279	7325	12,050	24.37	39.69	4-5"	66	92	82	24x24	60
SS280	8250	13,575	27.41	44.71	4-5"	66	92	82	24x28	65
SS281	9175	15,100	30.45	49.66	4-5"	66	92	82	28x28	70
SS282	10,100	16,625	33.49	54.61	4-5"	66	92	82	28x28	70
SS283	11,025	18,150	36.53	59.56	5-5"	66	92	82	28x32	75
SS284	11,950	19,675	39.57	64.51	5-5"	66	92	82	32x32	80

For smoke pipe, base dimensions and other measurements, see next page.

Measurements, All Series Square Boilers, Including Smokeless



	180	200	250	G270	230 SS230	WN270 SS270	400	500
A	25 1/2"	28 3/4"	34 1/4"	36"	41 1/4"	57 3/4"	47"	57 1/4"
B	28 3/4"	32 1/2"	39 3/4"	43 1/2"	48 1/2"	71 3/4"	67"	71 3/4"
C	48"	54"	58 3/4"	55 1/4"	67"	77 1/4"	60 1/4"	77 1/4"
D	40 1/2"	46 1/2"	49"	45 1/2"	55"	66"	49"	66"
E	25 1/2"	29 3/4"	28 3/4"	27 1/2"	31"	33 1/4"	35"	38"
F	.....	.....	.....	.....	.....	20 1/4"	7 1/2"	20 1/4"
G	7 1/2" x 11 1/2"	9 1/4" x 14 1/2"	9 1/4" x 14 1/2"	8" x 13"	9 1/4" x 15 1/4"	10" x 17"	10" x 17"	10" x 17"
H	.....	207-25"	257-32"	258-40"	278-33 1/2"	279-40 1/2"	410-48 1/2"	413-64 1/2"
I	184-6 1/4"	204-6 1/4"	255-16"	276-20 1/4"	278-24"	279-20 1/4"	408-9 1/2"	410-16 1/4"
J	12"	11 1/2"	11 1/2"	16"	14"	15"	19 1/2"	15"
K	44 1/2"	50 3/4"	52 3/4"	50"	59"	72"	54 1/4"	72"
L	37"	43 3/4"	45 3/4"	41 1/2"	52"	58 3/4"	45 1/2"	58 3/4"
M	.....	.....	.....	.....	.....	53 1/4"	46"	53 1/4"
N	10"	10"	12"	14"	14"	21"	18"	21"
O	14 1/4"	16 3/4"	17 1/4"	16"	19"	20 1/4"	.....	20 1/4"
P	184-20 1/4"	204-23 1/2"	255-37 1/4"	G276-36"	235-36"	WN276-36"	408-63 1/2"	508-67 1/2"
Q	add 6 1/4"	add 6 1/4"	add 8"	add 6 1/4"	add 8"	add 8"	add 8 1/4"	add 9 1/4"
R	184-20 1/4"	204-23 1/2"	255-36 1/2"	G276-35 1/4"	235-37"	WN276-37"	408-62 3/4"	508-68 1/4"
S	14 1/4"	18"	17"	15 1/2"	18"	19 1/4"	21"	23 1/2"
T	.....	.....	.....	.....	.....	14 3/8"	.....	14 3/8"

*Center of Fire Door above grate level. **On 414, fourth tapping is 72 1/2" from first tapping. †Dimension K is for top outlet smokehood which can be furnished on all square boilers. ‡Back openings must be connected across back of boiler with a pipe not less than 3 inches in diameter on WN270, SS270 and 500.

Bunting Iron Works

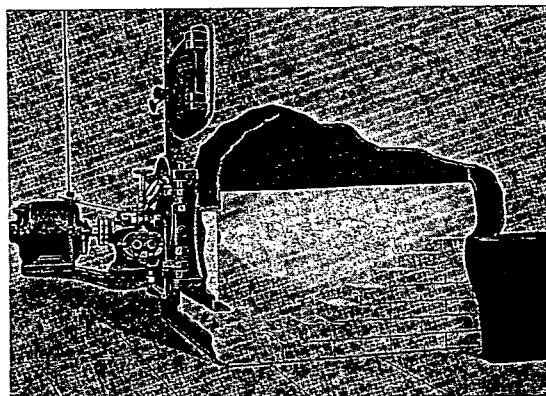
1215 First National Bank Bldg. :: SAN FRANCISCO, CAL.

VANCOUVER, B. C.—Barr & Anderson
 SEATTLE, WASH.—Sun Heating Co.
 PORTLAND, ORE.—C. C. Schenck Co.
 NEW ORLEANS, LA.—Rogers Higgins Co.
 ST. LOUIS, MO.—Economy Steam Specialty Co.
 MILWAUKEE, WIS.—Berryman Oil Burner Co.
 MANSFIELD, O.—Oil Burner Mfg. and Eqp. Co.
 NEW YORK, N. Y.—Simplex Oil Heating Corp.
 WASHINGTON, D. C.—Federal Heating Co.
 MEMPHIS, TENN.—Tennessee Oil Heating Co.
 DECATUR, ILL.—Harris Modern Heating Co.
 JACKSONVILLE, FLA.—Hooker & Lightbody

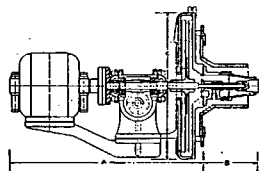
AGENTS

JUNEAU, ALASKA—Geo. F. Forrest
 SAN ANTONIO, TEXAS—A. H. Shafer Co.
 EL PASO, TEXAS—Elliott Engineering Co.
 DALLAS, TEXAS—Nash Engineering Co.
 KANSAS CITY, MO.—General Heating Supply Co.
 OKLAHOMA CITY, OKLA.—Frank Loeffler Supply Co.
 DETROIT, MICH.—Oil Automatic Heating Corp.
 CINCINNATI, O.—Warner & Stewart Co.
 CHICAGO, ILL.—Petroleum Appliance Co.
 PHILADELPHIA, PA.—Simplex Oil Heating Co.
 RICHMOND, VA.—Beverly Heating Co.
 MINNEAPOLIS, MINN.—Interstate Oil Co.

SIMPLEX HORIZONTAL ROTARY FUEL OIL BURNER



Single Unit Comprises Nozzle, Fan, Motor, Pump, Hinges on front of Boiler



Size	A	B	C	Capacity Steam Rad.	Motor
No. 1	18	4 1/2	14	1400	1/4
No. 1 1/2	18	4 1/2	14	3000	3/8
No. 3	20	4 1/2	18	7500	1/2
No. 5	21	4 1/2	18	10000	3/4

Simplex Fuel Oil Burners are of the rotary or mechanical atomizing type. In the **Improved Turbine** type the rotary atomizing cup is driven 8,000 R. P. M. by an air turbine and also embodies a Patented oil and air damper regulation feature, necessary and important to maintain efficient combustion.

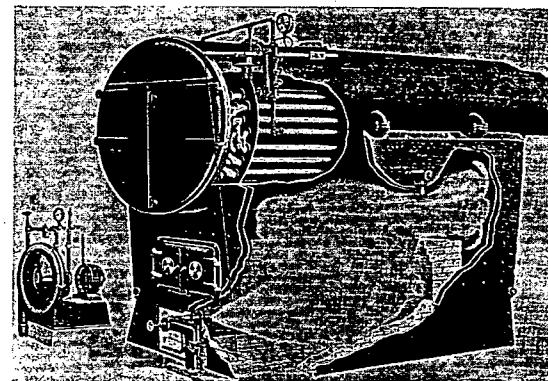
The **Horizontal Rotary** type has the atomizing cup directly connected to the motor shaft at 3,450 R. P. M. and is mounted by a hinge to the front of the boiler.

Almost any boiler can be converted over to oil burning. The grates are removed and a fire brick combustion chamber built as illustrated. Where fuel oil is available it is cheaper than coal and saves room—ashes—dust—soot—smoke—and gives a steady continuous fire without work or dirt.

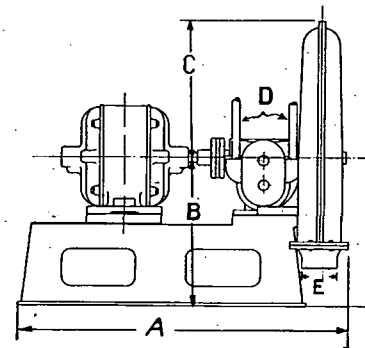
The saving of fuel oil over coal can be estimated by taking 50 per cent of the heat value of coal, 12,000 B.t.u. per lb. and 75 per cent of the heat value of fuel oil, 19,000 B.t.u. per lb. as the available B.t.u. and find that 112 gal. or 2.6 barrels equal a ton of coal. Substitute these values as required by conditions.

Request further information from our nearest agent.

SIMPLEX IMPROVED TURBINE FUEL OIL BURNERS

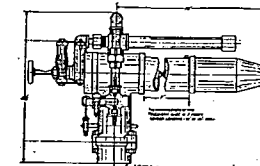


Illustrating Burner, Character of Fire and Motor, Fan, and Oil Pump Unit

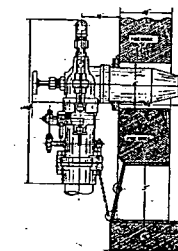


Motor, Fan and Oil Pump Unit

Size	A	B	C	D-Pipe	E-Pipe
11	23 1/2	10 1/4	9 1/4	1 1/2	2
12	23 1/2	10 1/4	9 1/4	1 1/2	2 1/2
21-22	26 1/2	12 1/2	11 1/4	3/4	2 1/2
23-24	26 1/2	12 1/2	11 1/4	3/4	3
28	38	14	11 1/4	1 1/4	4



Type "B" Burner for Brick-Set Boilers

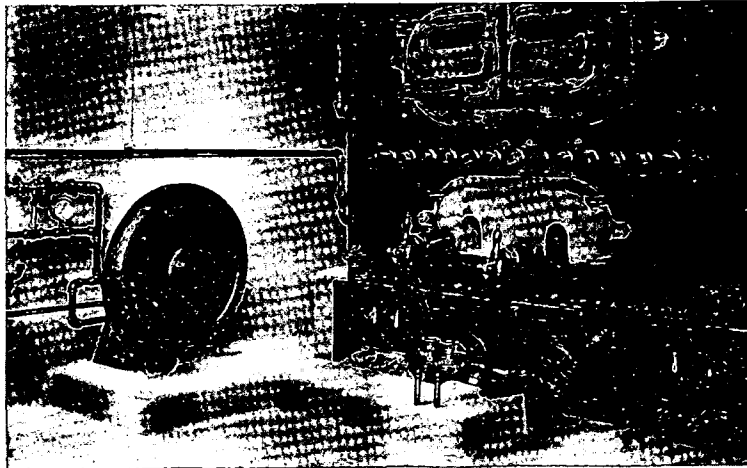


Type "A" Burner Nozzle for 4 1/4" Brick Wall

Size	No. of Burner in Battery	Min.—Max. One Burner Steam Rad.	Max. Comb. Capacity Steam Rad.	Min.—Max. Capacity One Burner Boiler, H. P.	Max. Comb. Capacity Boiler, H. P.	Size Motor H. P.
No. 11.	1	500-6000	6000	5-50	...	1/2
No. 12	2	500-3000	6000	10-60	...	3/4
No. 21	1	1000-7000	14000	10-60	120	1
No. 22	2	1000-7000	21000	10-60	180	2
No. 23	3	1000-7000	28000	10-60	340	2
No. 24	4	1000-7000	56000	10-60	480	5
No. 28	8	1000-7000	56000	10-60	480	5

Winslow Boiler & Engineering Co.

Builders of Oil Burners

CHICAGO
208 S. La Salle St.NEW YORK
SHOW ROOM: 46 E. 41st St.GALESBURG
Illinois

A WINSLOW INDUSTRIAL BURNER installation consists of a motor-blower unit and a burner nozzle assembly.

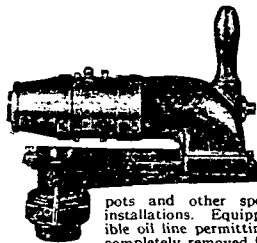
The motor blower unit may be located at any convenient point near the boilers and connected to the burner assembly, in front of the boilers, by oil and air piping of correctly proportioned sizes.

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.

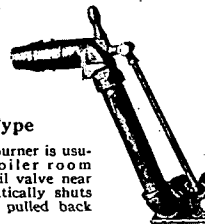
Single motor blower units handle a variety of burner assemblies and where dual units are twinned the capacities are not only doubled but the plant is insured against any shut down. There are several sizes of motor blower units and also of burners.

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.



Sliding Type

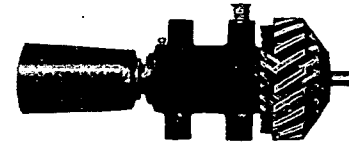
The sliding type burner is particularly adapted to bake ovens, lead melting pots and other special industrial installations. Equipped with a flexible oil line permitting burner to be completely removed from slide base.



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.

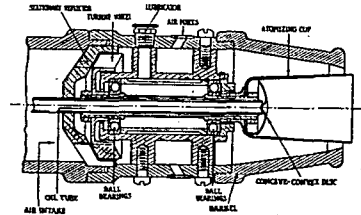
Wherever possible specify two smaller burner nozzles even though one larger one will do the work, so as to assure an easier control of fuel consumption. Frequently both burner nozzles will be used to build up steam pressure and then one can be cut entirely off. Where loads are apt to be variable the double burner nozzle is ideal.



The cut to the right above shows the efficient 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.	3/4	1/2"	2"
Amos.....	B-60	1	T 30	4,000'	24"x24"	265 lbs.	3/4	1/2"	2"
Anthony.....	B-60	2	T 30	6,000'	24"x24"	280 lbs.	3/4	1/2"	2"
Austin.....	B-60	1	T 40	5,000'	24"x24"	285 lbs.	3/4	1/2"	2"
Barney.....	B-90	2	T 30	7,000'	24"x24"	300 lbs.	1	1/2"	2"
Benjamin.....	B-90	3	T 30	9,000'	24"x24"	315 lbs.	1	1/2"	2"
Bernard.....	B-90	1	T 40	5,000'	24"x24"	290 lbs.	1	1/2"	2"
Blaine.....	B-90	2	T 40	9,000'	24"x24"	305 lbs.	1	1/2"	2"
Bruce.....	B-90	1	T 70	7,000'	24"x24"	300 lbs.	1	1/2"	2"
Charles.....	B-120	3	2T 40 1T 30	11,000'	24"x24"	320 lbs.	2	1/2"	2 1/2"
Curtis.....	B-120	2	1T 70 1T 40	11,000'	24"x24"	330 lbs.	2	1/2"	2 1/2"
Daniel.....	B-180	2	T 70	15,000'	28"x28"	365 lbs.	3	3/4"	2 1/2"
David.....	B-180	3	T 40	14,000'	28"x28"	355 lbs.	3	3/4"	2 1/2"
Dean.....	B-180	4	T 40	17,000'	28"x28"	370 lbs.	3	3/4"	2 1/2"
Delbert.....	B-180	5	T 30	18,000'	28"x28"	365 lbs.	3	3/4"	2 1/2"
Earl.....	B-300	1	T 250	25,000'	28"x28"	400 lbs.	5	3/4"	3"
Edward.....	B-300	4	T 70	30,000'	28"x28"	425 lbs.	5	3/4"	3"
Elmer.....	B-300	6	T 40	30,000'	28"x28"	455 lbs.	5	3/4"	3"
Eugene.....	B-300	8	T 30	30,000'	28"x28"	460 lbs.	5	3/4"	3"
Frank.....	B-500	2	T 250	50,000'	28"x28"	550 lbs.	5	3/4"	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

-:-

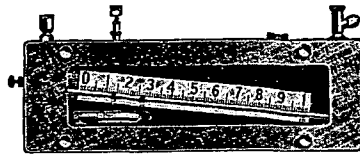
CHICAGO, ILL.



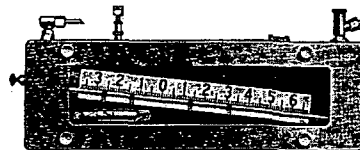
Ellison Draft Gages—the recognized standard for draft measurements—comprise a complete line of draft gages of the highest accuracy, quality, and finish, for every draft condition, completely equipped. The movement of oil in a glass tube is a fixed standard of measurement that stays calibrated.

The scales have sliding movement for quick zero adjustment, requiring no refilling for several years. Readings are visible across the boiler room.

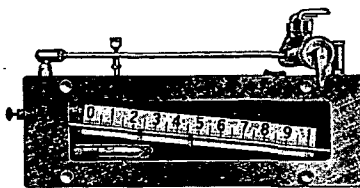
Bulletin of complete line on request



SINGLE-TUBE INCLINED: This gage, for power boilers, is made in 1, 1½, 2, 3, 4, 5 inches scale range, suction or pressure.



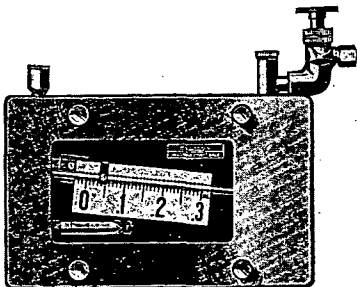
COMPOUND INCLINED: This gage reads furnace draft to left, flue draft or differential to right of zero.



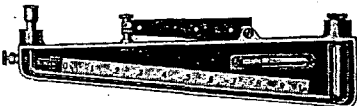
COMBINATION INCLINED: By turning the handle of the cock, this gage reads furnace, flue or differential 1, 1½ inches range.



SINGLE-TUBE INCLINED: This gage is for small boilers and furnaces, and for power boilers with operating draft not over ¼ inch. It is equipped with seal for 250 feet chimney height.



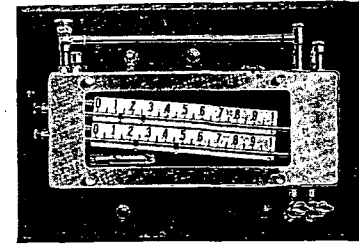
SINGLE-TUBE INCLINED: This gage was designed for domestic boilers and furnaces. 0.5 inch scale range with seal for 225 feet chimney height.



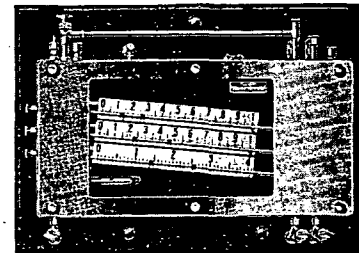
OPEN TYPE INCLINED: For laboratories and technical institutions, 1, 1½, 2, 3 inches range. Suspension plate relieves the gage from mounting strains, level adjusted with left suspension. Furnished with and without portable attachments.



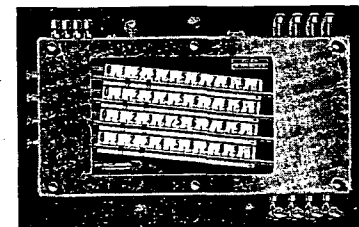
PORTABLE INCLINED: This gage was designed for traveling engineers, light and compact, ½, ¾, 1, 1½, 2 inches scale range. Furnished with attachments and carrying case for one or two gages.



TWO-TUBE INCLINED: By means of the differential system, this gage reads 1 to 1½ inches furnace draft and differential simultaneously; flue and furnace drafts when cock is closed. Without differential system, 1 to 5 inches range.

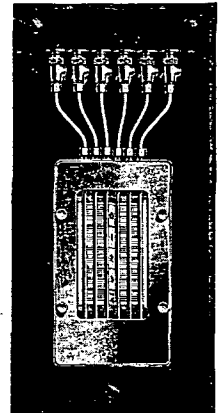


THREE-TUBE INCLINED: This gage is furnished with or without differential systems, with scales 1 to 1½ inches range like readings or combination readings from 1 to 6 inches scale range.



FOUR-TUBE INCLINED: This gage reads suction or pressure, 1 to 1½ inches like readings or combination readings 1 to 7½ inches.

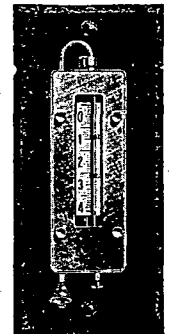
MULTI-TUBE VERTICAL: This gage is for the duct and zone pressures of forced draft traveling grate stokers. It is made in 1, 2, 3, 4, 5, 6, 7, 8 tubes, in 4 and 7 inches scale range, white metal. Furnished with panel or for gage boards, complete with connections and fillings.



By means of an Equalizer, all chambers are filled in one filling. With the sliding scale, the gage requires no refilling for several years.

Paper scales are furnished for plotting the load curves, inserted over the metal scale—the "Perfect Firing Guide."

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 and without panel.



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

11 South Desplaines Street

CHICAGO-U.S.A



Varnish Drying, Air Conditioning and High Temperature Baking Equipment and Heating Equipment.



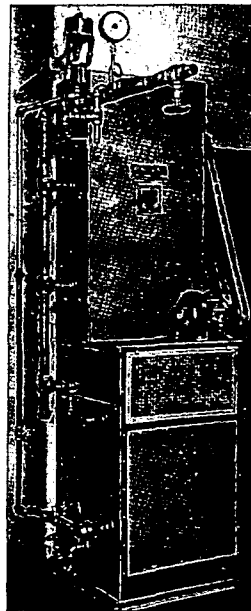
Drying Systems, Inc., specializes in drying and heating equipment. Our equipments have been applied with conspicuous success to the drying of Varnish and Undercoatings, Low and High Temperature Enamels, Dimensioned and Core Stock, Veneered Panels, Coated Cloth and Leather, and many other products, as well as for space heating purposes. We also design and install air conditioning apparatus for Finishing Rooms.

With Dry-Sys process and equipment the artificial hastening of drying is so effected that the coating is thoroughly and uniformly dried throughout its entire depth, because it provides adequate circulation of properly humidified and heated air. Heated air, alone causes surface-drying and detrimental changes. Since the Dry-Sys method provides the vital element in drying—HUMIDITY—drying becomes a perfected and rapid process, insuring a coating of finest quality, both in appearance and in durability.

And of even greater importance the Dry-Sys method of conditioned air drying insures a positive and unvarying time schedule regardless of outdoor weather. This permits the establishment of an efficient drying routine, on an exact schedule, greatly increasing production and minimizing costs.

Our broad experience in drying and conditioning, and in space heating as well, is at the disposal of our clients and we invite correspondence with reference to such problems.

312



The Drying Unit

THE DRYING UNIT consists of a substantially constructed sheet metal casing in which are compactly assembled a multi-blade fan, radiator (for either high or low pressure steam), an air washer-humidifier, automatic temperature and humidity control, steam supply and return, water supply and drain, and the necessary valves, all ready for quick connection. The Unit is manufactured in three sizes and can be installed in connection with dry rooms—from 2000 to 12000 cu. ft. contents—without radical changes in construction. Used in many plants for drying varnish, undercoatings, dimensioned and glued-up stock, and many other materials. Bulletin H-13 gives full particulars.

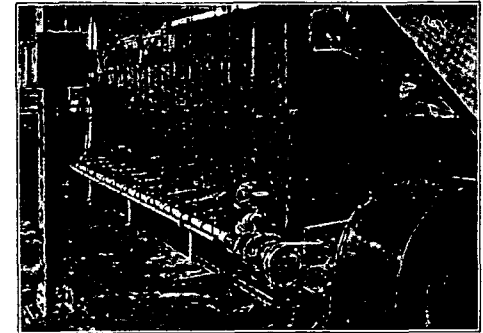
HIGH TEMPERATURE EQUIPMENT

Dry-Sys High Temperature equipment is exceptionally economical, as well as entirely safe, for High Temperature Baking of Enamels, Drying and then Processing of material. The range of delivering temperature is from 250° to 700° F. Low temperature applications of this equipment for space heating purposes have proved to be successful as well as very economical.

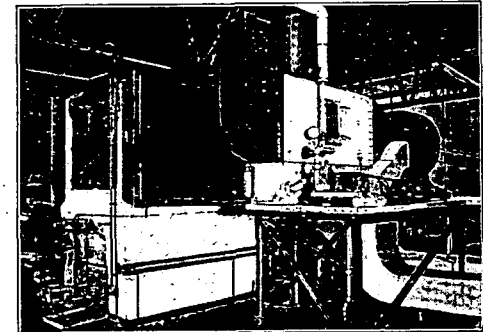
This equipment is built in sections, and additional sections may be added as required, with very little alteration to original setting. The unit-construction of the Lawrence Heater has another advantage in that it makes relocation simple—heater can be taken down and set up very quickly and at small expense.

The system embodies the scientific principle of counter-current flow or air. The air is forced downward through successive radiating zones, leaving the heater at the point of maximum temperature. These heaters are designed to use oil as fuel. While they operate satisfactory with gas, we recommend it only in those instances where the cost does not exceed that of oil.

Every condition is a new engineering problem. We shall be glad to give you the benefit of the long and specialized experience of our engineering corps—without obligation. Send for Bulletin H-14 and H-15.



The Lawrence Heater



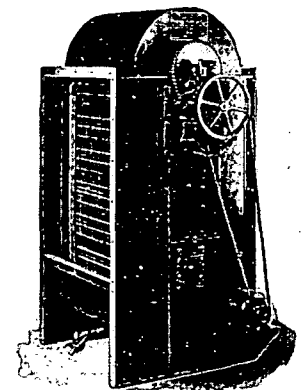
The Harrison Aertube Heater

THE PHOENIX AIR FILTER

The Phoenix Air Filter is self-cleaning, because the filter screen constantly rotates at a slow rate of travel, passing through an oil reservoir. It is a twenty-four hour-a-day performer, operating at all times with the same low resistance and efficiency. It requires no supervision or maintenance because there are no parts to get out of order or clogged cells to clean.

The Phoenix Air Filter is built in units ranging from 2,000 to 20,000 C. F. M. It is particularly adapted for turbo-generators, air compressors and ventilation work in public buildings, factories, department stores, etc. Ask for Bulletin No. H-26.

(2853)



"The Screen That's Always Clean"

DESCRIPTIVE BULLETINS WILL BE SENT UPON REQUEST

313

Expansion Joints

ESTABLISHED 1841

E. B. Badger & Sons Co.

Manufacturers of Expansion Joints for High and Low Pressure

63-75 Pitts Street

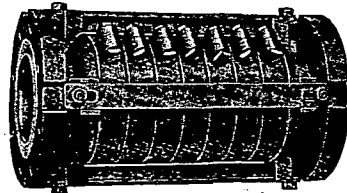
BOSTON, MASS.

SALES OFFICE: 101 Park Avenue, NEW YORK, N. Y.

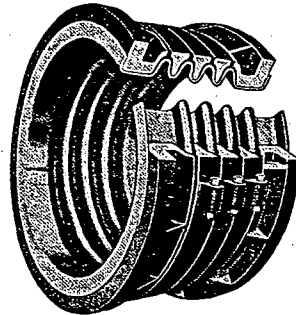
Badger Self-Equalizing Expansion Joints

The Badger Self-Equalizing Expansion Joints are one piece, made from special seamless copper tubes, fitted with cast iron or steel rings to control the expansion and distribute it equally over each corrugation. Made in Standard and Extra Heavy patterns.

Unless otherwise specified, expansion joints with standard flanges will be furnished for pressures up to and including 125 lb. and extra heavy flanges for all pressures from 125 to 200 lb.



This type of Badger Self-Equalizing Expansion Joint is furnished in 4 in. and 5 in. sizes, with four and eight corrugations to care for 1 in. and 2 in. of expansion. For smaller sizes we furnish a 4 in. joint with companion flanges, bolts and gaskets and tapped for any size required.



This type of Badger Self-Equalizing Expansion Joint is furnished in sizes 6 to 20 in., inclusive, with two and four corrugations, 2 1/4 in. deep, to care for 1 and 2 in. of expansion.

Size Inches	FOUR-CORRUGATION			EIGHT-CORRUGATION			Price with Extra Heavy American Standard Flanges Each
	Face to Face Dimensions Inches	Finished Weight Pounds	Price Each	Face to Face Dimensions Inches	Finished Weight Pounds	Price Each	
4	12 1/2	65	\$ 76	19 1/2	94	\$102	\$107.10
5	12 1/2	78	82	19 1/2	108	110	115.93

For any size up to 3 1/2 in., add to the price of the 4 in. joint \$4.00 net for American Standard 125 lb. pressure companion flanges, bolts and gaskets, and \$5.00 net for extra heavy American Standard flanges, bolts and gaskets tapped for whatever size required.

Size Inches	TWO-CORRUGATION			FOUR-CORRUGATION			Price with Extra Heavy American Standard Flanges Each
	Face to Face Dimensions Inches	Finished Weight Pounds	Price Each	Face to Face Dimensions Inches	Finished Weight Pounds	Price Each	
6	12 1/2	146	\$ 125	19	236	\$ 187	\$ 195.25
8	12 1/2	187	156	19	293	211	225.73
10	12 1/2	258	182	19	395	254	272.96
12	13	338	222	19 1/2	493	300	324.03
14	13 1/2	404	252	20	576	337	364.28
16	13 1/2	476	285	20	672	382	419.95
18	14	546	320	21	760	428	487.83
20	15	669	388	21 1/2	911	511	573.80

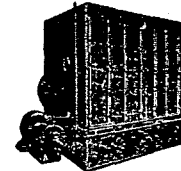
Fans and Ventilating Equipment

American Blower Company

Detroit, Michigan

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.

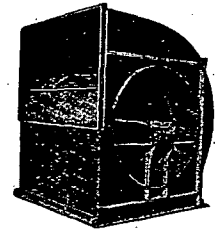
For Dehumidifying and Cooling in Candy Factories, Bakeries, Photo Film Drying Rooms, Blast Furnaces, Electric Generators, etc.

"Sirocco" Multiblade Fans and Blowers

For Heating, Ventilating and Cooling in Public, Office, Industrial and Educational Buildings.

For Drying and Mechanical Draft.

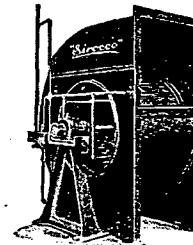
Several exclusive features make the "Sirocco" Fan the most efficient air-moving machine obtainable, for any of the many classes of service for which it is adapted. Its high efficiency is due to a design which, with large inlet, wheel without obstructions, specially curved blades and easy flowing lines, 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.

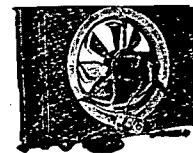
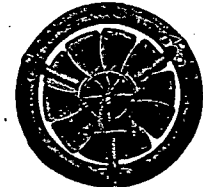
The "ABC" Air Washing and Cooling Fan is used in Schools, Theatres, Clubs, Churches, Auditoriums, Stores and Industrial Buildings, where it insures good air conditions, conducive to comfort and increased working capacity. It requires a minimum of attention and occupies small floor space.



"Ventura" Disc Ventilating Fan

For delivering large volumes of air at low pressure or against slight resistance. Cost of fan and installation are low and power consumption insignificant.

For ventilating rooms and buildings—Ventura motor driven ventilating fans, 600 C. F. M. to 17,500 C. F. M.



The No. 2 1/4 Reversible Ventura, either with or without the portable, adjustable frame shown in the illustration, is ideal for use in homes—for ventilating the kitchen, living room, bedroom or laundry—and for small offices.

Special Bulletins descriptive of the Equipment illustrated and listed will be sent upon request.

Bayley Manufacturing Co.

730 Greenbush Street

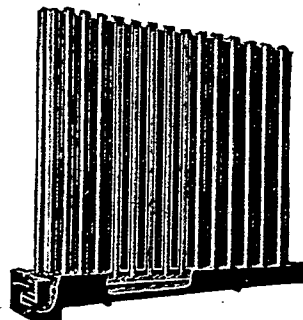
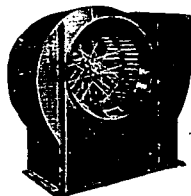
MILWAUKEE, WISCONSIN

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, Air Washers. 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.

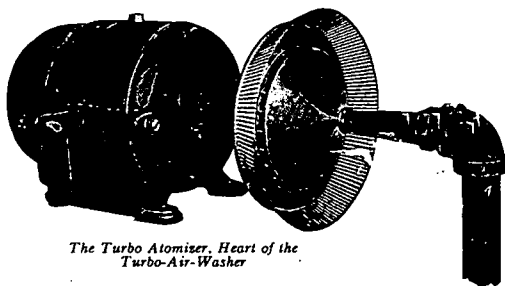


Chinook Heaters

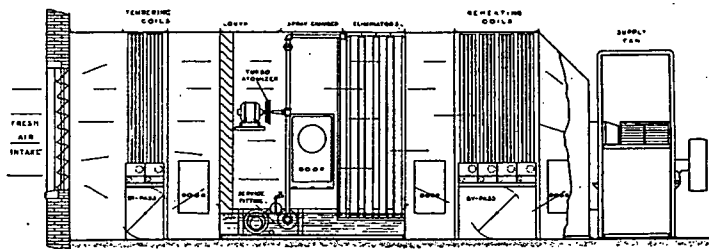
The Bayley Chinook Heater is a tube-within-a-tube radiator without return bends, elbows or nipples. Circulation is established from the steam chamber through the inner tube, and back through the outer tube to the return chamber. Used in connection with the Plexiform fan, also for direct and indirect radiation, and for cooling water.

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. Clogging is prevented, as the water is delivered to the cone through a nozzle with a large orifice and at low pressure. The non-clogging feature assures a steady, uniform spray, which insures intimate contact between the air and the spray. No screen in pump intake. Atomizer fits any air washer. Washers made in various sizes for washing air or gases and for use in chemical plants.



The Turbo Atomizer, Heart of the Turbo-Air-Washer



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, Washington Loan & Trust Bldg.
ST. LOUIS, 515 Chemical Bldg.
CINCINNATI, 606 Mercantile Library Bldg.
MINNEAPOLIS, 120 South Ninth St.
DENVER, 1718 California St.
LOS ANGELES, 638 H. W. Hellman Bldg.
INDIANAPOLIS, 1016 Fletcher Trust Bldg.
SAN FRANCISCO, Sharon Bldg.

CANADIAN BRANCH

Canadian Blower and Forge Co., KITCHENER, ONTARIO

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.

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.

Disc Fans are very useful for removing steam, odors or foul air in shops, mills and factories. Belted or direct motor driven types.

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.

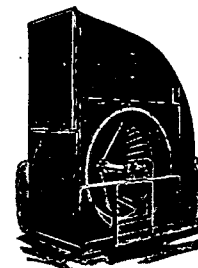
Conoidal Multiblade Fans
Carrier Air Washers
Pipe Coil Heaters
Ventilating Sets
Disc Fans
Humidifiers

Buffalo Products

Generator Coolers
Gas Scrubbers
Stoker Fans
Induced Draft Fans
Planing Mill Exhaust Fans

Dust Collectors
Pressure Blowers
Drying Apparatus
Spray Nozzles
Forge Shop Equipment

Send for Catalogue



Clarage Fan Company

Kalamazoo, Michigan

BOSTON
CHICAGO
CLEVELAND
LOS ANGELES

MINNEAPOLIS
ST. LOUIS
ROCHESTER
DENVER

NEW YORK
PHILADELPHIA
PITTSBURGH
INDIANAPOLIS

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.

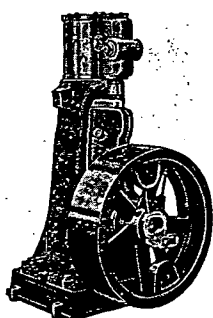
Multiblade Fans—Designed and built primarily for heating and ventilating where large volumes of air are handled at low pressures. Suitable for schools, theatres, churches, offices and factories. High efficiency, quietness of operation, small space required and adjustable features of design are points in which they have been found superior to other types. Range of sizes to fit every condition. Capacities from 500 to 250,000 cu. ft. of air per minute. Full housed fans up to and including No. 3 size are built with cast iron side plates and are adjustable for any angle of discharge. Built $\frac{3}{8}$ housed in sizes larger than No. 3. Double width fans have twice capacity of single width fans of same size. Can be motor, engine or turbine driven, by belt or direct connected.

Type "V" Air Washers—Seven ft. in length in all sizes, providing ample room for perfect cleaning and humidification of air. Provided with spray nozzles that do

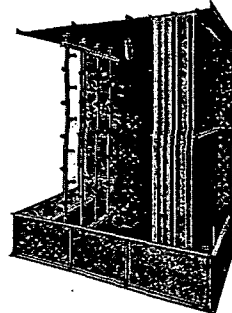
not clog, due to large passages, yet water is broken into fine mist insuring intimate association of water and air. Strain on sides of washer avoided by cast iron supports in bottom of tank, carrying entire weight of spray headers and eliminators. Small cost for erection, since eliminators can be assembled in fraction of time required on older types. Has observation door of improved type. Suitable for any washed air installation and for summer cooling. Range of sizes to cover every requirement. Fully guaranteed.

Vertical Steam Engines—Fully enclosed and provided with automatic oiling system lubricating every moving part. Built rugged for hard, constant service. Adaptable for driving ventilating fans, pumps, motor generators, etc. Sizes 4 to 9 in. stroke for steam pressures from 40 to 250 lb.

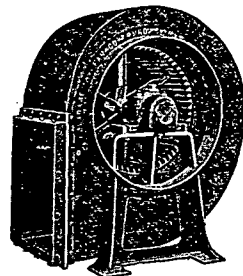
Cooperative Service—Our engineers have compiled elaborate data covering every Clarage product. Material will be found of value in determining requirements. We will gladly cooperate with engineers and owners in every way possible. Write for catalogs.



Type "V" Vertical Steam Engine



Inspection View of Air Washer



Multiblade Fan for Ventilating

Ilg Electric Ventilating Company

General Offices and Works:

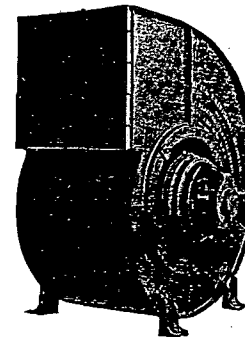
2880 N. Crawford Avenue

CHICAGO, ILL.

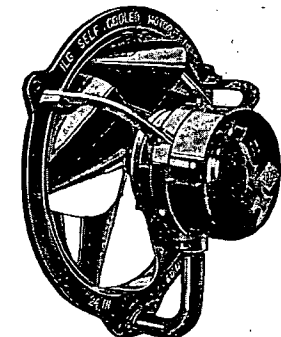
NEW YORK
13 Park Row
PHILADELPHIA
325 Commercial Trust Bldg.
BALTIMORE
Hearst Tower Bldg.
ST. LOUIS
1421 Syndicate Trust Bldg.

CLEVELAND
1314 Schofield Bldg.
PITTSBURGH
1024 Bessemer Bldg.
MINNEAPOLIS
442 Builders Exchange Bldg.
CINCINNATI
903 Union Central Bldg.
LOS ANGELES
600 Metropolitan Bldg.

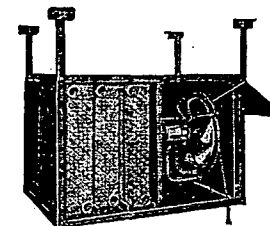
DETROIT
204 Owen Bldg.
BOSTON
136 Federal St.
INDIANAPOLIS
514 Board of Trade Bldg.
ROCHESTER
941 Granite Bldg.



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.



Ilg 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

Hersh Brothers Company

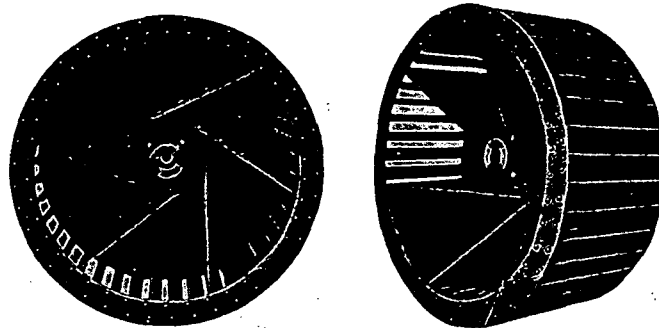
Allentown, Pa.

149 Broadway, N. Y.



131 State St., Boston

Fans and Blowers for Heating and Ventilating



Lehigh Multiblade Fans, Wheel Type "M"—Cut Showing a Counter Clockwise Wheel

This type of fan is designed particularly for use in connection with heating and ventilating systems in public and industrial buildings where large volumes of air are handled at comparatively low pressures. It is proportioned to give low velocities of air throughout with the least resistance both at the entrance and at the discharge.

The special construction of this type of wheel combines in one the desirable qualities of the older steel plate fan wheel with the large capacity and efficient operation of the Multiblade Type. This wheel requires no stay-rods to keep it in shape under any speed. The strength and rigidity of construction can be readily ascertained from examination of the radial blades which run to the hub of the wheel, so placed in order to give the greatest strength in the direction of rotation. The strains on this wheel are those of tension,

in which all metal is strongest, rather than shear, in which it is weakest. No wobbling side thrusts occur with this construction. The curvature of the Multiblades does not restrict the area of discharge and therefore the capacity of the wheel.

The housing, being rigidly braced with angle iron and the inlet and outlet with tee iron punched for sheet metal connection, is free from vibration under the highest speeds and pressures.

The bearings are of unusual quality (ball and socket type) with double ring oiling and best babbit. They are self-aligning in all directions. This prevents the shaft from becoming bound.

The shaft is constructed of the best grade of DRAW STEEL containing from 30 to 40% carbon.

LEHIGH

LEHIGH MULTIBLADE FANS—TYPE "M"

FOR USE IN HEATING AND VENTILATING

RECOMMENDED OPERATING CONDITIONS, 70° F., 29.92" BAR.

Fan No.	Dia. Wheel, In.	Area Outlet, Sq. Ft.	1/4" STATIC PR.					1/2" STATIC PR.					3/4" STATIC PR.					1" STATIC PR.					1 1/4" STATIC PR.				
			Total Pres., 356" Outlet Vel., 1300 ft. Per. Speed, 1610 ft.					Total Pres., 507" Outlet Vel., 1400 ft. Per. Speed, 1955 ft.					Total Pres., 641" Outlet Vel., 1500 ft. Per. Speed, 2145 ft.					Total Pres., 785" Outlet Vel., 1600 ft. Per. Speed, 2371 ft.					Total Pres., 939" Outlet Vel., 1700 ft. Per. Speed, 2578 ft.				
			C. F. M.	Rev.	H. P.	C. F. M.	Rev.	H. P.	C. F. M.	Rev.	H. P.	C. F. M.	Rev.	H. P.	C. F. M.	Rev.	H. P.	C. F. M.	Rev.	H. P.	C. F. M.	Rev.	H. P.				
2 1/2	15	1.24	1,610	409	.18	1,735	497	.25	1,860	546	.34	1,980	603	.44	2,110	656	.54	2,230	713	.64	2,350	770	.74				
3	18	1.78	2,320	341	.28	2,500	415	.36	2,680	455	.48	2,850	503	.62	3,030	547	.78	3,200	595	.88	3,370	643	.98				
3 1/2	21	2.43	3,160	292	.34	3,500	355	.48	3,650	390	.65	3,890	431	.84	4,130	469	1.1	4,370	507	1.1	4,610	545	1.4				
4	24	3.17	4,120	256	.44	4,500	311	.63	4,750	341	.84	5,075	377	1.1	5,400	410	1.4	5,725	441	1.6	6,050	471	1.8				
4 1/2	27	4.02	5,150	227	.55	5,620	276	.79	6,020	303	1.06	6,430	335	1.37	6,830	364	1.7	7,230	395	2.0	7,630	426	2.1				
5	30	4.96	6,450	209	.68	6,950	249	.97	7,450	273	1.3	7,950	303	1.7	8,450	333	2.1	8,950	363	2.4	9,450	393	2.7				
5 1/2	33	6.0	7,800	186	.81	8,400	226	1.16	9,000	248	1.56	9,600	274	2.1	10,200	298	2.6	10,800	324	3.0	11,400	348	3.4				
6	36	7.25	9,280	171	.96	10,000	207	1.37	10,700	227	1.85	11,400	252	2.4	12,100	273	3.0	12,800	298	3.6	13,500	324	4.0				
7	42	9.72	12,600	146	1.3	13,600	178	1.85	14,600	195	2.5	15,600	216	3.25	16,600	234	4.0	17,600	252	4.8	18,600	273	5.6				
8	48	12.7	16,500	128	1.7	17,750	156	2.4	19,000	170	3.2	20,300	188	4.2	21,500	205	5.3	22,750	227	6.4	24,000	252	7.5				
9	54	16.1	20,850	114	2.1	22,500	138	3.0	24,100	151	4.0	25,700	168	5.2	27,300	182	6.5	28,900	196	7.8	30,500	216	9.0				
10	60	19.8	25,750	103	2.6	27,800	124	3.7	29,700	137	5.0	31,700	151	6.4	33,700	164	8.0	35,700	178	9.6	37,700	196	10.4				
11	66	24.0	31,200	93	3.1	33,600	113	4.5	36,000	124	6.0	38,400	137	7.8	40,800	149	9.7	43,200	156	10.4	45,600	168	12.0				
12	72	28.6	37,100	86	3.6	40,000	104	5.2	42,800	114	7.0	45,700	126	9.1	48,500	137	11.3	51,300	149	13.2	54,100	168	15.2				
13	78	33.5	43,800	79	4.2	47,000	96	6.1	50,250	105	8.1	53,500	116	10.6	56,750	126	13.2	60,000	137	15.2	63,250	156	19.3				
14	84	38.9	50,600	73	4.8	54,400	89	7.0	58,300	98	9.4	62,300	108	12.2	66,200	117	15.2	70,100	126	18.4	74,000	145	22.4				
15	90	44.6	58,000	68	5.5	62,500	83	7.9	67,000	91	10.6	71,500	101	13.8	76,000	109	17.2	80,500	116	21.6	85,000	137	26.4				
16	96	50.8	66,000	64	6.2	71,200	78	8.9	76,200	86	11.9	81,200	95	15.5	86,200	103	19.3	91,200	116	24.0	96,200	137	30.0				
17	102	57.3	74,500	61	7.0	80,250	73	10.0	86,000	81	13.4	91,700	89	17.5	97,400	97	21.8	103,100	103	26.4	108,800	126	33.6				
18	108	64.3	83,500	57	7.8	90,000	69	11.2	96,500	76	15.1	102,800	84	19.6	109,200	91	24.4	115,600	103	28.8	122,000	126	38.4				
20	120	79.3	103,000	52	9.7	111,000	63	13.8	119,000	69	18.6	127,000	76	24.2	135,000	82	30.0	143,000	94	33.6	151,000	103	40.8				

Fan No.	Dia. Wheel, In.	Area Outlet, Sq. Ft.	1" STATIC PR.				1¼" STATIC PR.				1½" STATIC PR.				1¾" STATIC PR.				2" STATIC PR.										
			Total Pres., 1.202" Outlet Vel., 1800 ft. Per. Speed, 2950 ft.				Total Pres., 1.5" Outlet Vel., 2000 ft. Per. Speed, 3300 ft.				Total Pres., 1.83" Outlet Vel., 2300 ft. Per. Speed, 3625 ft.				Total Pres., 2.14" Outlet Vel., 2500 ft. Per. Speed, 3930 ft.				Total Pres., 2.455" Outlet Vel., 2700 ft. Per. Speed, 4220 ft.										
			C. F. M.	Rev.	H. P.		C. F. M.	Rev.	H. P.		C. F. M.	Rev.	H. P.		C. F. M.	Rev.	H. P.		C. F. M.	Rev.	H. P.								
2¼	15	1.24	2,230	751	.73	2,480	838	1.0	2,850	922	1.5	3,100	1000	1.85	3,350	1073	2.4	3,600	1146	2.8	3,850	1219	3.2	4,100	1292	3.6	4,350	1365	4.0
3	18	1.78	3,210	625	1.1	3,540	698	1.5	4,100	768	2.1	4,460	832	2.6	4,820	896	3.2	5,180	959	3.6	5,540	1023	4.0	5,900	1087	4.4	6,260	1151	4.8
3½	21	2.43	4,370	536	1.4	4,850	600	2.0	5,580	699	2.8	6,070	714	3.5	6,560	768	4.2	7,050	822	4.8	7,540	876	5.6	8,030	930	6.4	8,520	984	7.2
4	24	3.17	5,710	469	1.9	6,350	524	2.6	7,300	576	3.6	7,950	624	4.6	8,580	671	6.0	9,230	721	7.2	9,880	771	8.4	10,530	821	9.6	11,180	871	10.8
4½	27	4.02	7,240	417	2.3	8,040	466	3.2	9,250	513	4.6	10,000	555	5.8	10,850	597	7.6	11,700	640	8.8	12,550	683	10.0	13,400	726	11.2	14,250	771	12.4
5	30	4.96	8,930	375	2.9	9,900	419	4.0	11,400	461	5.6	12,400	500	7.1	13,400	537	9.3	14,400	573	10.4	15,400	613	11.6	16,400	653	12.8	17,400	693	14.0
5½	33	6.0	10,800	341	3.4	12,000	381	4.8	13,800	419	6.7	15,000	454	8.5	16,200	488	11.2	17,400	523	12.4	18,600	563	14.0	19,800	603	15.2	21,000	643	16.4
6	36	7.25	12,850	313	4.1	14,300	349	5.6	16,450	384	8.0	17,850	416	10.1	19,300	447	13.3	20,750	476	14.4	22,200	506	16.0	23,650	536	17.6	25,050	566	18.8
7	42	9.72	17,500	268	5.5	19,400	300	7.6	22,400	330	10.7	24,300	357	13.6	26,200	384	17.8	28,100	416	20.0	30,000	446	22.4	31,900	476	24.8	33,800	506	27.2
8	48	12.7	22,900	235	7.1	25,400	262	9.8	29,200	288	13.8	31,700	312	17.6	34,300	336	23.0	36,900	357	25.6	39,500	387	28.0	42,100	417	30.4	44,700	447	32.8
9	54	16.1	28,900	208	8.9	32,100	233	12.3	36,900	256	17.3	40,200	278	22.0	43,500	299	28.8	46,800	312	31.2	50,100	347	33.6	53,400	377	36.0	56,700	407	38.4
10	60	19.8	35,700	188	10.8	39,700	210	15.0	45,600	231	21.2	49,500	250	26.9	53,500	288	35.3	57,400	312	38.4	61,300	347	43.2	65,200	377	48.0	69,100	407	52.8
11	66	24.0	43,150	171	13.0	48,000	191	18.0	55,200	210	25.4	60,000	227	32.3	64,800	244	42.3	69,600	265	48.0	74,400	288	52.8	79,200	312	57.6	84,000	336	62.4
12	72	28.6	51,400	157	15.3	57,200	175	21.2	65,700	192	30.0	71,500	208	38.1	77,300	224	50.0	83,100	244	57.6	88,900	268	64.0	94,700	292	70.4	100,500	316	76.8
13	78	33.5	60,400	145	17.8	67,000	162	24.7	77,000	178	34.9	83,500	192	44.3	89,500	216	60.0	95,500	240	67.2	101,500	264	76.8	107,500	288	86.4	113,500	312	96.0
14	84	38.9	70,000	134	20.5	77,700	150	28.3	89,500	165	40.0	97,200	179	50.8	105,000	192	66.7	112,800	216	72.0	120,600	240	81.6	128,400	264	96.0	136,200	288	105.6
15	90	44.6	80,400	125	23.3	89,400	140	32.3	103,000	154	45.3	111,600	167	58.0	120,200	192	79.2	128,800	216	86.4	137,400	240	100.8	146,000	264	115.2	154,600	288	131.2
16	96	50.8	91,400	118	26.2	101,500	131	36.3	116,800	145	51.3	127,000	156	63.7	137,200	180	86.4	147,400	216	100.8	157,600	240	115.2	167,800	264	131.2	178,000	288	151.2
17	102	57.3	103,000	107	29.4	114,600	124	40.7	132,000	136	57.6	143,000	147	73.3	155,000	158	96.2	166,000	180	105.6	178,000	216	124.8	189,000	240	144.0	200,000	264	163.2
18	108	64.3	115,700	104	33.0	128,500	109	45.8	147,600	126	67.2	160,500	139	82.2	173,400	149	108.0	186,300	180	124.8	199,200	216	144.0	212,100	240	163.2	225,000	264	182.4
20	120	79.3	143,000	94	40.7	159,000	105	56.5	182,500	116	79.8	198,300	125	101.5															

The New York Blower Company

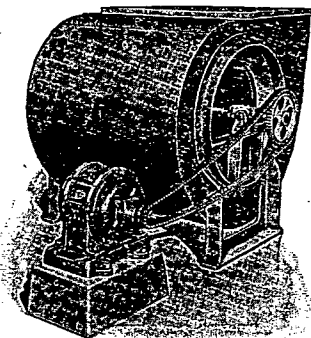
CHICAGO, ILL.

LAPORTE, IND.

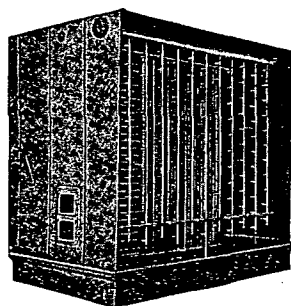
SALES OFFICES IN PRINCIPAL CITIES

Fans—Blowers—Heaters—Air Washers—Engines—Ventilators—Forges

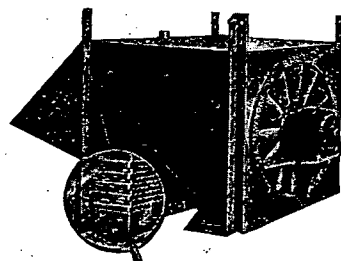
SERI-VANE Fans for the heating and ventilating of public buildings, schools, theatres, factories, mines, etc. Fans for mechanical draft, conveying systems, foundries, gas plants, stokers, etc. Pulley driven or motor driven disc and propeller fans of wide range.



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.

FAN FURNACES for churches, factories, schools, etc., requiring heat without any steam plant.

Special Unit Heaters for offices, libraries, and factories.

SPECIAL DESCRIPTIVE BULLETINS OF EACH PRODUCT WILL BE GLADLY SENT.

B. F. Sturtevant Co.

Hyde Park, Boston, Mass.



PLANTS LOCATED IN

CAMDEN, N. J. HYDE PARK, MASS. FRAMINGHAM, MASS.
STURTEVANT, WIS. GALT, ONT. BERKELEY, CALIF.

Montreal, P. Q.
New York, N. Y.
Philadelphia, Pa.
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 each installation is unique, it is usually necessary that an engineer analyze the conditions before making recommendations. The engineering staff of the B. F. Sturtevant Co. has been trained to analyze conditions and to properly apply our apparatus accordingly. 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.
- 227 Heating and Ventilating Layouts—Blue print Books.
- 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 Turbo Blower.
- 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.

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



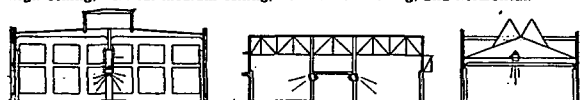
Horizontal Type

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—in effect the hot blast system—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.

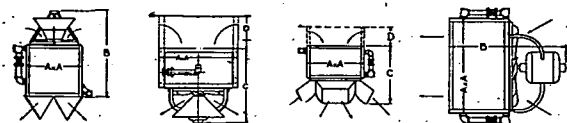
Wing Featherweight unit heaters are made in four different designs: vertical, high ceiling, vertical medium ceiling, vertical low ceiling, and horizontal.



Methods of Installation

The above 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 travelling 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.



Wing Featherweight Unit Heaters

Condensed Table of Engineering data

Size unit	A x A in.	B in.	C in.	D in.	Air Cu. f. m.	Motor hp.	Temperature		B.t.u. per hr. available	Approx. ship. wt., lb.
							Room	Leav.		
17-3-12	20 x 20	40	35	6	1950	1/4	65	113	92,500	265
22-4-12	25 x 25	44	36	6	2800	3/8	65	125	162,600	350
22-5-12	25 x 25	44	36	6	2600	1/2	65	135	173,200	360
25-4-12	30 x 30	48	37	7	4800	1/2	65	125	279,000	400
25-5-12	30 x 30	48	37	7	4500	3/4	65	135	300,000	415
30-4-85	35 x 35	56	45	8	6900	1	65	125	401,000	450
30-5-85	35 x 35	56	45	8	6500	1	65	135	433,000	470
36-4-85	41 x 41	64	51	8	9600	2	65	125	558,000	630
36-5-85	41 x 41	64	51	8	9000	2	65	135	599,400	660



Vertical High Ceiling Heater



Vertical Medium Ceiling Heater



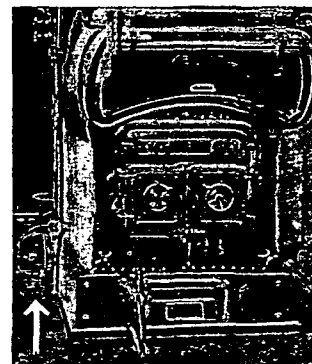
Vertical Low Ceiling Heater

This table will afford the engineer an opportunity to choose proper size and number of units for any given job where he desires to maintain a temperature of 65 deg. Space does not permit complete table for other room temperatures or larger heaters but this data will be gladly furnished on application.

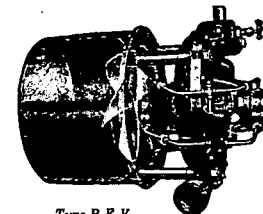
WING FORCED DRAFT BLOWERS

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 E M Motor Driven



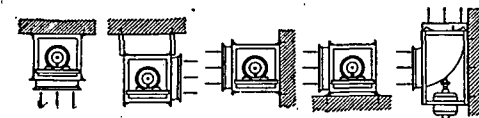
Type R E V Turbine Driven

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.

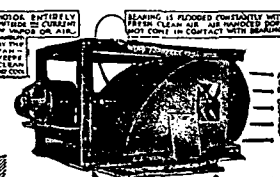
WING-SCRUPLEX EXHAUSTERS

The Wing-Scruplex exhauster consists of a highly efficient "screw-propeller" fan, combined with a casing of convenient design with the motor on the outside, where it will keep clean and cool and be easy of access. Because of these features it is used for duct work, where the resistance is low, instead of propeller fans with motors directly attached.

Being designed in the form of an elbow, it fits very well into any run of duct. Its rectangular frame greatly simplifies installation as will be seen from the following diagrams.



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



Wing-Scruplex Exhauster

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 1/4 in. Complete table up to 1 in. static on request.

Size	Inlet Sq. In.	Outlet Round, In.	Speed ft. per min.	Free Air		.15 in.		.25 in.		.40 in.		.50 in.	
				Cu. f. m.	Hp.	Cu. f. m.	Hp.	Cu. f. m.	Hp.	Cu. f. m.	Hp.	Cu. f. m.	Hp.
1-A	10	10 1/2	1750	850	0.052	630	0.054	330	0.060	.....	.....	.....	.....
2-A	13 1/2	14 1/2	1750	1440	0.060	990	0.069	395	0.090	.....	.....	.....	.....
2-B	13 1/2	14 1/2	2050	2050	0.195	1895	0.208	1695	0.216	1155	0.248	750	0.285
3-S	16 1/2	17 1/2	850	2130	0.090	1250	0.110	.....	.....	.....	.....	.....	.....
3-A	16 1/2	17 1/2	1150	2700	0.180	2150	0.195	1550	0.221	.....	.....	.....	.....
3-C	16 1/2	17 1/2	1750	4000	0.600	3720	0.635	3510	0.655	3150	0.700	2810	0.720
4-S	21	21 1/2	850	2850	0.100	2200	0.125	1610	0.150	.....	.....	.....	.....
4-A	21	21 1/2	1150	3575	0.170	3150	0.200	2775	0.220	1950	0.245	1550	0.280
4-C	21	21 1/2	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 FANS

Sizes including 25 in. in diameter are furnished with propellers of cast aluminum alloy. Larger than this are steel, pressed to the same form. Note particularly the true screw design of the propeller. Built in sizes 10 in., 13 in., 17 in., 22 in., 25 in., 30 in., 36 in., 42 in., 48 in., 54 in., and 60 in. Capacities from 950 C. F. M. to 33,000 C. F. M.



Wing-Scruplex Fan

THE DALZELL BROTHERS CO.

SHEET METAL SPECIALISTS

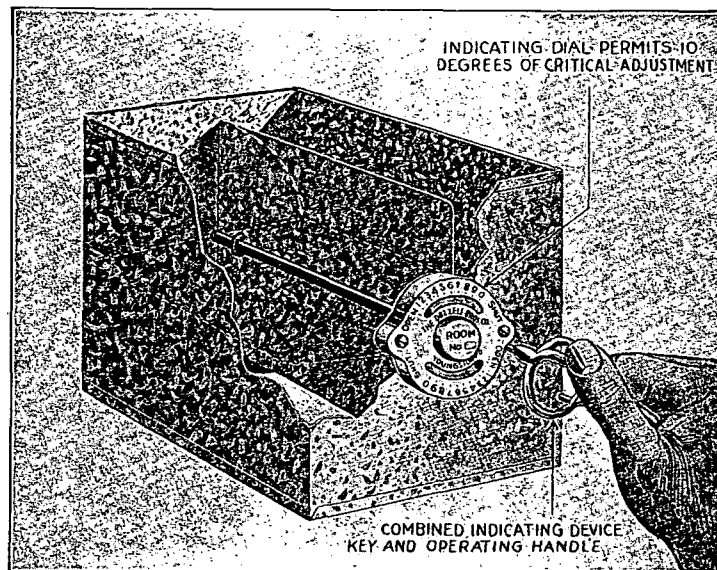
21 Holmes Street :: YOUNGSTOWN, OHIO

THE SURELOCK DAMPER QUADRANT has demonstrated its worth in actual service and has won the approval of heating and ventilating engineers, and leading architects and contractors who specify and use it in duct systems because of its adaptability to any size pipe as well as its accurate control of the air flow. It is designed for long and active service, being made of cast aluminum and so constructed that no unauthorized person can tamper with its adjustment.

A turn of the key adjusts the SURELOCK and the position of the damper is shown on a dial which is in full view. Only a slight pressure on the single key is required to operate it. This advantageous feature means that when the SURELOCK damper is adjusted it is automatically locked in the desired position and it therefore can be placed in any location in perpendicular, horizontal or angle pipe runs, also that the damper cannot be jarred out of position. This is especially desirable when it is used in buildings subject to constant jarring or vibration from street cars, railroad traffic or the operation of large machines such as printing presses, etc. Can be used on brick wall as well as on metal duct.

The simplicity of the SURELOCK construction can be seen from the accompanying illustration of the damper installed in a warm-air duct. It requires only two screws to attach it to any duct and only one size quadrant is required to fit all sizes of pipe.

The SURELOCK Damper Quadrant is a dependable product made by experienced sheet metal specialists whose staff is at the disposal of any engineer, architect or contractor interested in the control of air flow in heating and ventilating duct systems. List price \$3.00. Liberal discounts. Write for Bulletin A. C.



American Foundry & Furnace Co.

Bloomington, Ill.

SALES REPRESENTATIVES
MILWAUKEE, WIS.

ST. PAUL, MINN.

LOS ANGELES, CAL.

AMERICAN WARMING &
VENTILATING CO.

AMERICAN HEATING &
VENTILATING CO.

ATLANTA, GA.
CLEVELAND, O.

ELMIRA, N. Y.
TOLEDO, O.

PHILADELPHIA, PA.
RALEIGH, N. C.
RICHMOND, VA.

LIGE HEATING & VENTILATING CO., AUBURN, IND.
GILLESPIE-DWYER CO., CHICAGO, ILL.
MICHIGAN WARMING & VENTILATING CO., GRAND RAPIDS, MICH.
ATLANTIC HEATING & ENGINEERING CO., HEMPSTEAD, L. I.

W. H. JOHNSON & SON CO., INDIANAPOLIS, IND.
JOHN H. KITCHEN & CO., KANSAS CITY, MO.
STATE HEATING & POWER CO., MEMPHIS, TENN.
CASE FURNACE CO., SEATTLE, WASH.

DISTRIBUTED BY AMERICAN BLOWER CO. DETROIT, MICH.

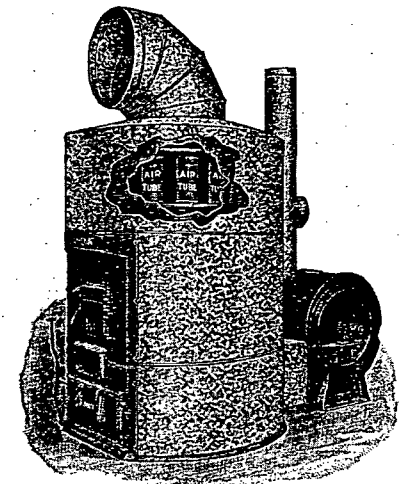
AMERICAN DIRECT-FIRED UNIT HEATER

Designed for Warm Air Blast
Work (with Air Tube radiator
at top) for

Heating—Ventilating
Drying

Burns Coal, Oil, Gas, Wood
or By-Products.

Creates and Delivers large volumes
of Warmed Air to every point in the
building. Points far away as warm as
points near the Heater being a feature
that indicates the distributing effi-
ciency of the Heater.



American Units have these
Outstanding Characteristics:

No. 3 1/2 AMERICAN SIROCCO MULTIBLADE FAN driven by Electric Motor or from Line Shaft.

Automatic Louvers in Air Inlet open when Fan is not operating thus permitting Unit to heat by Gravity Circulation. Special distributing ducts to meet special conditions.

Ball-Bearing Shaking Grates
Large Double Fuel Doors
Large Ashpan Door

Cast Humidifying Pan
Large Combustion Chamber
All Cast Iron, Extra Heavy

DATA

No.	*Floor Space	Height	Grate Surface	Smoke Pipe	Motor H. P.	B.t.u. per hour	C. F. M.
630-G	9' 5"x5' 2"	10'	572 sq. in.	10"	2	400,000	4,300

* Floor space includes Heater and Fan.

AMERICAN DIRECT TRANSMISSION HEATERS AND AMERICAN ASBESTOS-STEEL CASES are specially designed to meet the service demands of Schools, Churches, Theatres and Public Buildings. They have capacities of 334,000 to 11,000,000 B.t.u. depending on size and number of Units. Data will be gladly furnished upon application.

Furnaces, Warm Air

Langenberg Manufacturing Co.

Successors to

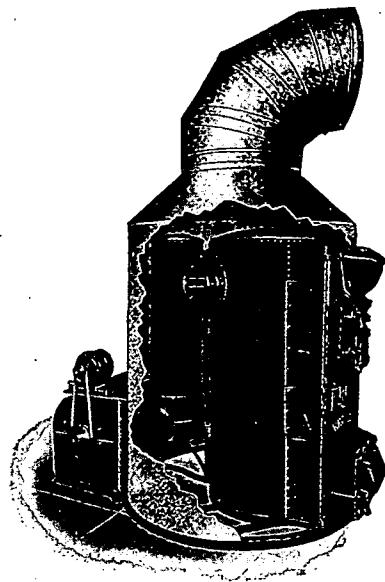
Haynes-Langenberg Mfg. Co.

4549 No. Euclid Ave. :: ST. LOUIS, MO.

FRONTRANK

TRADE NAME REGISTERED

Dealers in all parts of the United States



FRONTRANK UNIT HEATER

Gas tight, dust proof.

Long gas travel insuring low flue temperature.

Correctly designed casings of known capacity.

Separate grates. Burns any fuel.

Large heating surfaces.

Fan constructed to give maximum capacity for energy applied.

Fan allows free air passage when not running.

Slow speed—noiseless in operation.

A unit carefully built to give heat and circulation at a low operating cost.

Easily adapted to home use.

The most efficient way to heat open type buildings such as garages, foundries, machine shops, etc.

DATA ON **FRONTRANK** 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-FH	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	12x13 1/2	3500	1400	365	18	1/2	1350	180,576
616	12x13 1/2	3900	1570	390	18	1/2	1550	252,396
707	12x13 1/2	4400	1750	314	21	3/4	1850	314,640
1018	12x13 1/2	5900	2400	238	24	3/4	2150	383,040
1018	12x13 1/2	7000	2600	275	24	1	2250	406,980

NOTE:—When burning Illinois Coal producing about 10,000 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.

Furnaces, Warm Air

Moncrief Furnace Co.

Atlanta, Ga.

Henry Furnace & Foundry Co.

Cleveland, Ohio

MONCRIEF WARM AIR FURNACES

All Cast Top Return Flue

SPECIFICATIONS

Series A				
No. of Furnace	Inside Diameter of Fire Pot Inches	Diameter of Casings Inches	Heating Furnace less Casings Inches	Estimated Heating Capacity Cu. Ft.
20A	20	36	48	8-15,000
22A	22	40	49 1/2	15-25,000
24A	24	44	51	25-35,000
27A	27	48	53	40-55,000

Series 500A				
518A	18	36	50 1/2	8-12,000
520A	20	36	52	10-20,000
522A	22	40	52 1/2	20-30,000
524A	24	44	55	30-45,000
527A	27	48	57	45-60,000
530A	30	56	61	55-80,000

Pipeless Series 1500				
			Size of Reg. Face	
1518	18	46	24x28	8-12,000
1520	20	46	24x28	10-20,000
1522	22	50	30x30	20-30,000
1524	24	54	30x36	30-45,000
1527	27	58	36x36	45-60,000



Pot Furnace

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.

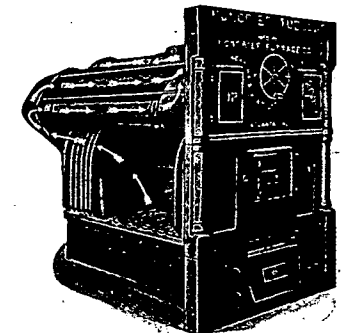
MONCRIEF INDUSTRIAL TUBULAR FURNACE

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. Sq. ft. radiating surface 320. B.t.u. per hour capacity 780,000.

Installed singly or in batteries with steel or brick casing. Adapted for coal or oil burning.



Moncrief Industrial Tubular Furnace

The XXth Century Heating & Ventilating Co.

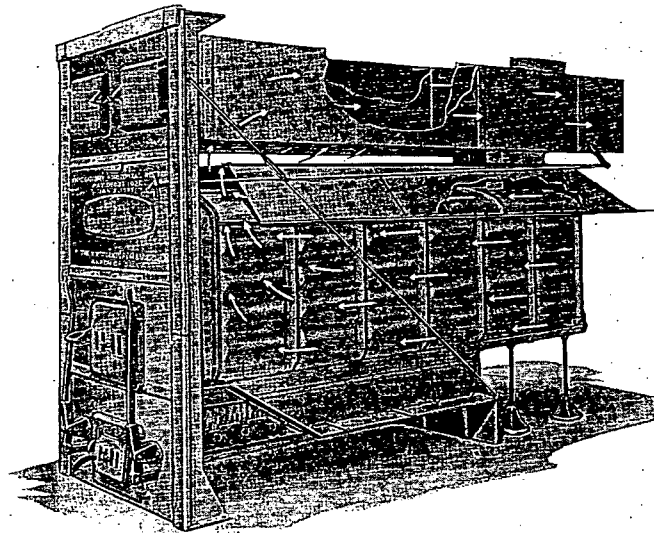
General Office and Factory

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 five 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.

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

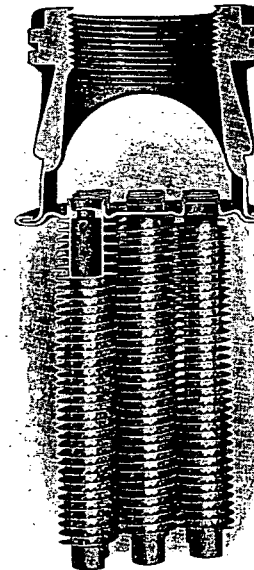
AEROFIN is a new, but proved, surface for the heating or cooling of air and is the final development of investigation and experimentation extending over a period of eight years. Actual commercial installations of AEROFIN have been in operation for more than two years. AEROFIN is therefore a proved product approved by leading engineers everywhere.

AEROFIN (except the galvanized casing) is constructed entirely of brass and copper. The heat-transmitting surface itself consists of straight, seamless copper tubes about which is wound a helical extended surface, in the form of a crimped brass ribbon. Only the inner edge of the ribbon is crimped, the crimping reducing the internal diameter of the helix to the outside diameter of the tube. Thus the linear contact between the tube and the extended surface is equal to the total length of the outer edge of the ribbon. The ribbon is mechanically soldered to the tube as it is wound in place and the ample metallic union so effected, together with the rapidity of heat conduction through copper and brass (more than twice the rate through cast iron) make the extended surface fully as effective as prime surface. It is therefore feasible to make the extended surface 80 per cent of the total heating surface, thereby effecting remarkable lightness in weight, and great compactness.

The completed tubes with their extended surface are mechanically forced into pressed brass tube plates. The holes in the tube plate are made slightly smaller than the tubes, insuring a tight force-fit, and each tube is expanded into the plates. About each hole in the tube plate there is formed a deep recess and "collar," making the tube joint flexible and allowing for expansion and contraction without danger of developing leaks. In addition, the whole tube plate is flexible. Severest tests, units being subjected to 20 lb. pressure and 20 in. vacuum in quick alternation, have proved that AEROFIN will withstand the hardest service, such as on-and-off automatic control.

The tube plate is roll-seamed to the pressed brass header and the entire core—tubes, tube plate, and headers—is solder-bathed. AEROFIN is guaranteed for steam or liquid pressures up to 50 lb. and for any vacuum.

Inside the end of each tube at the supply end there is pressed an orifice ring which restricts the entrance to the tube and sets up a slight differential between the steam (or water) pressure in the supply header and that in the tubes. This accomplishes absolutely uniform distribution of the heating medium throughout every tube, without any short-circuiting, and not only insures the maximum possible heat transmission from



Section thru Header, Tapping Hub, Tube Plate and Tubes, showing construction of Aerofin. See text.

the entire surface, but equalizes the expansion and contraction of all tubes. This is one of the carefully engineered features which achieve the remarkable heat-transmitting capacity of AEROFIN.

AEROFIN is sold in *standard units, completely encased* and ready for pipe connections. This, we think, is the most important advance in the history of heat transmitting surfaces.

The casing is made of galvanized sheet steel, die stamped to standard template, flanged and punched to facilitate assembly and installation, all units of the same size being interchangeable.

The punched flange not only affords a convenient means of assembly, but an equally convenient means of attaching the duct work, again facilitating installation and minimizing expense. The steel casing forms a rigid, sturdy protection for the AEROFIN core itself, simplifying handling and shipping, and insuring against accidental damage.

The casing also relieves the core itself of any stress due to expansion or contraction, since the core is rigidly keyed to the casing in such manner that any stress imposed by the movement of the piping or the whole unit itself is borne entirely by the casing. The tapping hubs at the ends of the headers are slotted and keyed rigidly to the ends of the casing, thus transferring directly to the casing any strain which the pipe might exert upon the hub while connections are being made.

In addition to the rigid attachment of the core to the casing, through the keyed hubs, the entire length of the header bears against steel angles which are riveted to the casing, as shown in the photographs. There are four of these angles, one at either edge, top and bottom. Thus each header is firmly supported throughout its entire length, but since the angles bear against the outer edges, their rigidity does not affect the flexibility of the tube plate itself.

The supporting angles and side baffles prevent the air from by-passing between the headers or side tubes and the casing, thus insuring uniformly effective transmission to all of the air from all of the surface.

This brief description reveals the fundamentals which combine to make AEROFIN the lightest and most compact of all heating surfaces having adequate strength and serviceability, and the *only* 50 lb. non-corrosive, *encased unit* surface ever offered to the Profession and the Trade. AEROFIN costs slightly more than equivalent cast iron surface, but the savings in transportation, erection, encasing, and connection, much more than offset this.

AEROFIN is so light and sturdily encased that it can easily be suspended or supported on steel legs which are furnished as a standard accessory at a small charge. Thus AEROFIN saves the expense of foundations, as well as the expense of fitting casings on the job—great savings in labor and time.

Shipping weight of template-punched sheet steel supporting legs, attachable for either horizontal or vertical installation by means of eight $\frac{1}{4}$ in. stove bolts, 25 lb. per leg.

One leg under each end of any unit up to 8-ft. tube length, installed with tubes horizontal, is ample support; three legs for units longer than 8 ft.-0 in. tube length, the third leg to be placed in the center of the span.

When two units are installed with tubes vertical, casings connected side by side, one leg under the outside end of each unit is sufficient, but if three or more units are so connected there must be one leg per unit, such legs being installed one at the outside ends of each of the outside units, the other legs being placed at the center of the bottom flange of each of the other units.

AEROFIN headers are provided with a brass tapping hub, *cast directly into* the pressed brass header. These hubs are tapped with standard pipe threads and AEROFIN can therefore be connected quickly and easily, *without special tools or fittings*.

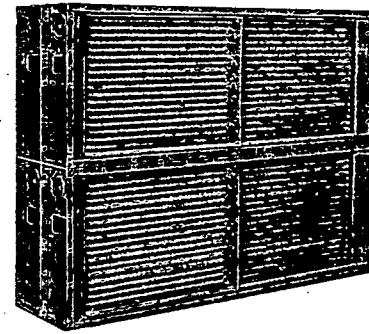
STANDARD UNITS

Compactness

AEROFIN is furnished in standard, *encased units*, as shown. The width of the casing, overall, is 29 in., in all sizes. The depth of the casing in direction of air flow, is 10 in. overall, in all sizes. The length of the casing is the tube length plus $8\frac{1}{2}$ in. Units are furnished, as ordered, with tubes of any specified length between 2 ft.-0 in. and 6 ft.-0 in., in increments of 6 in.; and between 6 ft.-0 in. and 12 ft.-0 in. in increments of 1 ft. The 15 tube lengths thus available make AEROFIN readily adaptable to any requirement.

AEROFIN units are made up with one, two, or three rows of tubes, as required. Same headers and casings are used in all cases. The 3-row unit is therefore most compact and economical and should be used whenever possible. Single or 2-row units cost slightly more per linear foot of tube, but are often required, of course, for preheaters or reheaters. *Specify number of rows desired.*

Single-row AEROFIN occupies about the same space as equivalent cast iron; 2-



Four Standard 5'-6" Units of Aerofin Set with Tubes Horizontal, showing Unit Casing Construction and method of attaching Flange to Flange

row about 50 per cent; and 3-row only 35 per cent of the space occupied by equivalent cast iron.

Steam Supply and Drain

Each Standard Single or 2-Row Unit is provided with one 3 in. supply tapping at end of header as shown, and with one 2 in. drain tapping at diagonally opposite end of opposite header. Three-Row units with tubes up to 9 ft.-0 in. long, have 3 in. supply and 2 in. return tapplings. Three-Row units with tubes longer than 9 ft.-0 in. have 3 in. supply and 3 in. return tapplings. Because of the use of orifice rings supply connection *must* be made to supply header, which is plainly marked. Best piping practice is shown in photographs. *Do not bush drip connection.*

Additional supply tapplings, in supply header, can be furnished, when necessary, at an extra charge of \$11.25 for each additional tapping.

If AEROFIN units are to be "laid flat," i.e., "face down" (tubes in a plane parallel with plane of floor), 3 in. drip tapplings are required and *must not be bushed*. This must be clearly specified.

If AEROFIN is to be used with water, all outlet tapplings in all sizes must be same size as inlet tapping and this must be clearly specified.

Capacities

The abridged table following shows Final Temperature and Condensation at 5 lb. steam, for various face velocities, at the most used temperatures. Complete Capacity Tables, at 5 lb. and 40 lb. steam,

are contained in our general Bulletin, which we will be glad to send upon request.

Note that *Net Face Area* means only that area facing the tubes and does not include headers or casings.

Net Face Area of any unit equals tube length $\times$ 2 ft. which is width across tubes between inner surfaces of casing. Hence to find tube length for any unit divide required *Net Face Area* per unit by two.

To find Linear Feet of Tubing in a given unit, multiply tube length by, 18 if single-row, 35, if 2-row, and 53 if 3-row.

Weight

AEROFIN weighs from 9 to 16 per cent of equivalent cast iron. A close approximation of the weight of any unit may be determined as follows:

No. of linear feet of tubing $\times C + 47$
= Weight of unit in pounds.
C for single-row = 0.9 C for 2-row = 0.65
C for 3-row = 0.55

Casings

Galvanized sheet steel casing, template-punched flanges all around and on ends, as shown. All units of same size interchangeable. End holes match for connection of units. Face flanges holes for duct connection, and for supporting legs.

Face flanges of all casings are punched on lines bisecting casing in both directions (measuring from outer edges of flanges) and at intervals of 3 in. from these center bolt holes toward the corners. The corners are riveted there being no corner bolt hole. All bolt holes are $\frac{9}{32}$ in. and are centered on a line $\frac{1}{4}$ in. from the outside edge of flange.

Specification

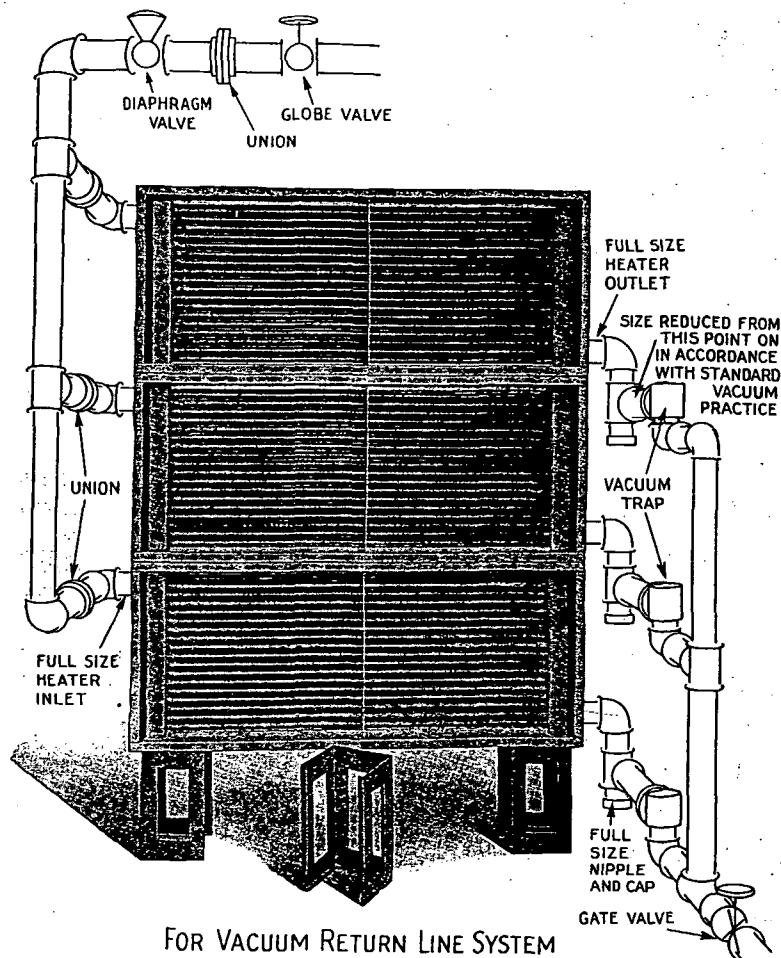
When ordering, specify No. of units, No. of rows of tubes in each unit, length of tubes, and assembly, i.e., whether units will be installed with tubes horizontal or vertical or "laid flat." No. of sections high or wide. Specify whether steam or water is to be used. Specify No. of steel supporting legs 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.

Working Pressure

AEROFIN is guaranteed for 50 lb. steam or water pressure, fluid temperature up to 300° F., and any vacuum.

Sales

AEROFIN is sold by all manufacturers of nationally advertised Blower Heating Apparatus.



Aerofin Units installed three-high, tubes horizontal, showing uses of pressed steel supporting legs. (The third leg in front of battery, is not required as a support, two legs being sufficient up to 8'-0" tube length, but is shown to illustrate design.) Typical piping diagram for Vacuum Return Line System is also shown. Our complete bulletin, sent on request, shows piping diagrams for other systems and for vertical tubes

See Capacity Table next page.

Final Temperatures and Condensations—5 Pounds Steam—227° Temperature

Temp. Entering Air	Row Tubes Deep	Velocity of Air Through Net Face Area*—in feet per minute—Measured at 70° F. and 29.92" Barom.											
		300' Face Velocity Friction per Row = .02*			400' Face Velocity Friction per Row = .0337*			500' Face Velocity Friction per Row = .054*			600' Face Velocity Friction per Row = .074*		
		Final Temp. Air	Cond. Lbs. per Hr. Lin. Ft. Tube	Final Temp. Air	Cond. Lbs. per Hr. Lin. Ft. Tube	Final Temp. Air	Cond. Lbs. per Hr. Lin. Ft. Tube	Final Temp. Air	Cond. Lbs. per Hr. Lin. Ft. Tube	Final Temp. Air	Cond. Lbs. per Hr. Lin. Ft. Tube	Final Temp. Air	Cond. Lbs. per Hr. Lin. Ft. Tube
-20°	1	34.5	1.07	21.0	2.05	17.7	2.30	15.5	2.55	13.5	2.80	11.3	3.05
	2	60.3	1.35	35.9	1.93	40.6	2.24	45.3	2.32	49.7	2.32	53.8	2.32
	3	88.2	1.38	83.0	1.76	70.3	2.04	71.2	2.32	67.0	2.42	62.6	2.42
	4	111.5	1.27	105.0	1.69	95.2	1.90	92.0	2.17	87.5	2.24	82.8	2.24
	5	120.4	1.14	123.5	1.47	117.0	1.70	111.0	2.01	105.4	2.15	99.8	2.15
-10°	1	32.0	1.37	30.0	2.00	27.0	2.31	24.0	2.55	22.0	2.80	20.0	3.00
	2	65.5	1.46	62.0	1.85	57.0	2.16	52.5	2.41	50.0	2.65	48.5	2.80
	3	87.5	1.42	83.0	1.77	77.0	2.07	73.0	2.31	69.0	2.55	65.0	2.80
	4	115.5	1.31	108.0	1.64	101.4	1.82	95.0	2.08	90.0	2.31	85.0	2.55
	5	132.5	1.09	127.0	1.40	121.0	1.67	115.0	1.91	110.0	2.15	105.4	2.31
0°	1	40.0	1.50	38.0	1.99	35.0	2.30	32.4	2.53	30.4	2.80	28.0	3.00
	2	70.6	1.30	64.0	1.59	58.0	1.87	53.4	2.12	50.0	2.36	46.5	2.60
	3	96.0	1.16	94.0	1.46	88.0	1.74	83.4	1.98	79.3	2.20	75.0	2.40
	4	120.0	1.04	114.0	1.34	108.4	1.60	103.0	1.83	98.0	2.04	93.5	2.23
	5	136.0	0.89	130.7	1.19	124.7	1.47	119.5	1.69	114.2	1.90	109.0	2.15
+0°	1	140.0	0.85	144.0	1.22	138.2	1.47	133.0	1.69	127.4	1.89	122.5	2.08
	2	158.0	0.75	153.0	1.04	148.7	1.37	144.0	1.58	139.0	1.78	134.0	1.96
	3	174.7	0.69	170.5	0.90	166.0	1.17	161.5	1.37	157.2	1.54	152.7	1.73
	4	180.0	0.60	175.8	0.83	171.8	1.10	168.0	1.29	164.0	1.47	160.0	1.64
	5	180.0	0.53	175.8	0.75	171.8	1.07	168.0	1.25	164.0	1.47	160.0	1.64
+40°	1	72.3	1.21	70.4	1.52	68.3	1.77	65.8	1.99	64.5	2.14	63.5	2.25
	2	120.0	1.04	115.3	1.13	111.3	1.31	107.0	1.51	103.0	1.69	100.4	1.83
	3	136.0	0.92	131.5	1.18	127.0	1.40	123.0	1.56	119.0	1.78	115.0	1.93
	4	149.0	0.83	144.7	1.07	140.0	1.28	135.8	1.47	131.4	1.63	127.0	1.79
	5	160.0	0.75	155.0	0.99	150.0	1.19	145.0	1.39	140.0	1.59	135.0	1.79
+50°	1	80.0	1.15	78.5	1.42	76.5	1.65	75.0	1.87	73.3	2.04	71.0	2.16
	2	123.4	1.07	120.0	1.20	116.8	1.45	113.0	1.62	110.0	1.78	106.4	1.91
	3	130.3	0.95	128.0	1.11	124.6	1.31	120.0	1.50	116.0	1.67	112.0	1.83
	4	143.5	0.87	140.3	1.01	136.0	1.20	132.0	1.38	128.0	1.54	124.0	1.68
	5	152.5	0.78	148.5	0.94	144.0	1.12	140.0	1.30	136.0	1.48	132.0	1.63
+60°	1	80.0	1.09	86.5	1.34	84.5	1.53	81.4	1.75	81.5	1.85	80.0	2.00
	2	112.0	1.00	108.3	1.24	105.3	1.46	103.0	1.66	100.0	1.80	98.0	1.95
	3	120.0	0.89	116.0	1.12	112.4	1.32	109.5	1.51	106.0	1.66	103.0	1.80
	4	130.0	0.80	126.0	1.04	122.0	1.22	119.5	1.41	116.0	1.56	113.0	1.70
	5	145.7	0.73	141.0	0.94	137.0	1.12	134.0	1.29	130.0	1.44	127.0	1.57

* Net Face Area means only that area facing the tubes and does not include the headers or casings.

SKINNER BROTHERS

HOME OFFICE AND FACTORY
1400-1490 S. VANDEVENTER AVE.
ST. LOUIS, MO.

EASTERN OFFICE AND FACTORY
100-160 BAYWAY
ELIZABETH, N. J.

DIRECT SALES OFFICES

BOSTON, 445 Little Bldg. DETROIT, 308 Scherer Bldg. MINNEAPOLIS, 802 Metropolitan Life Bldg.
BUFFALO, 702 Morgan Bldg. PITTSBURGH, 714 Magee Bldg.
CHICAGO, 1703 Fisher Bldg. SPOKANE, 409 First Avenue NEW YORK, 1702 Flatiron Bldg.
CLEVELAND, 612 Marshall Bldg. WASHINGTON, D. C., 714 Evans Bldg.

Sales Offices and Branches in all Principle Cities

SKINNER BROS. (BAETZ PATENT) AIR HEATERS



Heaters are made up of separately controlled banks of pipe coils interset at right angles for alternate rows, backward curve multibladed fan wheel with scroll beneath heater. Heaters are equally satisfactory for exhaust steam or live steam up to 125 lb. pressure.

These heaters are built in both the floor type and the inverted type for overhead suspension.

Distributing outlets may be either round or rectangular to properly suit any given conditions. Heater fans will overcome resistance of duct work when required.

GENERAL DATA ON (BAETZ PATENT) AIR HEATERS

Size No.	Floor Space Required	Weight, Lb.	Capacity, B.t.u.
2 x 2	2' 4" x 2' 4"	1000	135,000
3 x 3	3' 4" x 3' 4"	1700	350,000
4 x 4	4' 4" x 4' 4"	2900	700,000
5 x 5	5' 6" x 5' 6"	4350	1,000,000
6 x 6	6' 6" x 6' 6"	6300	1,350,000
6 1/2 x 6 1/2	7' 0" x 7' 0"	7300	1,750,000

The above capacities are based upon 5 lb. steam pressure.

SKINNER BROS. PATENTED DIRECT FIRED HEATERS

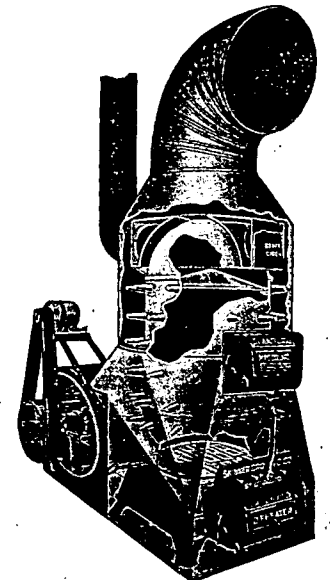
This is the pioneer heating system of its type, and is recommended for buildings where steam is not available and where the cost of a steam system is prohibitive.

The extra heavy firing chamber with deflector plate above, in conjunction with hollow smoke condenser, provide a maximum heat radiating surface which insures high efficiency. The circulation of air through the heater is accomplished by means of a backward curved multibladed fan. It is unnecessary to operate the fan for satisfactory results during moderate weather.

This heater is built in three sizes, having capacities of 250,000 B.t.u., 450,000 B.t.u. and 750,000 B.t.u. respectively. Bituminous or anthracite coal, coke, or oil are satisfactory as fuel.

Pioneer Manufacturers

Skinner Bros. Mfg. Co. is the pioneer in its field and through long experience is equipped to design, manufacture and install heating and ventilating equipment for regulating humidity and controlling atmospheric conditions, providing separate and individual control to properly secure to the best possible advantage, air circulation.



Skinner Bros. Patented Direct Fired Heater

GUARANTEE: Skinner Bros. (Baetz Patent) Heaters and Skinner Bros. Direct Fired Heaters are fully guaranteed when installed as directed by our engineers.

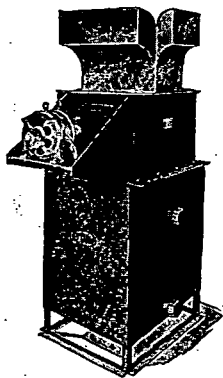
Our sales offices are fully equipped to supply complete particulars for each requirement, including Up and Down Circulation Dryer for Soap, Veneer, Leather. We have thoroughly established our service to obviate every possible delay. Our engineers will give you prompt attention by mail or personal call. Write to office nearest you.

York Heating and Ventilating Corp.

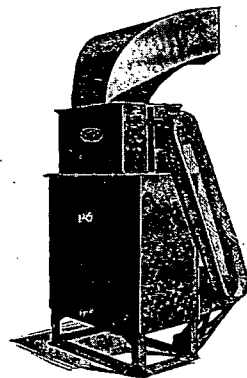
1502 Locust Street :: PHILADELPHIA

Unit Heaters—Unit Fans—Rotary Ventilators—Stationary Ventilators—Cyclone Dust Collectors—Dampers—Quadrants—Blast Gates—Drying Trays—Radiators—Brackets—Sheet Metal Work and Light Structural Iron Fabrication.

YORK "WELDED COIL" UNIT HEATER



* York Unit with motor directly coupled to fan shaft.



York Unit with motor belted to fan shaft. Furnished with or without motor and belt guard as illustrated.

No. 2 UNIT HEATER For Steam Pressure of 5 lb.									
R. P. M.	A. P. M.	H. P. Motor	Recirculating—Air at 60° F. Entering Unit			Basic Data—Air at 0° F. Entering Unit			
			B.t.u. per Hr.	Final Temp.	Cond. per Hr.	B.t.u. per Hr.	Final Temp.	Cond. per Hr.	
590	2160	1/2	165,000	139°	171 lb.	226,000	108°	234 lb.	
680	2500	1	186,000	137°	193 "	253,000	104°	262 "	
850	3110	1 1/2	216,000	131°	224 "	296,000	97°	306 "	
1150	4200	2	268,000	124°	278 "	368,000	88°	382 "	
1425	5200	3	314,000	120°	293 "	430,000	83°	445 "	

No. 2-A UNIT HEATER For Steam Pressure of 5 lb.									
R. P. M.	A. P. M.	H. P. Motor	Recirculating—Air at 60° F. Entering Unit			Basic Data—Air at 0° F. Entering Unit			
			B.t.u. per Hr.	Final Temp.	Cond. per Hr.	B.t.u. per Hr.	Final Temp.	Cond. per Hr.	
590	2700	1/2	220,000	145°	228 lb.	300,000	116°	310 lb.	
680	3040	1	240,000	142°	248 "	326,000	112°	338 "	
850	3680	1 1/2	270,000	135°	280 "	360,000	103°	379 "	
1150	4800	2	324,000	129°	336 "	440,000	94°	455 "	
1425	5800	3	375,000	126°	388 "	510,000	89°	528 "	

No. 3 UNIT HEATER For Steam Pressure of 5 lb.									
R. P. M.	A. P. M.	H. P. Motor	Recirculating—Air at 60° F. Entering Unit			Basic Data—Air at 0° F. Entering Unit			
			B.t.u. per Hr.	Final Temp.	Cond. per Hr.	B.t.u. per Hr.	Final Temp.	Cond. per Hr.	
590	3850	1 1/2	280,000	135°	290 lb.	381,000	102°	395 lb.	
680	4450	2	310,000	131°	321 "	422,000	97°	436 "	
850	5540	3	358,000	126°	371 "	490,000	90°	507 "	
1150	7500	5	450,000	120°	465 "	620,000	83°	642 "	
1425	9500	7 1/2	520,000	116°	540 "	716,000	77°	740 "	

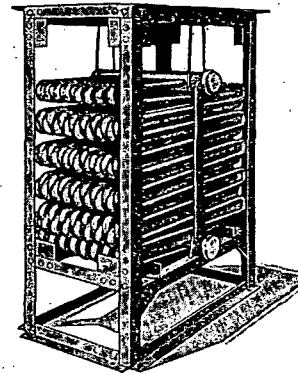
Complete Heating, Ventilating and Dust Collecting Systems; designed, built and installed.

No. 3-A UNIT HEATER For Steam Pressure of 5 lb.									
R. P. M.	A. P. M.	H. P. Motor	Recirculating—Air at 60° F. Entering Unit			Basic Data—Air at 0° F. Entering Unit			
			B.t.u. per Hr.	Final Temp.	Cond. per Hr.	B.t.u. per Hr.	Final Temp.	Cond. per Hr.	
590	4450	1	340,000	139°	352 lb.	460,000	107°	477 lb.	
680	5100	1 1/2	368,000	135°	381 "	500,000	102°	517 "	
850	6300	2	426,000	132°	442 "	580,000	97°	600 "	
1150	8500	3	530,000	124°	548 "	720,000	87°	745 "	
1425	10,400	5	625,000	120°	647 "	850,000	81°	880 "	

No. 4 UNIT HEATER For Steam Pressure of 5 lb.									
R. P. M.	A. P. M.	H. P. Motor	Recirculating—Air at 60° F. Entering Unit			Basic Data—Air at 0° F. Entering Unit			
			B.t.u. per Hr.	Final Temp.	Cond. per Hr.	B.t.u. per Hr.	Final Temp.	Cond. per Hr.	
590	8700	2	610,000	132°	631 lb.	830,000	98°	860 lb.	
680	10,000	3	670,000	128°	693 "	910,000	93°	940 "	
850	12,500	5	790,000	124°	820 "	1,060,000	86°	1100 "	
950	14,000	7 1/2	860,000	122°	890 "	1,170,000	84°	1210 "	
1050	15,400	10	930,000	121°	963 "	1,260,000	83°	1300 "	

No. 4-A UNIT HEATER For Steam Pressure of 5 lb.									
R. P. M.	A. P. M.	H. P. Motor	Recirculating—Air at 60° F. Entering Unit			Basic Data—Air at 0° F. Entering Unit			
			B.t.u. per Hr.	Final Temp.	Cond. per Hr.	B.t.u. per Hr.	Final Temp.	Cond. per Hr.	
590	10,300	3	810,000	140°	838 lb.	1,100,000	109°	1140 lb.	
680	11,900	5	895,000	136°	925 "	1,220,000	104°	1260 "	
850	14,800	7 1/2	1,040,000	131°	1070 "	1,430,000	97°	1480 "	
950	16,500	10	1,130,000	129°	1170 "	1,540,000	94°	1590 "	
1050	18,200	15	1,210,000	127°	1250 "	1,650,000	91°	1710 "	

Ratings on larger sizes and special units will be furnished on request.



Welded Coils of Number 2, 2-A and 3 Units. Number 3-A and larger Units have a double set of coils, twice the number of headers illustrated.

OPERATING FEATURES

1. **Low Power Requirements**—the balanced fan, running on ball bearings, reduces power requirements to a minimum. Path of air is straight through the heater—there are no baffles, etc., to cause back pressure.
2. **Maintenance is Low**, coils are welded to the headers—there are no joints or valves to leak causing rust, damage and necessitating repair.
3. **In Mild Weather**—the unit can be run for a short time to bring the room to the desired temperature and to put the air into circulation. Then, the power can be shut off, and 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.

MECHANICAL FEATURES

1. **Welded Pipe Coils**—no joints from inlet to outlet. Coils are tested to 300 lb. pressure. Good for 150 lb. working pressure.
2. **Supply and Return Headers**, to which the coils are welded, are both inside the unit housing—hence heat radiated from the headers, goes into the air passing through the heater.
3. **Steam** is admitted to the top header, which runs the full length of the coils—it then passes through the coils to the return header at the bottom, where it is collected as condensed.
4. **Fan Wheel**, of the efficient, double inlet type, is mounted on ball bearings—insuring freedom from vibration.
5. **Ball Bearings**—self-aligning, dustproof type, mounted outside the fan housing and not in contact with hot air. Their location permits oiling without removing fan housing.
6. **Base of the Heater** is open on all four sides, hence the unit draws its air from the floor where the air is naturally coldest. This simplifies connection to outside air supply when same is desired for it can easily be made with a rectangular duct of ample size, from any one side.

INSTALLATION FEATURES

1. Fan may be belted to line shaft or motor, or directly coupled to motor.
2. Fan Pulley is located near the top of the unit, which makes connection to line shafting easy. This is also convenient for belting to electric motor (fastened to ceiling, wall or column, no belt guards are required with this arrangement. The belted unit may also be arranged with motor mounted on bracket attached to the heater.
3. The Unit stands on an angle iron base, no extra foundations are required.
4. The Unit occupies a floor space greater in length than in depth, making it easily adaptable to unused floor spaces.
5. These Units can be arranged for suspension from ceiling or roof trusses, or they can be mounted on special extended supports, allowing underneath headroom.
6. Operates equally satisfactory on vacuum, low pressure or high pressure steam systems.

SPECIFICATIONS

No. of Unit	Size Pulley		No. of Steam Conn.	Sq. Ft. Heat Sur.	Equiv. Sq. Ft. Direct Radiation	Outlet Size Outside of Angles	Size Base Angles	WEIGHTS		Approximate Height Incl. Outlet	Width Inches	Length Inches
	Dia.	Face						Unit Heaters Complete No Motor	Unit Heaters Complete With Motor			
2	8"	3"	1	180	1200	17 1/2"	2x2 1/2"	1500 lb.	1650 lb.	96	22	42 1/2
2-A	8"	3"	1	260	1500	17 1/2"	2x2 1/2"	1900 lb.	2100 lb.	99	31	42 1/2
3	8"	3"	1	260	2000	20 1/2"	2x2 1/2"	2000 lb.	2300 lb.	114	31	42 1/2
3-A	8"	3"	2	360	2400	20 1/2"	2 1/2 x 2 1/2"	2800 lb.	3100 lb.	114	43	43 1/4
4	12"	4"	2	520	3500	27 1/2"	2 1/2 x 2 1/2"	3600 lb.	3900 lb.	132	43	61
4-A	12"	4"	4	880	5000	27 1/2"	3x3 1/2"	5800 lb.	6100 lb.	132	54	85

All Frames made from Steel Angles with Gusset Plates Hot Riveted—coils made of 3/4 in. std Steel Pipe—Both Headers are 3 in. std Steel Pipe with outside male thread.

UNIT HEATER—B.t.u. Constants for Various Steam Pressures and Temperatures of Entering Air

Steam Press. Lbs.	Temperature of Air Entering Heater													
	-10°	0°	10°	20°	30°	40°	45°	50°	55°	60°	65°	70°	75°	
0	.975	.93	.89	.84	.80	.76	.73	.71	.69	.67	.64	.62	.60	
2	1.01	.96	.92	.87	.83	.79	.76	.74	.72	.70	.68	.65	.63	
3	1.04	1.00	.96	.91	.87	.82	.80	.78	.76	.74	.71	.69	.67	
10	1.06	1.03	1.01	.97	.92	.88	.85	.83	.81	.79	.76	.74	.72	
15	1.15	1.10	1.05	1.01	.97	.92	.90	.88	.86	.83	.81	.79	.76	
20	1.18	1.14	1.09	1.05	1.00	.96	.94	.92	.89	.87	.85	.83	.81	
30	1.25	1.21	1.16	1.12	1.08	1.03	1.01	.98	.96	.94	.92	.90	.88	
40	1.30	1.26	1.22	1.17	1.12	1.08	1.06	1.04	1.02	1.00	.97	.95	.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	.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	
70	1.43	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 given above, by rated B.t.u.'s at 0° entering and 5 lb. pressure.

Catalogs on any products, sent on request.

Alberger Heater Company

HOWARD IRON WORKS

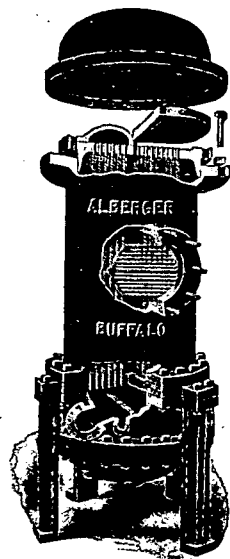
218 Chicago St.

BUFFALO, N. Y.

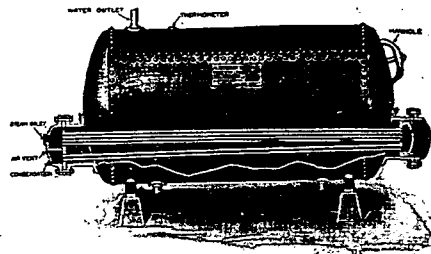
REPRESENTATIVES IN PRINCIPAL CITIES

Heaters — Condensers — Coolers — Economizers — Expansion Joints

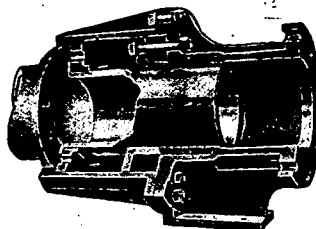
ALBERGER heaters are of five distinct types each having outstanding characteristics to insure a high heat transfer, economical operating and insignificant maintenance costs. The Multi-Head Instantaneous heater for domestic and feed water purposes is made in types H, horizontal and V, vertical. Type A 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



Type S Storage Heater



Howard Expansion Joint

SIZES OF TYPE "S" HEATER FOR TEMPERATURE RANGE 50 to 180 deg.—Steam at 212 deg. Fahr.

Cal. 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	IY-3	KY-3	LY-3					
300	AY-7	BY-6	CY-7	DY-6	EY-6	FY-5	GY-5	HY-5	IY-4	KY-4	LY-4					
400	AA-9	BA-8	CA-9	DY-7	EY-8	FY-6	GY-6	HY-6	IY-6	KY-6	LY-5					
500	AA-11	BA-10	CA-11	DA-9	EA-10	FY-8	GY-8	HY-7	IY-7	KY-7	LY-6					
600	AA-14	BA-12	CA-13	DA-11	EA-12	FA-9	GA-10	HA-9	IY-8	KY-8	LY-7					
700	AB-16	BA-14	CB-15	DA-12	EA-13	FA-11	GA-12	HA-10	IY-10	KY-10	LY-8					
800	AB-18	BB-16	CB-17	DA-14	EA-15	FA-12	GA-13	HA-11	IY-11	KY-11	LY-9					
900	AB-20	BB-18	CB-20	DB-16	EB-17	FA-14	GA-15	HA-13	IY-12	KY-12	LY-10					
1000	AB-22	BB-20	CB-22	DB-17	EB-19	FB-15	GB-17	HA-14	IY-14	KY-14	LY-12					
1100	BB-22	CB-25	DB-19	EB-21	FB-17	GB-18	HB-15	IA-15	JA-15	KA-15	LA-13					
1200	BB-24	CD-27	DB-21	EB-23	FB-19	GB-20	HB-17	IB-17	KB-16	LA-14						
1300	BD-25	CD-29	DB-22	ED-25	FB-20	GB-22	HB-18	IB-19	KB-18	LA-15						
1400	BD-27	CD-31	DB-24	ED-26	FB-21	GB-23	HB-20	IB-19	KB-19	LB-16						
1500	BD-29	CD-34	DD-26	ED-29	FB-23	GB-25	HB-21	IB-21	KB-20	LB-18						
1600	BD-31		DD-28	ED-30	FD-25	GD-27	HB-22	IB-22	KB-21	LB-19						
1700	BD-33		DD-29	ED-32	FD-26	GD-28	HB-24	IB-23	KB-23	LB-20						
1800			DD-31	ED-34	FD-28	GD-30	HD-25	IB-25	KB-24	LB-21						
1900			DD-33	ED-35	FD-29	GD-32	HD-27	ID-26	KB-26	LB-22						
2000			DD-34	EF-37	FD-31	GD-33	HD-28	ID-27	KB-27	LB-23						
3000					FF-46	GF-49	HF-42	IF-41	KF-40	LD-35						
4000						GH-67	HH-56	JH-54	KH-54	LF-46						
5000								JH-58	KH-67	LH-58						
6000								JL-81	KL-81	LH-69						
7000										LI-80						
8000										LI-92						

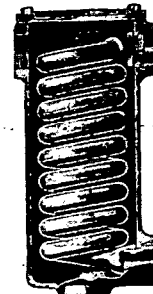
Howard Expansion Joints are extensively used in high and low pressure piping systems for all classes of service. They are a reliable means for accommodating expansion in such lines and are specified for all important work.

TO ARCHITECTS
ENGINEERS
CONTRACTORS EVERYWHERE

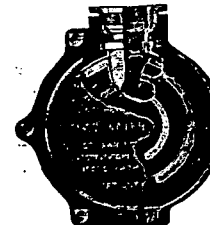
If you have not received a copy of the Alberger Engineers Heater Data Book describing all types and giving dimensions, service and installation data please send in your name immediately. Also remember that our experience in designing and building special heaters and coolers is available to prospective clients.

Excelso Specialty Works, Inc.

119 Clinton St., BUFFALO, N. Y.



Sectional View



New Double-Coil Heater

The new heaters take care of installations from 160 to 400 gal. Double the No. 18 up in batteries of two and 800 gal. can easily be heated.

These new heaters are built along the same general lines as the famous single coil heaters except that they have a double coil.

The Excelso Water Heater consists of a heavy copper coil heating element fitted in a cast iron shell by means of patented ground joint connections. All parts are interchangeable and easily accessible.

Connected on the outside of steam or vapor boilers the Excelso eliminates the fire pot coil and insures a constant supply of domestic hot water all during the heating season at an even temperature.

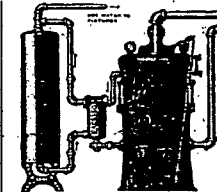
The Excelso method of generating domestic water is so satisfactory and the expense so trifling that boiler manufacturers and heating engineers generally are recommending its use.

The New Heavy Duty Double Coil Heater—For larger installations—for apartment houses, buildings and other places where large quantities of hot water are required.

These larger heaters are made in four sizes for tank capacities of 160, 200, 300 and 400 gal.

Connecting two or more of these heaters in battery will heat domestic water for most any tank capacity.

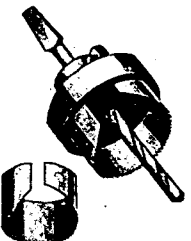
Special problems involving the use of Excelso Heaters will be given prompt attention by our engineering department.



Excelso Heater Connected to Round Steam Boiler

Excelso Rotary Hack Saw Tool—Boilers may be easily and quickly tapped by means of Excelso Rotary Hack Saw Tool.

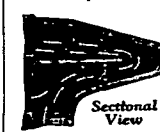
Each tool cuts holes for either 1, 1½ or 2 in. pipe tap. Price \$7.50 net, including 6 blades, 2 of each size.



Hack Saw Tool



Top View



Sectional View

Also Manufacturers of EXCELSO-PHAETON FIRE POT HEATERS.

Excelso Fire Pot Generator—This generator fits any type hot water boiler or hot air furnace, and is also designed to be entirely above the fire. Made in two sizes and in either cast iron, galvanized iron or brass. Size No. 1. Up to 40 gal. capacity. Size No. 2. From 40 to 60 gal. capacity.

Dimensions—Price List—Capacities

Size of Heater	Jr.	11	12	13	14	15	25	26	27	28
Length, in.	8½	10½	14	11½	15	19½	12½	15	19	23¼
Diameter, in.	5	5	5	6½	6½	6½	2	9	9	9
Shell opening, in.	1	1	1	1½	1½	1½	2	2	2	2
Coil opening, in.	¾	¾	¾	1	1	1	1½	1½	1½	1½
Weight, crated, lbs.	11	17	23	31	39	46	58	68	82	95
List Price	\$12.50	\$30	\$40	\$50	\$60	\$70	\$120	\$150	\$180	\$210

*Formerly Nos. 16, 17 and 18.

HEATING WATER BELOW WATER LINE OF STEAM OR VAPOR BOILERS

Size of Heater	Jr.	11	12	13	14	15	25	26	27	28
Tank Capacity	30	30	45	60	90	120	160	200	300	400

HEATING WATER WITH LIVE STEAM

Size of Heater	Jr.	11	12	13	14	15	25	26	27	28
Tank Capacity	45	50	75	100	150	200	250	300	450	600

INSTRUCTIONS FOR ORDERING HEATERS

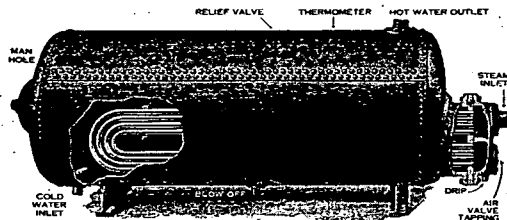
Many tanks are installed too small and heaters should always be ordered to correspond with work required and not size of tank. Also make liberal allowance if circulating system is used.

The Patterson-Kelley Co.

101 Park Avenue
New York City

Preheaters, Heat Exchangers, Heaters for Chemicals, Gases, Oils. Coolers for Brine, Chemicals, Gases, Oil and Water. Hot Water Heaters for all purposes. Pool Heaters and Converters.

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.



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 'U' 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	2500
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.

Thermal Appliance Company

342 Madison Avenue, NEW YORK

SALES OFFICES
332 S. MICHIGAN AVENUE, CHICAGO 7 EAST 42nd STREET, NEW YORK

TACO

WATER HEATER

For heating domestic water with the same fire that heats the home or building. There is a TACO for any steam, vapor, vacuum, hot water or hot air heating plant. Types for each heating system are classified below.

Domestic and Apartment Tacos

DOMESTIC TACO

No.	Capacity Gals.	Shipping Weight Lb.	List Price
30	30	11	\$15.00
1	40	14	20.00
2	80	24	30.00
3	160	52	50.00

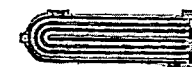


Domestic and Apartment Taco Heaters are for use in connection with steam or vapor-heating boilers connected below the water line.

They are also for use in heating hot-water radiators in bathrooms, garages, greenhouses or elsewhere.

APARTMENT TACO

No.	Capacity, Gal.	Length, Inches	Diameter, Inches	Boiler Tank Connections	Shipping Weight, Lb.	List Price
4	320	26 1/2	8	2	85	\$100.00
5	640	38 1/2	11 1/4	2 1/2	195	200.00
6	960	40 1/2	13 1/2	3	265	300.00



FLO-LINE TACO

No.	Capacity with Steam	Gals. with Hot Water	Height, Inches	Diameter, Inches	Tank Connections	Side Openings, Inches	Flange, Inches	Shipping Wt., Lb.	List Price
01	60	30	9 1/2	5 1/4	3/4	1	3	25	\$25.00
02	120	60	13 1/2	6 3/4	1	4	4	40	35.00
03	240	120	19 1/2	8	1 1/4	5	5	75	55.00



Flo-Line Taco Heaters are for connection in the main outlet of steam and vapor heating boilers.

Body of heater is sufficiently large, so the pipe area is not restricted.

Can also be used in connection with Hot Water Heating Boiler. (See Note.)

NOTE.—The Flo-Line "TACO" Heater is recommended for use in connection with hot-water heating plants only where provision is made for the use of gas or coal heater on wash days, and at such other times when extremely hot water is required. Domestic water will be heated to within 20 deg. of heating plant temperature. Its use will be a convenience in the home and will save gas or coal.

UNIVERSAL TACO

No.	Capacity, Gal.	Made of	Shipping Weight, Lb.	List Price
9-30-6-9-30	30	Iron	10	\$ 8.00
9-60-6-9-60	60	Iron	17	14.00
3-30	30	Iron	10	8.00
3-60	60	Iron	17	14.00
6-9-30	30	Brass	10	20.00
6-9-60	60	Brass	17	35.00



Recommended for use in the fire pot of hot water heating boilers. The No. 9-30 and 9-60 are furnished with studs for round boilers having coil openings 9 in. c. to c.; 6-9-30, 6-9-60 without studs for round boilers having (coil openings) 6, 9, or more inches c. to c. The No. 3-30 and No. 3-60 for use with square boilers of any type.

Where stocks are carried: TACO is carried in stock by all leading boiler and radiator manufacturers at their branch showrooms; and by leading jobbing supply houses.

TACO TOOL

For use when tapping boiler. Comes in three sizes: 1-in, 1 1/4-in. and 1 1/2-in. \$3.00 net each.

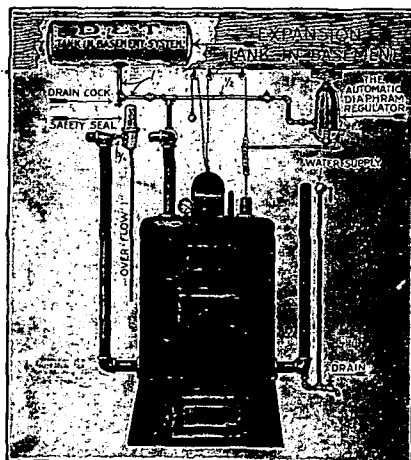


D. & T. Manufacturing Company

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 90,000 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.

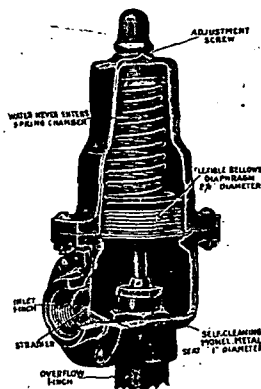
Send for booklet entitled, "Progress in Hot Water Heating."

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.

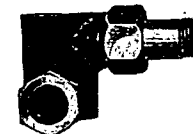
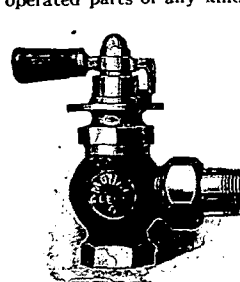
This disc is made of a composition which will stand a temperature of 300 deg. Fahr. The seat is made of the well-known non-corrosion Monel metal, which is self-cleaning and assures proper action at all times. The disc is 1 in. in diameter and the bellows which lifts the disc from the seat is 2½ in. in 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.

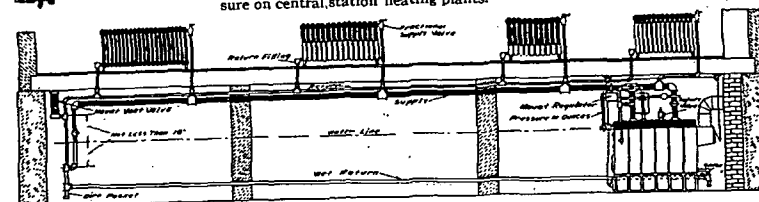
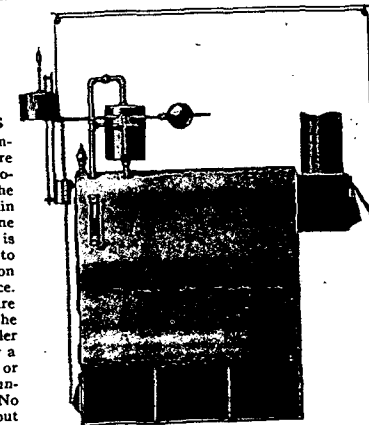
DAMPER REGULATORS

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.

VAPOR PRESSURE GAUGES

The Mouat Vapor Pressure Gauge indicates ounces of pressure by water elevation in a glass tube.



Showing how the Heat can be Graduated or Controlled

Grinnell Company, Incorporated

Heating, Industrial and Power Plant Piping, Fittings, Hangers, Valves, Pipe Bending, Welding, Piping Supplies, Etc.

Executive Offices
PROVIDENCE, R. I.

BRANCHES AND PLANTS

ATLANTA, GA. (Plant and Foundry)	DALLAS, TEX.	NORTH CHARLOTTE, N. C. (Plant)
AUBURN, R. I. (Plant and Foundry)	DETROIT, MICH.	ORLANDO, FLA.
BALTIMORE, MD.	GREENVILLE, S. C.	PHILADELPHIA, PA. (Plant)
BOSTON, MASS.	KANSAS CITY, MO.	PROVIDENCE, R. I. (Plant and Foundry)
CHICAGO, ILL. (Plant)	MILWAUKEE, WIS.	ROCHESTER, N. Y.
CINCINNATI, OHIO	MINNEAPOLIS, MINN.	ST. LOUIS, MO.
CLEVELAND, OHIO	NEW ORLEANS, LA.	WARREN, OHIO (Plant and Foundry)
COLUMBUS, OHIO	NEW YORK, N. Y.	

GRINNELL COMPANY OF THE PACIFIC		
LOS ANGELES, CALIF. (Plant)	SAN FRANCISCO, CALIF. (Plant)	SEATTLE, WASH.

GRINNELL COMPANY OF CANADA, LTD.		
MONTREAL, QUE. (Plant)	TORONTO, ONT. (Plant and Foundry)	
VANCOUVER, B. C. (Plant)	WINNIPEG, MAN.	

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 Dryers—Tray Type Dryers—Grinnell tray type dryers establish a new measure of perfection in drying results, a new basis of economy in operating costs, a new standard of value in structural materials and workmanship. These

new dryers are offered to the trade only after years of laboratory and field experience. They dry uniformly over every inch of every tray and without disturbing even the finest product. Their satisfactory performance is absolutely guaranteed.

Textile Drying Machinery—In addition to its tray type dryers, Grinnell also manufactures a complete line of textile drying machinery and through its engineering force is prepared to advise on any drying problem. The chief features of our textile drying machinery are its more rugged construction and its double insulation.

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.

GRINNELL COMPANY

Heating, Industrial and Power Plant Piping, Fittings, Hangers, Valves, Pipe Bending, Welding, Piping Supplies, Etc.

GRINNELL COMPANY

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 $1\frac{1}{2}$ 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)

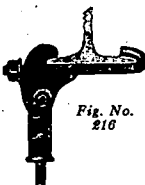


Fig. No. 210

ADAPTABLE to many uses, this Side I-Beam Clamp has ample strength for hanging $\frac{3}{4}$ 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

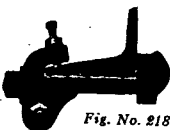


Fig. No. 218

DUE to the adjustability of the Grinnell Channel Iron Clamp, four 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.

GRINNELL COMPANY

Heating, Industrial and Power Plant Piping, Fittings, Hangers,
Valves, Pipe Bending, Welding, Piping Supplies, Etc.

Adjustable Wall Radiator Brackets



Fig. No. 190

THE Grinnell Adjustable Wall Radiator Brackets shown here were designed to support either a single section of radiation or two sections—one in front of the other. Fig. No. 190 shows bracket with single foot for supporting one section—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.

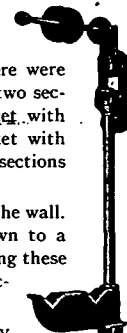


Fig. No. 191

Adjustable Wall Coil Hangers

(Patented May 20, 1923)

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 $2\frac{1}{4}$ or $6\frac{1}{4}$ in. from back of bracket. Where double coils are used the second hangs $3\frac{1}{2}$ 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.



Fig. No. 160

Saddle Hangers—Standard Type

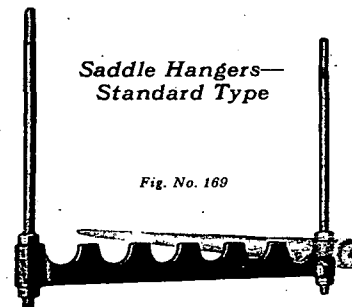


Fig. No. 169

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 almost unlimited 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 $\frac{1}{2}$ in. rods and hex-nuts on 2 to 8 branch hangers— $\frac{3}{8}$ 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.

GRINNELL COMPANY

Heating, Industrial and Power Plant Piping, Fittings, Hangers,
Valves, Pipe Bending, Welding, Piping Supplies, Etc.



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 results in the "roll" actually rolling when expansion or contraction of piping takes place.

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.

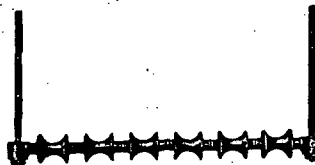


Fig. No. 178

Adjustable Pipe Stand—Anchor Chair— Pipe Seat—used with Welded Steel Bracket

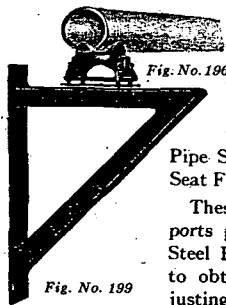


Fig. No. 199



Fig. No. 197

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. 198

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.

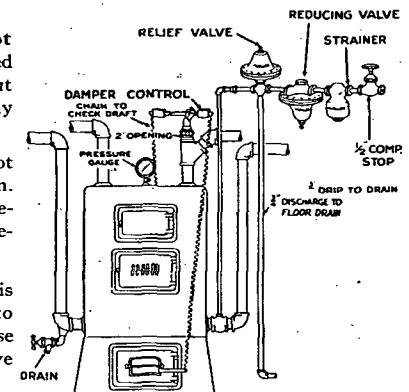
A very considerable saving in fuel is effected due to the automatic control of dampers and rapid circulation.

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.

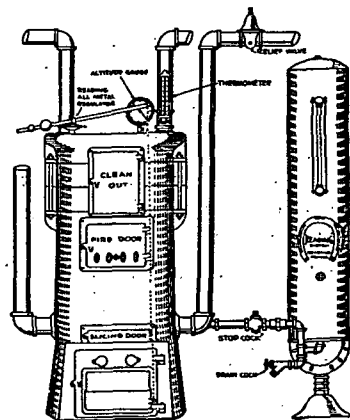
Manufacturers and Distributors of

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)

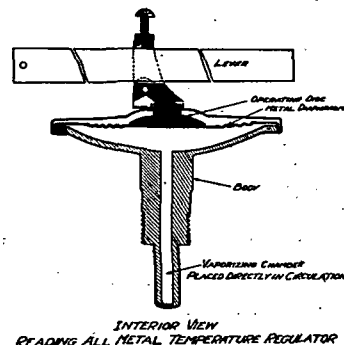
No. 1.	300 to 500 ft. of Radiation	\$38
No. 2.	500 to 800 ft. of Radiation	40
No. 3.	800 to 1,000 ft. of Radiation	41
No. 4.	1,000 to 1,300 ft. of Radiation	45
No. 5.	1,300 to 1,800 ft. of Radiation	50
No. 6.	1,800 to 2,600 ft. of Radiation	55

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.



INTERIOR VIEW
READING ALL METAL TEMPERATURE REGULATOR

E. Vernon Hill Co.

Aerologists

64 W. Randolph St.

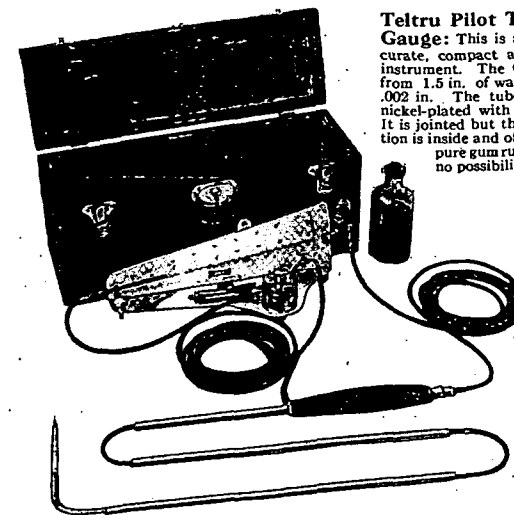
CHICAGO

One Kind of Air Testing Instruments

Air Meters
Microscopes
Psychrobooks
Complete
Test Cases



Psychrometers
Thermometers
Dust Counters
Pitot Tubes and
Gauges



Teltru Pilot Tube and Gauge: This is a highly accurate, compact and portable instrument. The Gauge reads from 1.5 in. of water down to .002 in. The tube is heavily nickel-plated with a cork grip. It is jointed but the static portion is inside and of continuous pure gum rubber tubing, no possibility of leaks.



Healthometer: A handsome, convenient, wet and dry-bulb instrument, with comfort curves on the back. The wick cannot become incrustated or the water in the bulb evaporate. An ideal instrument for schools.



Whirling Psychrometer: The case forms the handle when the instrument is in use. A very convenient pocket instrument. Each thermometer is individually tested and a correction curve furnished with the same when required.



A. C. Machine: A compact, portable and very useful instrument for determining air motion in a room and studying air currents. It solves many vexing problems of air distribution.

Taylor Instrument Companies

ESTABLISHED 1851
Executive Offices and Factory, ROCHESTER, N. Y.
Canadian Plant, Tycos Building, Toronto, Canada

SALES OFFICES

NEW YORK PITTSBURGH SAN FRANCISCO TULSA CHICAGO CLEVELAND MILWAUKEE DETROIT
BOSTON LOS ANGELES ST. LOUIS ATLANTA PHILADELPHIA INDIANAPOLIS CINCINNATI MINNEAPOLIS

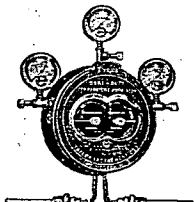
Tyco Products Include

Indicating, Recording and Controlling Instruments in over 8000 types and styles.
For Steam, Power, Refrigerating and Cold Storage Plants.
Air Duct, Oven, Kiln and other Industrial Manufacturing Applications.

Among the instruments of particular interest to Heating and Ventilating Engineers are:
Thermometers.
Pyrometers.
Electrical Contact Temperature Controls.

"Single-Duty" and "Double-Duty" Temperature Regulators.
"Thermo-Tyme" Regulators.
Self-Acting Temperature Regulators.
Pressure Regulators.
Draft and Vacuum Gages.

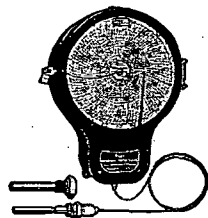
Tyco's temperature and pressure regulators for use on air ducts, feed water heaters, hot water storage tanks, etc., are air operated and made in three styles, Single-Duty, Type P and Double-Duty. There are a great variety of applications for these units and there is a Tyco's Regulator for every service.



Tyco's Temperature Regulator

For very close control of temperature in dry kilns, bake or enameling ovens, etc., for instance, the electric-contact control is recommended as it will automatically regulate the temperature of any apparatus heated by gas, steam or electricity.

Tyco's recording thermometers automatically furnish a complete record in ink on a paper chart of the exact temperature maintained for every minute of operation. Ruggedness of construction, accuracy and reliability are outstanding features of Tyco's recording and indicating thermometers. Vapor tension, mercury and gas actuated types are made for temperature units respectively of 30 to 550 deg. Fahr. and -40 deg. to +1000 deg. Fahr. and furnished with suitable tubing and bulbs.



Tyco's Recording Instrument

An accurate record of humidity conditions can be obtained with Tyco's wet and dry bulb recording thermometers.

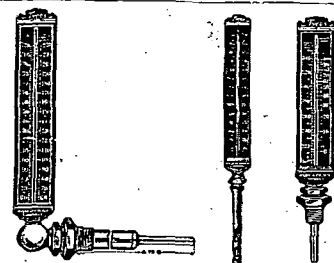
In the Tyco line of thermometers are the industrial types for indicating, feed water, condenser, economizer, super-heated steam and flue gas temperatures.

Tyco's Thermo-Steam Gages are made for high and low pressure and are graduated for both temperature and pressure. Thermo-Vacuum Gages are especially useful in steam turbine operation and Air Duct Thermometers are extremely sensitive and are favored by heating and ventilating engineers.

Catalogs of Tyco's Instruments

In addition to the items listed in this catalog we make a full line of instruments for indicating, recording and controlling.

General Catalog of Tin-Case, Copper-Case, and Cabinet (wood back) Thermometers; Hydrometers, etc.
General Catalog of Short & Mason Meteorological Instruments, such as Barometers, Pocket and Surveying Compasses, Rain Gages, Wind Gages, etc.



Tyco's Thermometers

trolling temperature and pressure, aggregating some 8000 types and styles. They are covered by the following catalogs, any of which will be sent on request.

- Part 1.—Instruments for Steam-Power Plants.
- Part 200.—Instruments for Sugar-Manufacturing Plants.
- Part 300.—Instruments for Refrigerating and Cold-Storage Plants.
- Part 500.—Instruments for the Food-Preserving Industry.
- Part 600A.—Instruments for the Milk and Ice-Cream Industry.
- Part 600B.—Instruments for Condensed, Evaporated and Powdered Milk Processes.
- Part 600.—Instruments for Gas Plants.
- Part 700.—Instruments for Varnish Making, Oil Boiling, Asphalt Melting, etc.
- Part 700A.—Instruments for Oil Tempering, Metal Baths, Tempering Ovens, etc.
- Part 800.—Instruments for Enclosed-Space Applications, Air Ducts, Ovens, Kilns, etc.
- Part 900.—Instruments for Bakers, Confectioners, Syrup Makers, etc.
- Part 1400.—Engraved Thermometers.
- Part 1500.—Hydrometers.
- Part 1700.—Instruments for the Oil Industry.
- Part 4000.—Radiation, Thermoelectric and Optical Pyrometers.
- Part 8000.—Recording and Index Thermometers.
- Part 11850.—Electric-Contact-Type Temperature Controls.
- Part 15000.—Single-Duty Temperature Regulators.
- Part 16150.—Double-Duty Temperature Regulators.
- Part 16300.—Thermo-Tyme Regulators.
- Part 16700.—Self-Acting Temperature Regulators.
- Part 16100.—Pressure Regulators.
- Part 17000.—Type-F (Rigid Stem) Temperature Regulators.
- Part 18000.—Accessories for Temperature and Pressure Regulators.

Johns-Manville Inc.

292 Madison Avenue, at 41st Street, N. Y. City
Branches in 62 Large Cities

JOHNS-MANVILLE ASBESTO-SPONGE FELTED

Sectional Pipe, Sheet and Block Insulation

An efficient and durable insulation for insulating saturated and superheated steam pipes and surfaces at temperatures up to 750 deg. Fahr.

It is made of layers of thin felt, composed of asbestos fibre and particles of finely ground spongy material forming an extremely cellular felt, built up in laminated form, thus confining a large volume of minute dead air cells in the felt and between the layers, because of its construction, and unlike insulations of the moulded type, Johns-Manville Asbesto-Sponge Felted is tough, flexible and practically indestructible in service. Vibration and the general wear and tear to which insulation is subjected will not pulverize Asbesto-Sponge Felted or cause it to break away from the pipe.

Asbesto-Sponge Felted is furnished in thicknesses from 1/2 to 3 in., in three foot sections with canvas jacket and brass-lacquered bands, to fit standard pipe sizes. It is also furnished in sheets and blocks for boilers, flues and other large regular surfaces. Sheets 24 x 36 in. and blocks 6 by 36 in. in thicknesses from 1/2 to 4 in.

JOHNS-MANVILLE IMPROVED ASBESTOCEL

Sectional Pipe, Sheet and Block Insulation

For insulating pipes conveying steam at medium or low pressures, hot water or hot air pipes and surfaces.

Improved Asbestocel is made up of a multitude of small air cells closed upon themselves by corrugations in both directions, thus retarding the free circulation of air along the pipe. These cross corrugations add strength to Improved Asbestocel and enable it to give long and efficient service without deterioration.

Improved Asbestocel is furnished in 2, 3, 4, 5 and 6-ply thicknesses, each ply approximately 1/4 in. thick. It is made in three foot sections with canvas jacket and brass-lacquered bands, to fit standard sizes of pipe. Also furnished in sheet and block form for boilers, flues and other large regular surfaces. Sheets 36 x 36 in. and blocks 6 x 36 in. 4 x 18 in. and 3 x 18 in. or special sizes, in thicknesses from 1/2 to 4 in.

JOHNS-MANVILLE 85% MAGNESIA

Sectional Pipe and Block Insulation

A light-weight efficient insulation of the moulded type made of 85% carbonate of magnesia and 15% asbestos fibre, for insulating steam pipes and hot surfaces.

Our manufacturing process produces an 85% Magnesia with the maximum number of voids or minute dead-air cells which increase its natural resistance to heat transmission and reduce its weight. In addition, this process provides maximum mechanical strength consistent with high efficiency.

85% Magnesia is made in various thicknesses, from standard (appr. 1 in. thick) to 3 in. thick, in 3 ft. sections with canvas jacket and brass-lacquered bands, to fit pipe sizes up to and including 12 in. in diameter. Also furnished in blocks for boilers, flues and other large regular and irregular surfaces. Blocks are made 3 x 18 in. or 6 x 36 in. in thicknesses from 1/2 to 4 in.

JOHNS-MANVILLE UNDERGROUND SYSTEM OF INSULATION

For Steam Lines

A complete underground insulation which saves at least 90% of the heat that would be wasted from bare pipes. Consists of a vitrified container, Asbesto-Sponge filling as an insulator, rolls and supports, pits and underdrain. Each system designed and installed by Johns-Manville Inc.

JOHNS-MANVILLE STEAM TRAPS

In the Johns-Manville Steam Trap there is little to wear and nothing to adjust. The only moving part is a hollow, seamless ball. The operation of this trap is noiseless. Its size is small in comparison with its capacity. The cast iron models are made in capacities ranging from 700 to 6000 lb. condensate per hour and are suitable for all steam pressures.

Junior Traps (for steam pressures up to 100 lb.) are made of bronze with 1/2 in. inlet and outlet pipe connections.

Radiator Traps operate at any pressure up to 10 lb. and are equally effective whether used on vacuum or atmospheric return line systems. To be used on cast iron radiators only, unless specially ordered for special cases.

Insulating Material

Norristown Magnesia and Asbestos Co.

Norristown, Pa.

ASBESTOS
PRODUCTS



FACTORIES:

Norristown, Pa.
Doylestown, Pa.
Pleasant Mills, N. J.

HEAT INSULATING MATERIAL

Superheated steam and high pressure saturated steam service:

2-Point—Efficient, durable and adaptable insulation.

Indent—Designed for severe conditions.

Ideal—Combines efficiency and strength.

Asbestos Magnesia—Econ-
omical moulded type.

Low pressure steam and hot water.

Air Cell and Norriscel—
Standard for low temperature in-
sulations, inexpensive. Norriscel
has smaller cells and is the more
efficient.

Wool Felt—Not fireproof, but
very efficient.

Asbestos Boiler Cement:

"S"—A good, reliable, inex-
pensive cement.

"101"—Strong and efficient.

"505"—Easy to apply, great
holding and covering power.

COLD INSULATING MATERIALS

Exposed Pipe Lines—Wool Felt with water-
proof liner: inexpensive, yet very efficient.

Cold Lines Running Through Heated or
Damp Rooms—Sweat Proof covering: wool felt
protected from water and moisture, made to
prevent air filtration through covering.

Outdoor Lines Exposed to Severe Weather—
Frost Proof covering, a combination of hair
and wool felt. Brine and ammonia lines: com-
bination Diamond N, a built-up covering of hair
and wool felt, waterproofed.

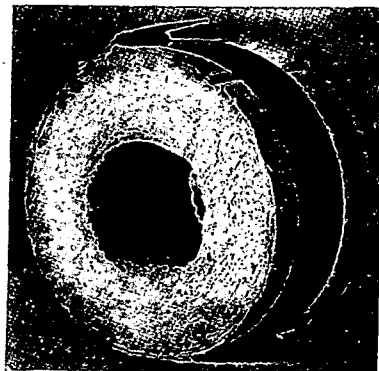
Other Products—Furnace cement, braking
materials, lining for floors, partitions, ovens and
doors, general heat and fire and acid fume pro-
tection, etc. Gaskets and packing. Asbestos
millboard.

2-Point is a heat insulating material
made of felted asbestos and loosely
packed diatomaceous earth so fashioned
that a very large quantity of air is im-
prisoned in small cells. It is one of the
newer developments in insulation and is
particularly useful where extreme conditions of temperature and hard usage must be
met. Its efficiency in preventing the escape of heat has been accurately determined and
the results obtained are available to those who wish complete details.

Norriscel is adaptable to widely differing conditions of service. It is made of
successive layers of plain and corrugated felted asbestos, the corrugations having a depth
of slightly less than $\frac{1}{8}$ in., bound firmly together. The arching effect produces great
strength, yet retains lightness, so that it is quickly and easily applied or removed. Its
asbestos composition makes it durable so that it is a most economical covering for
medium and low temperature installations, while it is frequently used for higher tem-
peratures where low initial expense is desirable. In block form for ovens, kilns, boilers
and other large surfaces, it is made in sizes as desired for greatest ease of application.

Frictionite is an excellent and economical braking material for both ordinary and
very severe conditions. It is composed of pure asbestos felted into a firm body, im-
pregnated with a binding material which, under subsequent heat treatment, becomes
strong and tough, holding the asbestos with great strength. In use, it is not affected
by the heat generated by friction and will not cause fire. It does not "peel" or "ball
up" even under high normal pressures: Oily surfaces have little effect upon it and the
coefficient of friction is high.

356



2-Point

Insulating Materials

Established 1910

Telephone
Main 4995

The Ric-Wil Company

UNDERGROUND CONDUIT SYSTEMS FOR HEATING PIPES

Union Trust Building

CLEVELAND, OHIO

AGENTS IN PRINCIPAL CITIES—REFER TO LOCAL TELEPHONE DIRECTORY

Products—Ric-wil Interlocking Conduit, Inter-
locking Base Drain, Pipe Supports and Ric-wil
Underground Pipe Covering used in the "Ric-wil
Method" of Insulating Underground Steam, Hot
Water and Fuel Oil Pipes.

Ric-wil Interlocking Conduit—Ric-wil Con-
duit is first quality, standard weight, vitrified salt
glazed tile of the bell and spigot type, and made of
"Akron" shale. 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 bot-
tom halves are numbered in pairs so that com-
panion pieces may be kept together. Sections all
in 2-ft. lengths, sizes from 4 to 24 in. inside di-
ameter. 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.

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.

Four Types of Ric-wil Conduit—Ric-wil Con-
duit for pipes underground is of four types to meet
varying service requirements.

Type DA—for hot water, fuel oil, and condensa-
tion 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, mak-
ing it specially adapted to house oil and steam
pipes together for fuel oil transmission. Excep-
tionally easy to install.

Type DF—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.

Type SPC—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.

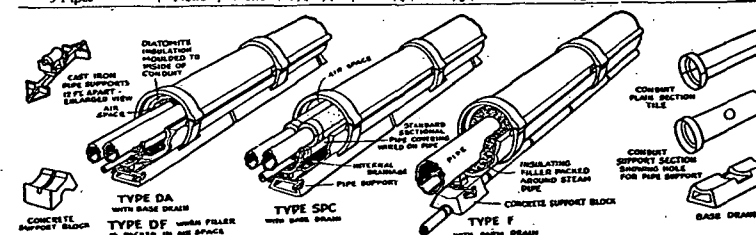
Type F—for steam heating and power pipes. A
lower priced type than the others, consisting of
unlined tile with conduit filler packed around the
pipes. Filler is the same as described in Type DF
System.

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 main-
tained 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	1 1/2	3	4 1/2	6	8	10	12	14	16	18
2 Pipes	1 1/2-1/2	3-3/4	4 1/4-1 1/4	2-2	3-3	4-4	5-5	6-6	7-7	8-8
3 Pipes	None	None	1 1/2-1 1/4-1	2-2 1/4	3-3 1/2	4-4 2	5-5 2/2	6-6 3	7-7 3/2	8-8 4



357

Monarch Metal Products Company



5010 Penrose Street
St. Louis, Mo.



Certified Heating Efficiency and Economy

A successful heating plant from the standpoint of operation and low fuel costs must be designed by an engineer using heat loss factors that will remain practically constant for years after a building has been in use.

No pre-determined number of air changes can remain constant. Wind velocity and direction, size of crack and clearance between sash and frame, the number of windows in a room and the size of the room, all affect the number of air changes. The size of the room and the number of windows are the only factors that remain constant. Therefore to use any given number of air changes is at best only guess work and not engineering.

ROOM 1.

Size, 15' x 16' x 9' = 2160 cu. ft.

Location, N. W. Corner

Windows, 2 North; 2 West

Size Windows, 3' x 6'

Total Crack Perimeter, 84'

Crack, $\frac{1}{8}$ "; Clearance, $\frac{1}{8}$ "

ROOM 2.

Size, 12' x 20' x 9' = 2160 cu. ft.

Location, North Side

Windows, 3

Size Windows, 4' x 5'

Total Crack Perimeter, 68'

Crack, $\frac{1}{8}$ "; Clearance, $\frac{1}{8}$ "

ROOM 3.

Size, 14' x 17' x 9' = 2160 cu. ft.

Location, North East.

Windows, 2 East; 2 North, D.H.

Size Windows, 3' x 6' on East
4' x 7' on North

Crack Perimeter, 42' on East
52' on North

Crack, $\frac{1}{8}$ "; Clearance, $\frac{1}{8}$ "

The component parts of each equation are as follows, using the Tongue and Groove equation for room No. 3 as an example:

$$\frac{(94 \times 15 \times 1.7 \times 0.018 \times 70) + (4 \times 21 \times 15 \times 0.018 \times 70)}{240}$$

A B C D E F G B D E

A—Lineal feet of crack.

B—Wind movement in miles per hour.

C—Infiltration in cubic feet per hour per foot of crack per mile wind movement.

D—Number of B.t.u. required to raise 1 cu. ft. of air 1 deg. Fahr.

E—Degrees difference inside and outside temperature—(0.70 deg.)

F—Number of windows in room.

G—Cubic feet of elsewhere leakage through any size window

1 7/8" Sash COMPARATIVE LEAKAGES											
Leakage C.F.H. per ft. Crack per mile Wind Velocity 70° Temp. Diff.											
B.T.U. per hour per ft. Crack per mile Wind Velocity 70° Temp. Diff.											
Crack	Plain Window	Monarch Interlocking Weather Strip				Tongue & Groove Weather Strip					
	1/16"	1/16"	1/8"	3/16"	1/4"	1/16"	1/8"	3/16"	1/4"	1/2"	3/4"
Clearance	1/16"	1/16"	1/8"	3/16"	1/4"	1/16"	1/8"	3/16"	1/4"	1/2"	3/4"
1/16"	2.1	2.65	3.38	4.50	6.76	7.88	1.2	1.5	1.4	1.76	2.14
1/8"	2.9	3.65	4.50	5.65	7.88	9.13	1.3	1.64	1.5	1.89	2.39
3/16"	3.7	4.66	4.50	6.76	8.10	9.13	1.4	1.76	1.6	2.01	2.52
1/4"	5.0	6.30	4.50	6.76	8.10	1.0	1.26	1.4	1.76	1.6	2.01
1/2"	10.0	12.6	9.0	13.5	16.2	2.0	2.52	2.7	3.40	3.0	3.78
3/4"	15.0	18.9	13.5	20.25	24.3	3.0	3.78	4.05	5.13	4.5	5.67

Note: Plain or Non-Stripped window figures are for both sashes locked at meeting rail.
If frames are not caulked add 1.9 cu. ft. of air per lineal foot of crack per mile wind velocity.
Frame crack = Height plus width x 2
Add 21 cu. ft. per opening per mile wind velocity for elsewhere leakage.
Sash perimeter = 3 x width plus 2 x Height

Table of B.t.u. losses

NOTE.—The above figures for non-stripped window are based on sash being locked.

Infiltration and B.t.u. losses are for 1 lineal foot of window crack of various widths and clearances. (See Diagram.) No allowance is made for leakage back of the frame, which should be caulked. For uncaulked frames, add 1.9 cu. ft. per foot of frame crack per hour of wind velocity.

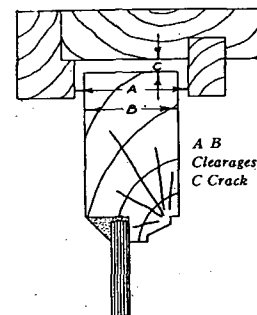
Frame crack equals width plus height X 2.

Sash crack equals 2 X height plus 3 X width.

Elsewhere leakage is 21 cu. ft. per opening per hour per mile of wind velocity.

NOTE.—Size of window does not affect the elsewhere leakage, as practically all the leakage is through the pulley holes.

Twenty manufacturers of window sash and frames furnish information that standard construction calls for minimum clearance of $\frac{1}{8}$ in. Sixteen universities furnish information from actual micrometer measurements of sash and frame, that the maximum crack is 17/42 in. and the maximum clearance is 9/64 in. and the minimum crack is 3/64 in. and the minimum clearance is 3/64 in. The average for buildings 10 years old is given as $\frac{1}{16}$ in. for the crack and 3/32 in. for the clearance. Wind velocities should be taken from government reports.



MONARCH METAL WEATHER STRIPS

Interlocking Type

"Standard Control of Infiltration"

Send for Data Sheets

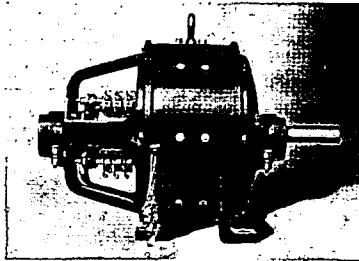
Reliance Electric & Engineering Co.

Ivanhoe Road :: CLEVELAND, O.

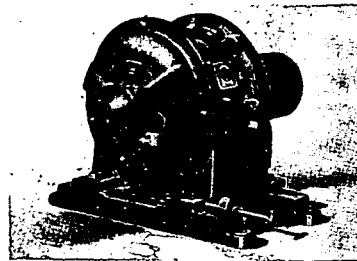
BRANCHES—BOSTON, NEW YORK, PHILADELPHIA, PITTSBURGH, CINCINNATI,
DETROIT, CHICAGO, BIRMINGHAM, ALA.

Sales to building industry in New York City are handled by Building
Equipment and Machinery Co., 39 Cortland Street.

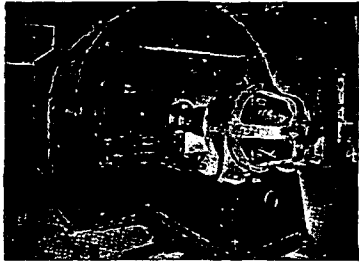
ELECTRIC MOTORS, Direct and Alternating Current



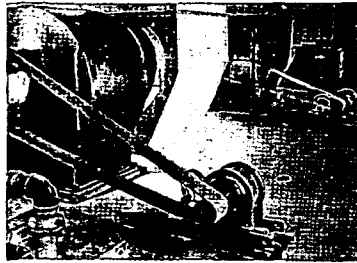
Type T Heavy Duty Reliance Motor for
Direct Current



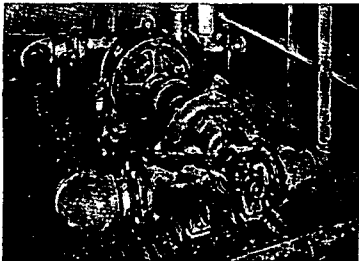
Type AA Reliance Squirrel Cage
Induction Motor



25 H. P. 190-240 R. P. M. Type T Reliance
Motor Driving Ventilating Fan in
Cleveland Auditorium

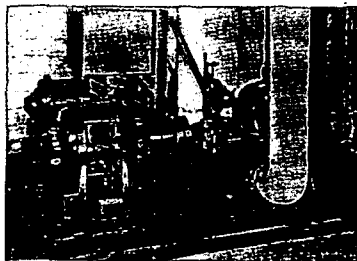


Type AA Reliance Motors Driving
Ventilating Fans



10 H. P. 1150 R. P. M. Type T Reliance Motor
on Air Washer Pump, Federal Reserve Bank,
Cleveland; 34 Reliance Motors are used
in this Building

Reliance Motors were used for all Veni-
lating Equipment in New Hotel
Stoller, Buffalo and Union
Trust Bldg., Cleveland



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

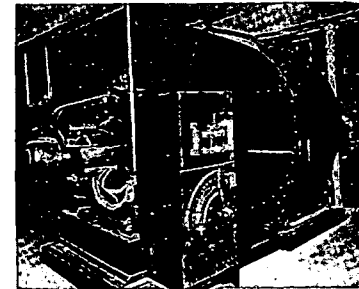
Albany, N. Y.
Atlanta, Ga.
Bakersfield, Cal.
Baltimore, Md.
Birmingham, Ala.
Bluefield, W. Va.
Boston, Mass.
Bridgeport, Conn.
Buffalo, N. Y.
Burlington, Ia.
Butte, Mont.
Canton, O.
Casper, Wyo.
Cedar Rapids, Ia.
Charleston, W. Va.
Charlotte, N. C.
Chattanooga, Tenn.
Chicago, Ill.
Cincinnati, O.
Cleveland, O.
Columbus, O.
Dallas, Tex.
Dayton, O.
Denver, Colo.

Des Moines, Ia.
Detroit, Mich.
Duluth, Minn.
El Paso, Tex.
Elmira, N. Y.
Fort Wayne, Ind.
Fresno, Cal.
Grand Rapids, Mich.
Hammond, Ind.
Hartford, Conn.
Houston, Tex.
Huntington, W. Va.
Indianapolis, Ind.
Ishpeming, Mich.
Jackson, Ore.
Jacksonville, Fla.
Kansas City, Mo.
Knoxville, Tenn.
Little Rock, Ark.
Louisville, Ky.
Los Angeles, Cal.
Madison, Wis.
Memphis, Tenn.
Middlesboro, Ky.

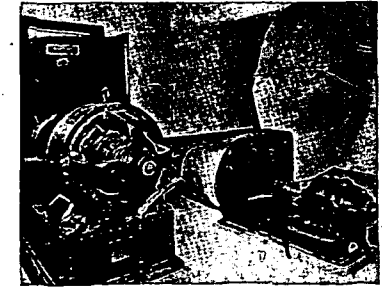
Milwaukee, Wis.
Minneapolis, Minn.
Newark, N. J.
New Haven, Conn.
New Orleans, La.
New York, N. Y.
Niagara Falls, N. Y.
Norfolk, Va.
Oklahoma City, Okla.
Omaha, Neb.
Peoria, Ill.
Philadelphia, Pa.
Pittsburgh, Pa.
Portland, Me.
Portland, Ore.
Providence, R. I.
Raleigh, N. C.
Richmond, Va.
Rochester, N. Y.
Rock Island, Ill.
Saco, Me.
St. Louis, Mo.
Salt Lake City, Utah
San Antonio, Tex.

San Francisco, Cal.
Seattle, Wash.
Shreveport, La.
Spokane, Wash.
Springfield, Ill.
Springfield, Mass.
Syracuse, N. Y.
Tacoma, Wash.
Terre Haute, Ind.
Toledo, O.
Tucson, Ariz.
Tulsa, Okla.
Utica, N. Y.
Washington, D. C.
Watertown, N. Y.
Wichita, Kans.
Wilkesbarre, Pa.
Worcester, Mass.
Youngstown, O.
Hawaiian Electric Co.,
Ltd., Honolulu, T. H.
—Agent

Motors and Control for all kinds of Ventilating Equipment, Elevators, Pumps, etc.



Type SK Motor Driving Exhaust Fan Controlled
by Type HS Panel.



Ventilating Equipment in Seaboard National Bank
New York.

The Westinghouse Electric & Mfg. Co. is in position to furnish complete electrical equipment for operating ventilating appliances, from the small blower for ventilating a single room to the automatic system for conditioning the air for the largest building.

The motors and controllers offered for this service have been especially designed to suit the power and speed characteristics

of fans and blowers. At the same time, quietness of operation has been retained.

The long experience of Westinghouse in making successful applications of ventilating equipments, is at the service of Heating and Ventilating Engineers and they are invited to submit their ventilating problems to us for recommendations of electrical equipment that will produce the most satisfactory results at minimum cost.

Data Desired in Applying Ventilating Motors

Kind of Current. A-C.—Voltage, Phase, Frequency. D-C.—Voltage.

Type, make, speed and size of fan or blower.

Motor speed.

Constant or Varying Speed. If the latter, the speed range and horse-power required at normal or maximum speed.

Method of Connection.

Intermittent or Continuous Service.

Crane Co.

Chicago

Largest Manufacturers and Distributors of Pipe, Valves and Fittings in the World

FLOW OF STEAM IN POUNDS PER MINUTE THROUGH STANDARD AND EXTRA STRONG PIPES AND PRESSURE DROP OF STEAM IN POUNDS THROUGH 100 FEET STANDARD AND EXTRA STRONG PIPES
VELOCITY, 3000 FT. PER MINUTE
TABLES FURNISHED BY CRANE CO.

GAUGE PRESSURE IN POUNDS PER SQUARE INCH																		
STANDARD PIPE																		
Sizes	1	3	5	10	15	25	35	50	75	100	125	150	175	200	EXTRA STRONG PIPE			
1/2 Flow	255	236	315	388	461	604	745	953	1296	1632	1965	2304	2636	2962	1772	2028	2278	1/2
Drop	1537	1746	1903	2352	2790	3656	4515	5775	7445	988	1187	1396	1596	1792	1772	2028	2278	1/2
3/4 Flow	448	501	553	681	808	1058	1305	1669	2271	2860	3445	4038	4621	5190	3282	3753	4216	3/4
Drop	906	1014	1118	1380	1636	2140	2640	3377	4600	5780	6962	8180	9375	10500	5450	6236	7050	3/4
1 Flow	725	812	896	1105	1310	1715	2115	2705	3681	4636	5588	6548	7490	8419	10111	11544	12999	1
Drop	597	668	736	910	1079	1410	1740	2222	3028	3803	4595	5400	6172	6940	6355	7273	8260	1
1 1/2 Flow	1256	1405	1552	1912	2270	2968	3662	4683	6172	7630	9070	10500	11924	13348	9720	1125	1248	1 1/2
Drop	569	644	714	884	1054	1384	1714	2224	2824	3424	4024	4624	5224	5824	3826	4470	4900	1 1/2
2 Flow	284	318	351	434	512	671	828	1061	1440	1817	2187	2567	2938	3295	1338	1531	1721	1 1/2
Drop	2818	3152	3480	4290	5085	6590	8215	10511	1429	18011	21861	25671	29381	32951	2238	2560	2877	2
2 1/2 Flow	4012	4501	4968	6122	7260	9515	11735	15000	20411	25700	30955	36200	41455	46700	1883	2155	2418	2 1/2
Drop	140	158	174	215	254	334	411	525	714	869	1082	1272	1457	1637	3233	3675	4128	2 1/2
3 Flow	6211	6945	7665	9455	11211	14588	18100	23148	31488	39687	47886	56085	64284	72483	1410	1605	1790	2 1/2
Drop	1099	1223	1353	1653	1953	2553	3153	3953	5153	6353	7553	8753	9953	11153	5000	5725	6433	3
4 Flow	1059	1196	1332	1627	1922	2517	3112	3912	5112	6312	7512	8712	9912	11112	985	1129	1268	3
Drop	106	124	142	182	222	292	372	452	592	732	872	1012	1152	1292	8715	9970	1120	4
5 Flow	1683	1832	2075	2558	3033	3973	4900	6270	8535	10735	12935	15135	17335	19535	649	743	820	4
Drop	1048	1184	1320	1616	1912	2508	3104	3904	5104	6304	7504	8704	9904	11104	1377	1577	1771	5
6 Flow	2427	2716	2996	3694	4380	5755	7075	9025	12325	15625	18925	22225	25525	28825	464	531	595	5
Drop	1037	1172	1307	1603	1899	2495	3091	3887	5083	6279	7475	8671	9867	11063	1975	2261	2538	6
8 Flow	4295	4808	5321	6538	7755	10125	12500	15875	21250	26625	32000	37375	42750	48125	361	413	463	8
Drop	1025	1160	1295	1591	1887	2483	3079	3875	5071	6267	7463	8659	9855	11051	3460	3957	4448	8
10 Flow	6780	7585	8390	1032	1224	1602	1972	2528	3438	4348	5258	6168	7078	7988	247	282	317	10
Drop	1019	1154	1289	1585	1881	2477	3073	3869	5065	6261	7457	8653	9849	11045	565	646	726	10
12 Flow	9650	10799	11948	14688	17428	22800	28172	33545	43918	54291	64664	75037	85410	95783	180	205	231	12
Drop	1015	1150	1285	1581	1877	2473	3069	3865	5061	6257	7453	8649	9845	11041	8215	9405	1056	12

FLOW OF STEAM IN POUNDS PER MINUTE THROUGH STANDARD AND EXTRA STRONG PIPES AND PRESSURE DROP OF STEAM IN POUNDS THROUGH 100 FEET STANDARD AND EXTRA STRONG PIPES

VELOCITY, 4000 FT. PER MINUTE

TABLES FURNISHED BY CRANE CO.

		STANDARD PIPE																EXTRA STRONG PIPE			
		GAUGE PRESSURE IN POUNDS PER SQUARE INCH																			
Sizes		1	3	5	10	15	25	35	50	75	100	125	150	175	200	150	175	200	Sizes		
1/2 Flow	340	381	420	518	614	805	993	1270	1727	2175	2620	3072	3515	3974	4364	2364	2704	3038	1/2		
Drop	2733	3100	3364	4180	4955	6500	8030	10235	13393	17541	21692	25842	29992	34142	38292	3152	3600	4055	1/2		
3/4 Flow	597	668	737	908	1077	1411	1740	2225	3029	3834	4593	5382	6160	6920	7680	4272	5005	5631	3/4		
Drop	1610	1803	1995	2452	2900	3805	4700	6000	8190	10290	12390	14490	16590	18690	20790	1792	2053	2321	3/4		
1 Flow	968	1083	1195	1473	1746	2287	2821	3608	4908	6182	7448	8730	9990	11221	12452	7260	8310	9340	1		
Drop	1061	1190	1310	1616	1913	2492	3090	3956	5365	6775	8185	9585	10990	12390	13790	1128	1292	1450	1		
1 1/2 Flow	1635	1873	2068	2548	3023	3958	4882	6241	8490	10740	12990	15240	17490	19740	21990	1296	1482	1666	1 1/2		
Drop	657	734	811	1000	1185	1555	1915	2448	3330	4190	5045	5938	6796	7617	8438	6792	7730	8730	1 1/2		
2 Flow	2281	2551	2816	3471	4113	5388	6580	8500	1137	1437	1736	2035	2334	2633	2932	1785	2043	2295	2		
Drop	505	566	624	770	910	1194	1472	1883	2364	2822	3289	3755	4222	4689	5156	4150	4760	5370	2		
2 1/2 Flow	3760	4208	4641	5721	6782	8880	10960	14020	19060	24100	29140	34180	39220	44260	49300	2983	3413	3843	2 1/2		
Drop	334	376	412	509	602	788	976	1243	1690	2160	2662	3164	3666	4168	4670	3828	4430	5030	2 1/2		
3 Flow	5365	6000	6621	8165	9680	12688	15644	20000	27200	34200	41400	48600	55800	63000	70200	4280	4895	5500	3		
Drop	250	280	309	382	452	592	731	933	1270	1596	1926	2260	2595	2930	3265	2670	3065	3460	3		
4 Flow	8380	9280	10222	12600	14935	19575	24135	30855	42000	52880	63760	74640	85520	96400	107280	6670	7635	8585	4		
Drop	177	199	220	272	322	421	520	664	905	1138	1370	1610	1840	2063	2286	1861	2138	2415	4		
5 Flow	1426	1596	1761	2170	2573	3370	4158	5315	7235	9100	10980	12860	14740	16620	18500	1150	1318	1485	5		
Drop	118	133	146	181	214	279	345	441	580	725	868	1011	1154	1297	1440	1187	1363	1539	5		
6 Flow	2085	2366	2647	3258	3869	5040	6210	7980	10790	13600	16410	19220	22030	24840	27650	1683	1945	2207	6		
Drop	186	214	242	298	354	459	564	729	944	1159	1374	1589	1804	2019	2234	1863	2153	2443	6		
8 Flow	3236	3622	3995	4925	5838	7648	9458	12400	16420	20440	24460	28480	32500	36520	40540	2465	2820	3175	8		
Drop	266	304	342	424	506	666	826	1086	1346	1606	1866	2126	2386	2646	2906	2406	2766	3126	8		
10 Flow	5045	5650	6255	7715	9175	12000	14825	19650	26475	33300	40125	46950	53775	60600	67425	4140	4755	5370	10		
Drop	434	495	556	692	828	1088	1348	1808	2268	2728	3188	3648	4108	4568	5028	4140	4755	5370	10		
12 Flow	1286	1438	1588	1957	2320	3039	3746	4793	6320	8215	9890	11590	13270	14950	16630	1095	1253	1407	12		
Drop	1027	1171	1315	1620	1925	2530	3135	4090	5320	6550	7780	9010	10240	11470	12700	1027	1171	1315	12		

FLOW OF STEAM IN POUNDS PER MINUTE THROUGH STANDARD AND EXTRA STRONG PIPES AND PRESSURE DROP OF STEAM
IN POUNDS THROUGH 100 FEET STANDARD AND EXTRA STRONG PIPES

VELOCITY, 6000 FT. PER MINUTE

TABLES FURNISHED BY CRANE CO.

GAUGE PRESSURE IN POUNDS PER SQUARE INCH

Sizes	STANDARD PIPE														EXTRA STRONG PIPE		
	1	3	5	10	15	25	35	50	75	100	125	150	175	200	150	175	200 Sizes
1/2 Flow	426	476	526	648	768	1,006	1,241	1,587	2,159	2,718	3,275	3,838	4,392	4,935	2,954	3,380	3,798 1/2
Drop	4,290	4,840	5,393	6,545	7,745	11,26	12,55	16,00	21,77	27,58	33,00	38,75	44,58	49,72	49,25	56,40	63,30
3/4 Flow	746	835	922	1,136	1,347	1,764	2,176	2,783	3,783	4,765	5,741	6,730	7,700	8,651	5,470	6,255	7,030 3/4
Drop	2,520	2,822	3,135	3,838	4,545	5,950	7,340	9,380	12,75	16,38	19,35	22,75	26,03	29,40	28,08	32,03	36,14
1 Flow	1,210	1,354	1,494	1,842	2,182	2,859	3,527	4,510	6,138	7,778	9,310	10,91	12,48	14,03	9,080	10,38	11,67 1
Drop	1,660	1,858	2,048	2,530	2,993	3,920	4,840	6,182	8,420	10,60	12,93	14,98	17,16	19,27	17,64	20,20	22,66
1 1/4 Flow	2,093	2,342	2,586	3,185	3,778	4,943	6,100	7,608	10,61	13,37	16,11	18,88	21,61	24,28	16,20	18,54	20,82 1 1/4
Drop	1,026	1,148	1,268	1,564	1,850	2,428	2,990	3,833	5,190	6,545	7,890	9,27	10,62	11,90	10,62	12,15	13,64
1 1/2 Flow	2,852	3,190	3,520	4,340	5,144	6,738	8,315	10,63	14,47	18,21	21,95	25,72	29,42	33,04	8,040	9,210	10,33
Drop	790	885	976	1,204	1,428	1,865	2,304	2,942	4,013	5,045	6,080	7,130	8,160	9,160	37,30	42,70	47,95 2
2 Flow	4,698	5,255	5,800	7,148	8,48	11,10	13,69	17,52	23,83	30,00	36,14	42,37	48,44	54,42	5,230	5,998	6,720
Drop	522	587	644	795	945	1,232	1,520	1,918	2,645	3,330	4,010	4,705	5,395	6,035	53,50	61,22	68,72 2 1/2
2 1/2 Flow	6,708	7,500	8,290	10,21	12,10	15,86	19,55	25,00	34,00	42,83	51,60	60,45	69,18	77,75	3,800	4,460	4,985
Drop	301	338	383	476	567	706	877	1,142	1,458	1,883	2,497	3,010	3,533	4,040	83,40	95,45	107,2 3
3 Flow	10,36	11,58	12,78	15,75	18,67	24,47	30,18	38,60	52,48	66,10	79,65	93,50	106,8	120,0	2,743	3,180	3,522
Drop	277	312	345	425	503	658	815	1,040	1,430	1,778	2,143	2,515	2,886	3,260	145,2	166,2	186,6 4
4 Flow	17,83	19,94	22,02	27,13	32,15	42,13	51,95	66,45	90,40	113,8	137,2	160,6	184,0	206,7	1,820	2,062	2,275
Drop	185	207	228	284	333	437	539	691	940	1,180	1,423	1,668	1,910	2,140	229,6	263,0	295,4 5
5 Flow	28	31,33	34,38	42,60	50,32	66,21	81,65	104,3	142,0	178,8	215,5	252,5	289,0	324,6	1,287	1,476	1,657
Drop	132	149	165	210	240	315	389	497	676	852	1,035	1,203	1,380	1,545	338,9	376,5	425,0 6
6 Flow	40,42	45,23	49,93	61,55	73,00	95,70	117,9	150,7	205,2	258,3	311,2	364,7	417,5	468,7	1,000	1,145	1,283
Drop	103	116	128	158	187	245	302	384	525	660	794	931	1,068	1,196	576,8	659,8	741,8 8
8 Flow	71,61	80,20	88,40	108,9	129,2	169,3	208,7	267,0	363,2	457,5	551,3	645,8	739,0	831,0	686	784	880
Drop	271	309	347	427	507	667	827	1,087	1,447	1,807	2,167	2,527	2,887	3,247	943,0	1,078	1,212, 10
10 Flow	113,1	126,4	139,5	171,8	203,8	267,0	329,4	421,0	573,0	721,8	869,0	1,019	1,166	1,310	498	570	637
Drop	253	299	345	425	505	665	825	1,085	1,445	1,805	2,165	2,525	2,885	3,245	1,368	1,567	1,762 12
12 Flow	160,7	179,8	198,5	244,6	290,0	380,0	485,5	599,0	815,5	1,027	1,237	1,449	1,658	1,863	593	681	768
Drop	342	398	454	554	654	854	1,054	1,254	1,654	2,054	2,454	2,854	3,254	3,654	1,490	1,720	1,950

Buffalo Steam Pump Co.

Buffalo, N. Y.

BRANCH OFFICES

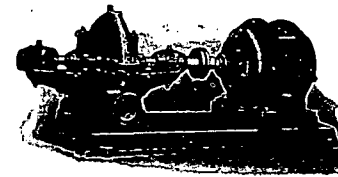
NEW YORK, N. Y., 39-41 Cortland St.
PHILADELPHIA, PA., 1301 Land Title Bldg.
BOSTON, MASS., 177 State St.
CLEVELAND, O., 368 Rockefeller Bldg.
PITTSBURGH, PA., 917 Union Trust Bldg.
DETROIT, MICH., Coon-DeVisser Co.
CHICAGO, ILL., 562 W. Washington Blvd.
WASHINGTON, D. C., Washington Loan & Trust Bldg.
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., 218 Pine St.
PORTLAND, ORE., 816-817 Lewis Bldg.

CANADIAN BLOWER AND FORGE CO., Kitchener, Ont.

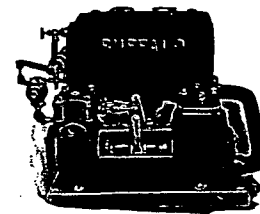
Products

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.



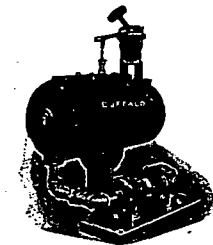
Class S Double Suction Centrifugal Pump

Horizontally divided casing. Extensively used with air washers, and for circulating systems and booster service.



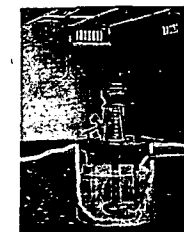
Duplex Steam Pump and Receiver

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

The Goulds Manufacturing Company

PUMP MAKERS SINCE 1848

BRANCHES

Atlanta Boston
New York Philadelphia

MAIN OFFICE AND WORKS

SENECA FALLS
New York

BRANCHES

Chicago Pittsburgh
Houston Washington, D. C.

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. 109. Portable Mine Pumps.

- No. 110. Single Stage, Double Suction Centrifugal Pumps.
No. 111. Centrifugal Pump Pumps.

- No. 112. Handic 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.

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 efficiencies.

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 ad-

justed by screw bolts.

CASING WEARING RINGS.

Casing is equipped with bronze wear-

ing rings, which can be renewed as re-

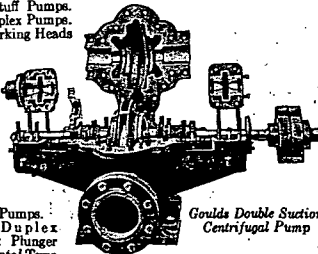
quired, thus keeping the clearances to

a minimum.

IMPELLER WEARING RINGS.

Wearing rings on bronze impellers

can be furnished as an extra.



Goulds Double Suction Centrifugal Pump

GOULDS CENTRIFUGAL PUMPS

CENTRIFUGAL PUMP DATA SHEET

Data Required for Customers

The conditions under which pumping units operate vary considerably. In order to make it possible to select the most efficient pump for a given service, the purchaser should give the following information in detail. It is requested that the purchaser also indicate the type of service to be performed, and the nature of the liquid to be pumped. It is requested that the purchaser also indicate the type of service to be performed, and the nature of the liquid to be pumped.

1. Name of Pump required. 2. Capacity, Gals. per Min. 3. Head, Feet. 4. Speed, Rev. per Min. 5. Type of Service. 6. Nature of Liquid. 7. Temperature of Liquid. 8. Viscosity of Liquid. 9. Specific Gravity of Liquid. 10. Other Data.

11. Name of Pump required. 12. Capacity, Gals. per Min. 13. Head, Feet. 14. Speed, Rev. per Min. 15. Type of Service. 16. Nature of Liquid. 17. Temperature of Liquid. 18. Viscosity of Liquid. 19. Specific Gravity of Liquid. 20. Other Data.

21. Name of Pump required. 22. Capacity, Gals. per Min. 23. Head, Feet. 24. Speed, Rev. per Min. 25. Type of Service. 26. Nature of Liquid. 27. Temperature of Liquid. 28. Viscosity of Liquid. 29. Specific Gravity of Liquid. 30. Other Data.

31. Name of Pump required. 32. Capacity, Gals. per Min. 33. Head, Feet. 34. Speed, Rev. per Min. 35. Type of Service. 36. Nature of Liquid. 37. Temperature of Liquid. 38. Viscosity of Liquid. 39. Specific Gravity of Liquid. 40. Other Data.

41. Name of Pump required. 42. Capacity, Gals. per Min. 43. Head, Feet. 44. Speed, Rev. per Min. 45. Type of Service. 46. Nature of Liquid. 47. Temperature of Liquid. 48. Viscosity of Liquid. 49. Specific Gravity of Liquid. 50. Other Data.

51. Name of Pump required. 52. Capacity, Gals. per Min. 53. Head, Feet. 54. Speed, Rev. per Min. 55. Type of Service. 56. Nature of Liquid. 57. Temperature of Liquid. 58. Viscosity of Liquid. 59. Specific Gravity of Liquid. 60. Other Data.

61. Name of Pump required. 62. Capacity, Gals. per Min. 63. Head, Feet. 64. Speed, Rev. per Min. 65. Type of Service. 66. Nature of Liquid. 67. Temperature of Liquid. 68. Viscosity of Liquid. 69. Specific Gravity of Liquid. 70. Other Data.

71. Name of Pump required. 72. Capacity, Gals. per Min. 73. Head, Feet. 74. Speed, Rev. per Min. 75. Type of Service. 76. Nature of Liquid. 77. Temperature of Liquid. 78. Viscosity of Liquid. 79. Specific Gravity of Liquid. 80. Other Data.

81. Name of Pump required. 82. Capacity, Gals. per Min. 83. Head, Feet. 84. Speed, Rev. per Min. 85. Type of Service. 86. Nature of Liquid. 87. Temperature of Liquid. 88. Viscosity of Liquid. 89. Specific Gravity of Liquid. 90. Other Data.

91. Name of Pump required. 92. Capacity, Gals. per Min. 93. Head, Feet. 94. Speed, Rev. per Min. 95. Type of Service. 96. Nature of Liquid. 97. Temperature of Liquid. 98. Viscosity of Liquid. 99. Specific Gravity of Liquid. 100. Other Data.

101. Name of Pump required. 102. Capacity, Gals. per Min. 103. Head, Feet. 104. Speed, Rev. per Min. 105. Type of Service. 106. Nature of Liquid. 107. Temperature of Liquid. 108. Viscosity of Liquid. 109. Specific Gravity of Liquid. 110. Other Data.

111. Name of Pump required. 112. Capacity, Gals. per Min. 113. Head, Feet. 114. Speed, Rev. per Min. 115. Type of Service. 116. Nature of Liquid. 117. Temperature of Liquid. 118. Viscosity of Liquid. 119. Specific Gravity of Liquid. 120. Other Data.

121. Name of Pump required. 122. Capacity, Gals. per Min. 123. Head, Feet. 124. Speed, Rev. per Min. 125. Type of Service. 126. Nature of Liquid. 127. Temperature of Liquid. 128. Viscosity of Liquid. 129. Specific Gravity of Liquid. 130. Other Data.

131. Name of Pump required. 132. Capacity, Gals. per Min. 133. Head, Feet. 134. Speed, Rev. per Min. 135. Type of Service. 136. Nature of Liquid. 137. Temperature of Liquid. 138. Viscosity of Liquid. 139. Specific Gravity of Liquid. 140. Other Data.

141. Name of Pump required. 142. Capacity, Gals. per Min. 143. Head, Feet. 144. Speed, Rev. per Min. 145. Type of Service. 146. Nature of Liquid. 147. Temperature of Liquid. 148. Viscosity of Liquid. 149. Specific Gravity of Liquid. 150. Other Data.

151. Name of Pump required. 152. Capacity, Gals. per Min. 153. Head, Feet. 154. Speed, Rev. per Min. 155. Type of Service. 156. Nature of Liquid. 157. Temperature of Liquid. 158. Viscosity of Liquid. 159. Specific Gravity of Liquid. 160. Other Data.

161. Name of Pump required. 162. Capacity, Gals. per Min. 163. Head, Feet. 164. Speed, Rev. per Min. 165. Type of Service. 166. Nature of Liquid. 167. Temperature of Liquid. 168. Viscosity of Liquid. 169. Specific Gravity of Liquid. 170. Other Data.

171. Name of Pump required. 172. Capacity, Gals. per Min. 173. Head, Feet. 174. Speed, Rev. per Min. 175. Type of Service. 176. Nature of Liquid. 177. Temperature of Liquid. 178. Viscosity of Liquid. 179. Specific Gravity of Liquid. 180. Other Data.

181. Name of Pump required. 182. Capacity, Gals. per Min. 183. Head, Feet. 184. Speed, Rev. per Min. 185. Type of Service. 186. Nature of Liquid. 187. Temperature of Liquid. 188. Viscosity of Liquid. 189. Specific Gravity of Liquid. 190. Other Data.

191. Name of Pump required. 192. Capacity, Gals. per Min. 193. Head, Feet. 194. Speed, Rev. per Min. 195. Type of Service. 196. Nature of Liquid. 197. Temperature of Liquid. 198. Viscosity of Liquid. 199. Specific Gravity of Liquid. 200. Other Data.

201. Name of Pump required. 202. Capacity, Gals. per Min. 203. Head, Feet. 204. Speed, Rev. per Min. 205. Type of Service. 206. Nature of Liquid. 207. Temperature of Liquid. 208. Viscosity of Liquid. 209. Specific Gravity of Liquid. 210. Other Data.

211. Name of Pump required. 212. Capacity, Gals. per Min. 213. Head, Feet. 214. Speed, Rev. per Min. 215. Type of Service. 216. Nature of Liquid. 217. Temperature of Liquid. 218. Viscosity of Liquid. 219. Specific Gravity of Liquid. 220. Other Data.

221. Name of Pump required. 222. Capacity, Gals. per Min. 223. Head, Feet. 224. Speed, Rev. per Min. 225. Type of Service. 226. Nature of Liquid. 227. Temperature of Liquid. 228. Viscosity of Liquid. 229. Specific Gravity of Liquid. 230. Other Data.

231. Name of Pump required. 232. Capacity, Gals. per Min. 233. Head, Feet. 234. Speed, Rev. per Min. 235. Type of Service. 236. Nature of Liquid. 237. Temperature of Liquid. 238. Viscosity of Liquid. 239. Specific Gravity of Liquid. 240. Other Data.

241. Name of Pump required. 242. Capacity, Gals. per Min. 243. Head, Feet. 244. Speed, Rev. per Min. 245. Type of Service. 246. Nature of Liquid. 247. Temperature of Liquid. 248. Viscosity of Liquid. 249. Specific Gravity of Liquid. 250. Other Data.

251. Name of Pump required. 252. Capacity, Gals. per Min. 253. Head, Feet. 254. Speed, Rev. per Min. 255. Type of Service. 256. Nature of Liquid. 257. Temperature of Liquid. 258. Viscosity of Liquid. 259. Specific Gravity of Liquid. 260. Other Data.

261. Name of Pump required. 262. Capacity, Gals. per Min. 263. Head, Feet. 264. Speed, Rev. per Min. 265. Type of Service. 266. Nature of Liquid. 267. Temperature of Liquid. 268. Viscosity of Liquid. 269. Specific Gravity of Liquid. 270. Other Data.

271. Name of Pump required. 272. Capacity, Gals. per Min. 273. Head, Feet. 274. Speed, Rev. per Min. 275. Type of Service. 276. Nature of Liquid. 277. Temperature of Liquid. 278. Viscosity of Liquid. 279. Specific Gravity of Liquid. 280. Other Data.

281. Name of Pump required. 282. Capacity, Gals. per Min. 283. Head, Feet. 284. Speed, Rev. per Min. 285. Type of Service. 286. Nature of Liquid. 287. Temperature of Liquid. 288. Viscosity of Liquid. 289. Specific Gravity of Liquid. 290. Other Data.

291. Name of Pump required. 292. Capacity, Gals. per Min. 293. Head, Feet. 294. Speed, Rev. per Min. 295. Type of Service. 296. Nature of Liquid. 297. Temperature of Liquid. 298. Viscosity of Liquid. 299. Specific Gravity of Liquid. 300. Other Data.

301. Name of Pump required. 302. Capacity, Gals. per Min. 303. Head, Feet. 304. Speed, Rev. per Min. 305. Type of Service. 306. Nature of Liquid. 307. Temperature of Liquid. 308. Viscosity of Liquid. 309. Specific Gravity of Liquid. 310. Other Data.

311. Name of Pump required. 312. Capacity, Gals. per Min. 313. Head, Feet. 314. Speed, Rev. per Min. 315. Type of Service. 316. Nature of Liquid. 317. Temperature of Liquid. 318. Viscosity of Liquid. 319. Specific Gravity of Liquid. 320. Other Data.

321. Name of Pump required. 322. Capacity, Gals. per Min. 323. Head, Feet. 324. Speed, Rev. per Min. 325. Type of Service. 326. Nature of Liquid. 327. Temperature of Liquid. 328. Viscosity of Liquid. 329. Specific Gravity of Liquid. 330. Other Data.

331. Name of Pump required. 332. Capacity, Gals. per Min. 333. Head, Feet. 334. Speed, Rev. per Min. 335. Type of Service. 336. Nature of Liquid. 337. Temperature of Liquid. 338. Viscosity of Liquid. 339. Specific Gravity of Liquid. 340. Other Data.

341. Name of Pump required. 342. Capacity, Gals. per Min. 343. Head, Feet. 344. Speed, Rev. per Min. 345. Type of Service. 346. Nature of Liquid. 347. Temperature of Liquid. 348. Viscosity of Liquid. 349. Specific Gravity of Liquid. 350. Other Data.

351. Name of Pump required. 352. Capacity, Gals. per Min. 353. Head, Feet. 354. Speed, Rev. per Min. 355. Type of Service. 356. Nature of Liquid. 357. Temperature of Liquid. 358. Viscosity of Liquid. 359. Specific Gravity of Liquid. 360. Other Data.

361. Name of Pump required. 362. Capacity, Gals. per Min. 363. Head, Feet. 364. Speed, Rev. per Min. 365. Type of Service. 366. Nature of Liquid. 367. Temperature of Liquid. 368. Viscosity of Liquid. 369. Specific Gravity of Liquid. 370. Other Data.

371. Name of Pump required. 372. Capacity, Gals. per Min. 373. Head, Feet. 374. Speed, Rev. per Min. 375. Type of Service. 376. Nature of Liquid. 377. Temperature of Liquid. 378. Viscosity of Liquid. 379. Specific Gravity of Liquid. 380. Other Data.

381. Name of Pump required. 382. Capacity, Gals. per Min. 383. Head, Feet. 384. Speed, Rev. per Min. 385. Type of Service. 386. Nature of Liquid. 387. Temperature of Liquid. 388. Viscosity of Liquid. 389. Specific Gravity of Liquid. 390. Other Data.

391. Name of Pump required. 392. Capacity, Gals. per Min. 393. Head, Feet. 394. Speed, Rev. per Min. 395. Type of Service. 396. Nature of Liquid. 397. Temperature of Liquid. 398. Viscosity of Liquid. 399. Specific Gravity of Liquid. 400. Other Data.

401. Name of Pump required. 402. Capacity, Gals. per Min. 403. Head, Feet. 404. Speed, Rev. per Min. 405. Type of Service. 406. Nature of Liquid. 407. Temperature of Liquid. 408. Viscosity of Liquid. 409. Specific Gravity of Liquid. 410. Other Data.

411. Name of Pump required. 412. Capacity, Gals. per Min. 413. Head, Feet. 414. Speed, Rev. per Min. 415. Type of Service. 416. Nature of Liquid. 417. Temperature of Liquid. 418. Viscosity of Liquid. 419. Specific Gravity of Liquid. 420. Other Data.

421. Name of Pump required. 422. Capacity, Gals. per Min. 423. Head, Feet. 424. Speed, Rev. per Min. 425. Type of Service. 426. Nature of Liquid. 427. Temperature of Liquid. 428. Viscosity of Liquid. 429. Specific Gravity of Liquid. 430. Other Data.

431. Name of Pump required. 432. Capacity, Gals. per Min. 433. Head, Feet. 434. Speed, Rev. per Min. 435. Type of Service. 436. Nature of Liquid. 437. Temperature of Liquid. 438. Viscosity of Liquid. 439. Specific Gravity of Liquid. 440. Other Data.

441. Name of Pump required. 442. Capacity, Gals. per Min. 443. Head, Feet. 444. Speed, Rev. per Min. 445. Type of Service. 446. Nature of Liquid. 447. Temperature of Liquid. 448. Viscosity of Liquid. 449. Specific Gravity of Liquid. 450. Other Data.

451. Name of Pump required. 452. Capacity, Gals. per Min. 453. Head, Feet. 454. Speed, Rev. per Min. 455. Type of Service. 456. Nature of Liquid. 457. Temperature of Liquid. 458. Viscosity of Liquid. 459. Specific Gravity of Liquid. 460. Other Data.

461. Name of Pump required. 462. Capacity, Gals. per Min. 463. Head, Feet. 464. Speed, Rev. per Min. 465. Type of Service. 466. Nature of Liquid. 467. Temperature of Liquid. 468. Viscosity of Liquid. 469. Specific Gravity of Liquid. 470. Other Data.

471. Name of Pump required. 472. Capacity, Gals. per Min. 473. Head, Feet. 474. Speed, Rev. per Min. 475. Type of Service. 476. Nature of Liquid. 477. Temperature of Liquid. 478. Viscosity of Liquid. 479. Specific Gravity of Liquid. 480. Other Data.

481. Name of Pump required. 482. Capacity, Gals. per Min. 483. Head, Feet. 484. Speed, Rev. per Min. 485. Type of Service. 486. Nature of Liquid. 487. Temperature of Liquid. 488. Viscosity of Liquid. 489. Specific Gravity of Liquid. 490. Other Data.

491. Name of Pump required. 492. Capacity, Gals. per Min. 493. Head, Feet. 494. Speed, Rev. per Min. 495. Type of Service. 496. Nature of Liquid. 497. Temperature of Liquid. 498. Viscosity of Liquid. 499. Specific Gravity of Liquid. 500. Other Data.

501. Name of Pump required. 502. Capacity, Gals. per Min. 503. Head, Feet. 504. Speed, Rev. per Min. 505. Type of Service. 506. Nature of Liquid. 507. Temperature of Liquid. 508. Viscosity of Liquid. 509. Specific Gravity of Liquid. 510. Other Data.

511. Name of Pump required. 512. Capacity, Gals. per Min. 513. Head, Feet. 514. Speed, Rev. per Min. 515. Type of Service. 516. Nature of Liquid. 517. Temperature of Liquid. 518. Viscosity of Liquid. 519. Specific Gravity of Liquid. 520. Other Data.

521. Name of Pump required. 522. Capacity, Gals. per Min. 523. Head, Feet. 524. Speed, Rev. per Min. 525. Type of Service. 526. Nature of Liquid. 527. Temperature of Liquid. 528. Viscosity of Liquid. 529. Specific Gravity of Liquid. 530. Other Data.

531. Name of Pump required. 532. Capacity, Gals. per Min. 533. Head, Feet. 534. Speed, Rev. per Min. 535. Type of Service. 536. Nature of Liquid. 537. Temperature of Liquid. 538. Viscosity of Liquid. 539. Specific Gravity of Liquid. 540. Other Data.

541. Name of Pump required. 542. Capacity, Gals. per Min. 543. Head, Feet. 544. Speed, Rev. per Min. 545. Type of Service. 546. Nature of Liquid. 547. Temperature of Liquid. 548. Viscosity of Liquid. 549. Specific Gravity of Liquid. 550. Other Data.

551. Name of Pump required. 552. Capacity, Gals. per Min. 553. Head, Feet. 554. Speed, Rev. per Min. 555. Type of Service. 556. Nature of Liquid. 557. Temperature of Liquid. 558. Viscosity of Liquid. 559. Specific Gravity of Liquid. 560. Other Data.

561. Name of Pump required. 562. Capacity, Gals. per Min. 563. Head, Feet. 564. Speed, Rev. per Min. 565. Type of Service. 566. Nature of Liquid. 567. Temperature of Liquid. 568. Viscosity of Liquid. 569. Specific Gravity of Liquid. 570. Other Data.

571. Name of Pump required. 572. Capacity, Gals. per Min. 573. Head, Feet. 574. Speed, Rev. per Min. 575. Type of Service. 576. Nature of Liquid. 577. Temperature of Liquid. 578. Viscosity of Liquid. 579. Specific Gravity of Liquid. 580. Other Data.

581. Name of Pump required. 582. Capacity, Gals. per Min. 583. Head, Feet. 584. Speed, Rev. per Min. 585. Type of Service. 586. Nature of Liquid. 587. Temperature of Liquid. 588. Viscosity of Liquid. 589. Specific Gravity of Liquid. 590. Other Data.

591. Name of Pump required. 592. Capacity, Gals. per Min. 593. Head, Feet. 594. Speed, Rev. per Min. 595. Type of Service. 596. Nature of Liquid. 597. Temperature of Liquid. 598. Viscosity of Liquid. 599. Specific Gravity of Liquid. 600. Other Data.

601. Name of Pump required. 602. Capacity, Gals. per Min. 603. Head, Feet. 604. Speed, Rev. per Min. 605. Type of Service. 606. Nature of Liquid. 607. Temperature of Liquid. 608. Viscosity of Liquid. 609. Specific Gravity of Liquid. 610. Other Data.

611. Name of Pump required. 612. Capacity, Gals. per Min. 613. Head, Feet. 614. Speed, Rev. per Min. 615. Type of Service. 616. Nature of Liquid. 617. Temperature of Liquid. 618. Viscosity of Liquid. 619. Specific Gravity of Liquid. 620. Other Data.

621. Name of Pump required. 622. Capacity, Gals. per Min. 623. Head, Feet. 624. Speed, Rev. per Min. 625. Type of Service. 626. Nature of Liquid. 627. Temperature of Liquid. 628. Viscosity of Liquid. 629. Specific Gravity of Liquid. 630. Other Data.

631. Name of Pump required. 632. Capacity, Gals. per Min. 633. Head, Feet. 634. Speed, Rev. per Min. 635. Type of Service. 636. Nature of Liquid. 637. Temperature of Liquid. 638. Viscosity of Liquid. 639. Specific Gravity of Liquid. 640. Other Data.

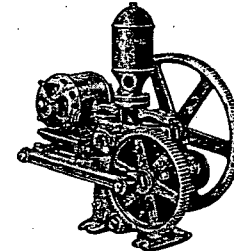
641. Name of Pump required. 642. Capacity, Gals. per Min. 643. Head, Feet. 644. Speed, Rev. per Min. 645. Type of Service. 646. Nature of Liquid. 647. Temperature of Liquid. 648. Viscosity of Liquid. 649. Specific Gravity of Liquid. 650. Other Data.

†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

Pumps

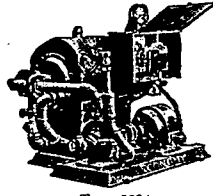
Economy Pumping Machinery Co.

98-124 N. Curtis St., CHICAGO

Works, JOLIET, ILL.

NEW YORK BALTIMORE DETROIT ST. LOUIS SALT LAKE CITY SAN FRANCISCO
PHILADELPHIA PITTSBURGH CINCINNATI NEW ORLEANS PORTLAND LOS ANGELES
BOSTON CLEVELAND ATLANTA DENVER SEATTLE MINNEAPOLIS

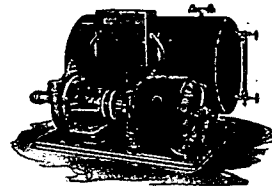
AUTOMATIC CENTRIFUGAL VACUUM AND BOILER FEED PUMPS Standard-Boiler Pressure 20 lb.



Type 2234
Made for Boiler Pressures
up to 100 lb.

Unit No.	Capacity Sq. Ft. Dir. Rad.	Motor Horse- Power	Cubic Feet Air per Min.	Return Connection Inches	Shipping Weight Pounds
C. V. 1	2,500	3/4	1 1/4	1 1/2	650
C. V. 2	5,000	1	4	2	750
C. V. 3	8,000	1 1/2	6	2 1/2	900
C. V. 4	16,000	2	10	3	1,025
C. V. 5	20,000	3	15	3	1,150
C. V. 6	27,500	5	19	3 1/2	1,300
C. V. 7	40,000	5	24	4	1,550
C. V. 8	65,000	7 1/2	40	5	1,800
C. V. 9	100,000	10	60	6	3,100
C. V. 10	150,000	15	90	6	4,000

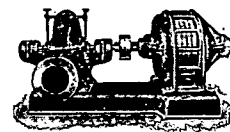
AUTOMATIC CONDENSATION PUMP AND RECEIVERS



Type 2178
Made for Boiler Pressures up to
125 lb.

No. of Unit	Capacity Sq. Ft. C. I. Direct Radiation	Motor Horse Power	Boiler Pres- sure Lbs.	Cap- acity Re- ceiver Gals.	Con- densation Gals. per Min. at 25 lb. per Sq. Ft.	Pump Cap- acity Gals. per Min.	Approx. Shipping Weight Lbs.
5	1,000	1/6	10	11	1 1/2	5	300
6	2,000	1/4	10	13	1 7/8	7 1/2	350
6 1/2	3,500	1/2	10	16	1 3/4	12	400
7	5,000	1/2	10	20	2 1/2	15	450
7 1/2	7,500	3/4	15	25	3 1/4	20	500
8	10,000	1	15	33	5	25	600
8 1/2	15,000	1 1/2	15	41	7 1/2	37	700
9	25,000	2	15	49	12 1/2	60	850
9 1/2	35,000	3	15	57	17 1/2	80	1,000
10	50,000	5	15	82	25	110	1,200

HORIZONTAL DOUBLE SECTION SINGLE STAGE PUMPS



Type 2235
Multi-Stage Pump for any
Pressure up to 230 lb.

Size Discharge Inches	Range of Capacity G.P.M.	Type H Maximum Head in Ft. 1750 R.P.M.	Type M Maximum Head in Ft. 1750 R.P.M.	Type S.M. Maximum Head in Ft. 1750 R.P.M.	Motor H.P. Depending Upon Head
1 1/2	20-40	...	...	70	1-2
1 1/2	40-90	...	...	70	1-3
2	50-75	...	...	100	1-5
2	75-175	...	...	90	2-7 1/2
2 1/2	75-125	160	110	110	7 1/2-15
2 1/2	125-250	220	130	130	10-35
3	250-400	220	140	140	15-40
3	400-700	250	140	...	15-75
5	600-900	275	150	...	15-100
6	800-1200	300	180	...	15-150
8	1000-2500	380	220	...	15-200
10	2000-3000	380	220	...	20-400

CAPACITIES, SPEEDS AND POWER BILGE PUMPS AND SEWAGE EJECTORS Made in Single or Duplex Form (Any Capacity for any Head)



Type 2104

Head in Feet	Capacity in Gals. per Min.	35-40	40-50	50-75	85-100	115-125	150-175
Size	1 1/2" S.	1 1/2" S.	2" S.	2" S.	2 1/2" S.	2 1/2" S.	3" S.
Speed	1750	1750	1750	1750	1750	1750	1750
H.P.	3/4	1	1 1/2	1 1/2	2	1 1/2	3
Capacity in Gals. Min.	200-250	300-350	400-500	600-700	800-1000		
Size	4" L.S.	4" L.S.	5" L.S.	5" L.S.	6" S.	6" S.	8" S.
Speed	1750	1150	850	1150	850	1150	850
H.P.	3	3	5	5	5	7 1/2	10

Pumps

The Nash Engineering Company

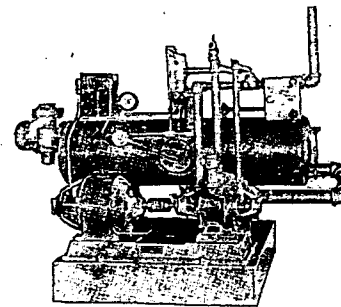
South Norwalk, Conn., U. S. A.

INDIANAPOLIS—821 Hume-Mansur Bldg.
KANSAS CITY—208 Mutual Bldg.
LOS ANGELES—1824 S. Hope St.
MINNEAPOLIS—501 S. Sixth Street
MONTREAL—84 Inspector Street
NEW ORLEANS—521 Baronne Street
NEW YORK—350 Madison Ave.
PHILADELPHIA—254 South 15th Street
PORTLAND—224 Pine Street
BOSTON—Nottingham Bldg., Copely Square
BUFFALO—840 Ellicott Square
CHICAGO—1220 Monadnock Block

SALES
OFFICES

CLEVELAND—1392 West 3rd Street
DALLAS—1020 Dallas County Bank Bldg.
DENVER—518 Boston Bldg.
DETROIT—Kerr Building
HOUSTON—Southern Pacific Bldg.
PITTSBURGH—Oliver Bldg.
SALT LAKE CITY—204 Dooley Bldg.
SAN FRANCISCO—Sharon Bldg.
SEATTLE—220 Railway Exchange
ST. LOUIS—4200 Forest Park Blvd.
TOLEDO—136 Huron Street
TORONTO—1001 Kent Bldg.

WASHINGTON—710 14th Street, N. W.



Jennings HYTOR Vacuum Pumps for Return Line Heating Systems. remove air and water and automatically return water to boiler or hot well. Pump consists of two independent units—a Hytor turbine air pump and a Jennings centrifugal water pump—combined in one casing. Air and water are pumped separately, thus saving in horsepower is over 50 per cent and cost of current is reduced proportionately.

Requires one-third the space necessary for other apparatus. Interior parts bronze. Moving parts revolve without contact, supported on annular ball bearings mounted outside casing.

Furnished direct connected to standard electric motors or for belt drive, also with steam turbine designed to operate at steam pressure of 75 lb., but this can be varied. Turbine units are designed to discharge condensate against boiler pressure not exceeding 20 lb.

Jennings Unit Type Condensation Pump and Receiver

This new Unit Type Condensation Pump and Receiver is essentially the same design as our well known Type M Jennings Return Line Vacuum Heating pump. The cut above shows the appearance of the 5,000 sq. ft. unit. You will note that no piping between pump and receiving tank is necessary. The only connections are main return, water discharge and air vent. Companion flanges are furnished, making the installation of this pump extremely simple and economical. The pump is equipped with an integral cast-bronze shaft mounted on motor shaft and supported by large motor bearings.

The automatic control in this unit is enclosed in its metal cabinet and includes overload and phase failure protection for polyphase current. The wiring between motor and float switches is done in our shop. The automatic control is operated by a 6 in. seamless drawn copper ball on a 14 in. stem, giving ample power. Standard units are furnished in this design for any capacity up to 16,000 sq. ft. and can be supplied for 10 or 20 lb. gage pressure at the pump.

Special bulletins are available describing this and our other products.

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	3/4
A	8,000	6	11	.9	1800	1
B	16,000	11	22	1.4	1800	1 1/2
C	26,000	19	35	2.0	1800	2
D	40,000	25	60	2.8	1200	3
E	65,000	42	90	3.9	1200	5
F	100,000	75	140	9	1200	10
G	150,000	90	200	10	900	10
H	250,000	180	400	19.	720	20

Skidmore Corporation

General Offices and Factory

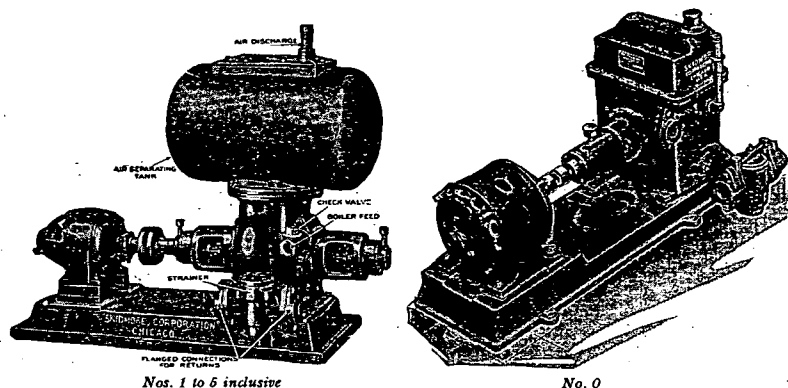
1535 Dayton Street

:-:

:-:

CHICAGO, U. S. A.

Set them as they come, connect returns, wire motor and run.



Nos. 1 to 5 inclusive

No. 0

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 50 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	5000	8	3/4	1	1 1/2	1	18" x 44"	580
1	8000	11	1	1 1/2	2	1 1/4	22" x 50"	650
2	16000	22	1 1/2	2	2	1 1/4	24" x 52"	700
3	26000	35	2	3	3	1 1/4	24" x 56"	750
4	40000	60	3	5	3	1 1/2	24" x 58"	850
5	65000	90	5	7 1/2	3	2	30" x 62"	1025

R. P. M. 1800 for all sizes.

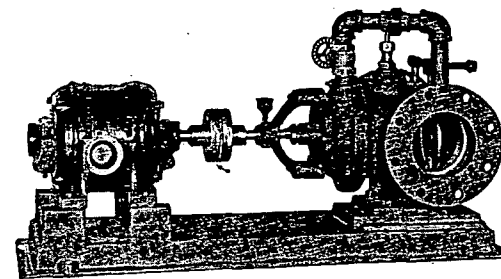
Above weights are for continuous service, add 75 lb. for automatic control.

Taylor Machine Works

85 S. Monroe St.

Battle Creek, Mich.

Manufacturers of Taylor Pumps and Patented Fuel Saving Devices



6" Direct Connected to Motor, Right Hand Type

Taylor Centrifugal Circulating Pumps can be used either in the flow or the return line of any hot water heating system. The pressure from the pump discharge increases the flow of water and when the by-pass valve is closed all the water flows in one direction. Each pump has a suction and discharge valve and by closing these valves it is possible to repack the stuffing box, or take out the impeller and shaft, without drawing the water from the system.

The impeller is made of hard brass with steel or bronze shaft if specified, and with

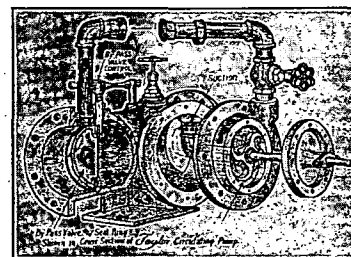
brass gland stuffing box. The main casting is of gray iron, but can be furnished brass-lined if desired.

Made for right or left hand discharge and for belt or motor drive. For economical operation, speeds listed here will give best results. Larger capacities can be furnished when so required.

Price List and Data Taylor Centrifugal Circulating Pumps For Direct Motor Drive

Pipe Size In Inches	Approx. Gals. per Min.	Speed R. P. M.	Power Required	List Price Without Motor
1 1/4 or 1 1/2	15	1750	1/4 H. P.	\$ 95.50
2	20	1750	3/8 H. P.	102.50
2 1/2	25	1750	1/2 H. P.	109.00
3	35	1750	3/4 H. P.	124.00
4 or 4 1/2	45	1750	1 H. P.	137.50
5	65	1750	1 1/4 H. P.	152.75
6	95	1150	1 H. P.	179.75
7 or 8	150	1150	1 1/2 H. P.	217.85

Prices for 10 in. or 12 in. on application.



PUMP DIVISION
(See also Vapor-Vacuum Division)

The Trane Company

La Crosse, Wis.

BRANCH OFFICES

NEW YORK	BUFFALO	CHICAGO	MINNEAPOLIS	FT. WAYNE
BOSTON	DETROIT	SEATTLE	SALT LAKE CITY	PORTLAND, ORE.
PHILADELPHIA	CLEVELAND	ALBANY	ATLANTA	GREENSBORO, N. C.

England—22-23 CLERKENWELL CLOSE, LONDON, E. C. 1
Canada—THOMAS ROBERTSON & Co., LTD., 134 CRAIG ST., WEST, MONTREAL
THE GRANT E. COLE CO., 23 RIVER ST., TORONTO

The Trane Systems of Vapor and Vacuum Heating, Patented Heating Specialties Trane Automatic Electric Pumps, For All Purposes

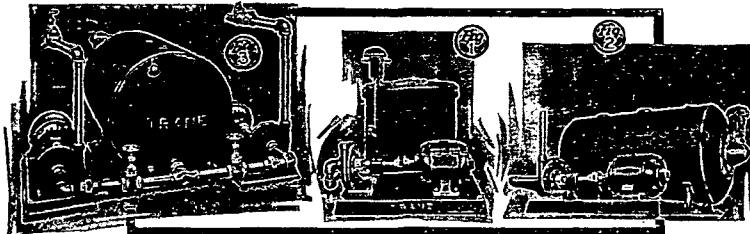


Fig. 1. Duplex Type Condensation Pump Fig. 2. Steel Tank Condensation Pump Fig. 3. Cast Iron Tank Condensation Pump
CONDENSATION PUMPS, SINGLE AND DUPLEX, SIZES, STYLES, AND CAPACITIES
For specifications and other information on these units turn to pages 374 and 375 following

Pump No.	Radiation in Sq. Ft.	Minimum Capacity per Minute	Maximum Pressure at Pump	Motor H. P.	Suggested Size of Piping Inches	Shipping Weight Lb.	Condensation Pump Complete Lb.	Shipping Weight Lb.	Duplex Pump Complete Lb.
410	4,000	6-8	10	1/4	1	325	475	1510	15,000
415	4,000	6-8	15	1/2	1	325	475	1515	15,000
420	4,000	6-8	20	1/2	1	325	475	1520	15,000
430	4,000	6-8	30	1/2	1	325	475	1530	15,000
440	4,000	6-8	40	1/2	1	325	475	1540	15,000
450	4,000	6-8	50	3/4	1	350	525	1550	15,000
460	4,000	6-8	60	3/4	1	350	525	1560	15,000
610	6,000	9-12	10	1/4	1 1/4	450	600	2010	20,000
615	6,000	9-12	15	3/4	1 1/4	450	600	2015	20,000
620	6,000	9-12	20	3/4	1 1/4	450	600	2020	20,000
630	6,000	9-12	30	3/4	1 1/4	500	700	2030	20,000
640	6,000	9-12	40	3/4	1 1/4	500	700	2040	20,000
650	6,000	9-12	50	1	1 1/4	500	700	2050	20,000
660	6,000	9-12	60	1	1 1/4	500	700	2060	20,000
810	8,000	12-16	10	1/2	1 1/4	500	700	2510	25,000
815	8,000	12-16	15	3/4	1 1/4	500	700	2515	25,000
820	8,000	12-16	20	3/4	1 1/4	525	750	2520	25,000
830	8,000	12-16	30	1	1 1/4	550	800	2530	25,000
840	8,000	12-16	40	1 1/2	1 1/4	550	800	2540	25,000
850	8,000	12-16	50	1 1/2	1 1/4	550	800	2550	25,000
860	8,000	12-16	60	1 1/2	1 1/4	550	800	2560	25,000
1010	10,000	15-20	10	1/2	1 1/2	525	750	3010	30,000
1015	10,000	15-20	15	3/4	1 1/2	525	750	3015	30,000
1020	10,000	15-20	20	1	1 1/2	525	750	3020	30,000
1030	10,000	15-20	30	1 1/2	1 1/2	550	800	3030	30,000
1040	10,000	15-20	40	1 1/2	1 1/2	550	800	3040	30,000
1050	10,000	15-20	50	2	1 1/2	575	850	3050	30,000
1060	10,000	15-20	60	2	1 1/2	575	850	3060	30,000
1510	15,000	25-30	10	1/4	2	525	750	30-40	10
1515	15,000	25-30	15	1/2	2	525	750	30-40	15
1520	15,000	25-30	20	1 1/2	2	525	750	30-40	20
1530	15,000	25-30	30	1 1/2	2	550	800	30-40	30
1540	15,000	25-30	40	2	2	575	850	30-40	40
1550	15,000	25-30	50	3	2	600	900	30-40	50
1560	15,000	25-30	60	3	2	600	900	30-40	60
2010	20,000	30-40	10	1/4	2	525	750	30-40	10
2015	20,000	30-40	15	1	2	575	850	30-40	15
2020	20,000	30-40	20	2	2	575	850	30-40	20
2030	20,000	30-40	30	3	2	600	900	30-40	30
2040	20,000	30-40	40	3	2	600	900	30-40	40
2050	20,000	30-40	50	5	2	625	950	30-40	50
2060	20,000	30-40	60	5	2	625	950	30-40	60
2510	25,000	40-50	10	1	2 1/2	550	800	40-50	10
2515	25,000	40-50	15	1 1/2	2 1/2	575	850	40-50	15
2520	25,000	40-50	20	2	2 1/2	575	850	40-50	20
2530	25,000	40-50	30	3	2 1/2	600	900	40-50	30
2540	25,000	40-50	40	3	2 1/2	600	900	40-50	40
2550	25,000	40-50	50	5	2 1/2	625	950	40-50	50
2560	25,000	40-50	60	5	2 1/2	625	950	40-50	60
3010	30,000	50-60	10	1	2 1/2	575	850	50-60	10
3015	30,000	50-60	15	1 1/2	2 1/2	600	900	50-60	15
3020	30,000	50-60	20	2	2 1/2	600	900	50-60	20
3030	30,000	50-60	30	3	2 1/2	625	950	50-60	30
3040	30,000	50-60	40	5	2 1/2	625	950	50-60	40
3050	30,000	50-60	50	5	2 1/2	675	1050	50-60	50
3060	30,000	50-60	60	5	2 1/2	675	1050	50-60	60

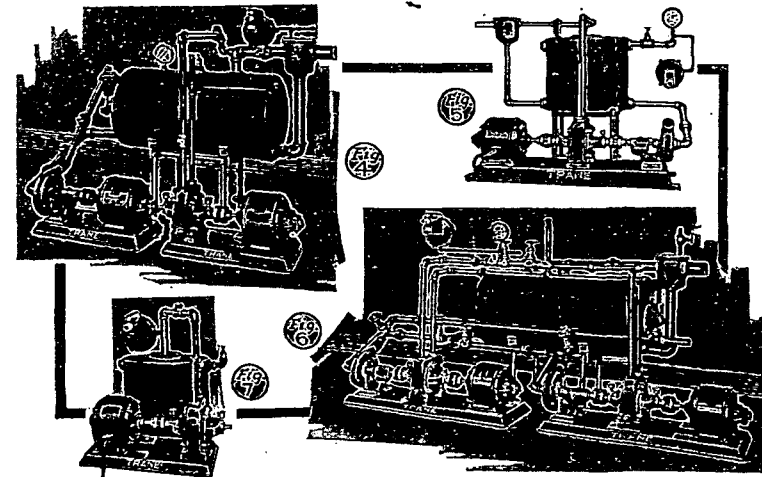


Fig. 4. Two-Motor Return Line Style. Fig. 5. Single Unit Return Line.
Fig. 6. Duplex Return Line. Fig. 7. Air Line

For Specifications, etc., see page 375 following

TWO-MOTOR RETURN LINE VACUUM PUMPS

Pump No.	Capacity Sq. Ft.	Capacity G. P. M.	Pressure at Pump	Motor H. P.	Shipping Weight Lb.
T610	6000	9	10	1/2	650
T615	6000	9	15	1/2	650
T810	8000	12	10	1/2	700
T815	8000	12	15	1/2	725
T1210	12000	18	10	3/4	775
T1215	12000	18	15	3/4	800
T1810	18000	27	10	3/4	825
T1815	18000	27	15	3/4	850
T2510	25000	38	10	1 1/2	875
T2515	25000	38	15	1 1/2	900
T3010	30000	45	10	1 1/2	900
T3015	30000	45	15	1 1/2	925

DUPLEX RETURN LINE VACUUM PUMPS

Pump No.	Capacity Sq. Ft.	Capacity G. P. M.	Pressure at Pump	Motor H. P.	Shipping Weight Lb.
RD610	6000	9	10	3/4	700
RD615	6000	9	15	1	725
RD810	8000	12	10	1 1/2	750
RD815	8000	12	15	1 1/2	800
RD1210	12000	18	10	1 1/2	850
RD1215	12000	18	15	1 1/2	875
RD1810	18000	27	10	1 1/2	875
RD1815	18000	27	15	2	900
RD3010	30000	45	10	2	1000
RD3015	30000	45	15	3	1200

SINGLE UNIT RETURN LINE VACUUM PUMPS

Pump No.	Capacity Sq. Ft.	Capacity G. P. M.	Pressure at Pump	Motor H. P.	Shipping Weight Lb.
R610	6000	9	10	3/4	450
R615	6000	9	15	1	475
R810	8000	12	10	1	475
R815	8000	12	15	1 1/2	500
R1210	12000	18	10	1 1/2	600
R1215	12000	18	15	1 1/2	625
R1810	18000	27	10	1 1/2	625
R1815	18000	27	15	2	650
R3010	30000	45	10	2	675
R3015	30000	45	15	3	725

AIR LINE VACUUM PUMPS

Pump No.	Capacity Sq. Ft.	Motor H. P.	Shipping Weight Lb.
8A	8000	1/2	350
16A	16000	3/4	400
30A	30000	1	450

NOTE—Motors of 1 1/4 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 auto control.

Water Pump Capacities Based on Water at 180 deg. Fahr.

See General Information on pages 374-375 following

SMALL SIZES ONLY LISTED HERE. WRITE FOR INFORMATION ON LARGE CAPACITY EQUIPMENT

BOOSTER AND CIRCULATING PUMPS

—see next page for specifications, etc.—

PERFORMANCE TABLE

All speeds 1725 r. p. m. except those marked in note.

NOTE—Pumps marked C11, C12 and C15 are to run at 1200 r. p. m. to give the rated 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.

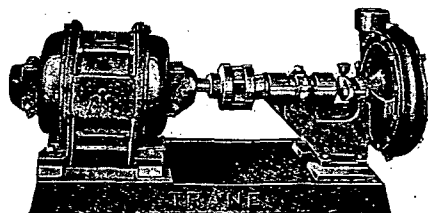


Fig. 8
Trane Circulating Pump

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.	1/4	1/4	1/4	1/2	1/2	1	1	1 1/2	1 1/2	1 1/2	1 1/2		
10	Pump No.	C1	C1	C1	C2	C3	C6	C6	C6	C6	C6	C6		
	H. P.	1/4	1/4	1/2	1/2	1	1	1	1 1/2	1 1/2	1 1/2	1 1/2		
20	Pump No.	C1	C2	C2	C3	C3	C7	C7	C7	C7	C8	C8		
	H. P.	1/4	1/2	1/2	3/4	1	1 1/2	1 1/2	2	2	3	3		
30	Pump No.	C2	C2	C3	C3	C4	C4	C7	C7	C8	C8	C8	C8	C8
	H. P.	1/2	1/2	3/4	1	2	2	2	2	3	3	3	3	3
50	Pump No.	C2	C3	C4	C4	C4	C5	C5	C9	C10	C11	C11	C12	C12
	H. P.	3/4	1	1 1/2	1 1/2	2	3	3	5	5	7 1/2	7 1/2	10	10
75	Pump No.	C4	C4	C4	C4	C5	C5	C5	C12	C12	C12	C12		
	H. P.	1 1/2	1 1/2	2	2	3	3	3	7 1/2	7 1/2	7 1/2	10		
100	Pump No.	C15	C15	C15	C14	C14	C14	C16	C16	C16	C16	C16		
	H. P.	2	3	3	5	5	5	7 1/2	10	15	15	20		
125	Pump No.	C15	C15	C15	C14	C14	C14	C16	C16	C16	C16	C16		
	H. P.	2	3	3	5	5	5	7 1/2	10	15	15	20		
150	Pump No.	C15	C15	C15	C14	C14	C14	C16	C16	C16	C16	C16		
	H. P.	3	3	3	5	5	5	7 1/2	10	15	15	20		
200	Pump No.	C15	C15	C15	C15	C16	C16	C16	C16	C16	C16	C16		
	H. P.	3	3	3	5	5	7 1/2	10	15	15	20	20		

Receiving Tank sizes, styles and Capacities for standard Trane Condensation and Vacuum Pumps

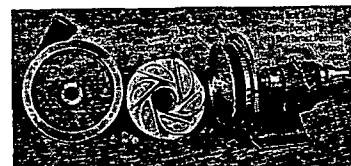
Pump No.	Style of Tank	Operating Capacity, Gal.
400 Series	Cast Iron	5 to 6 gal.
600-1000	20x30 steel	22 gal.
1500-3000	20x40 steel	30 gal.
T600-	Cast Iron	5 to 6 gal.
T800-1200	20x30 steel	22 gal.
T1800-3000	20x40 steel	30 gal.
R600	Cast Iron	5 to 6 gal.
R800-1200	20x30 steel	22 gal.
R1800-3000	20x40 steel	30 gal.

LARGER PUMPS

Write for data on larger sizes, and also on horizontal split shell pumps.

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

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.

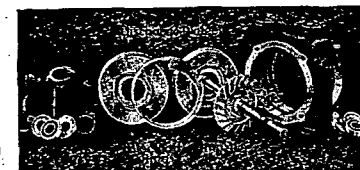
Trane Centrifugal Pumps are used on all Trane condensation units up to 20 lb. pressure, on all circulating units to 75 ft. head, and on booster and return line vacuum units.

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.

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.

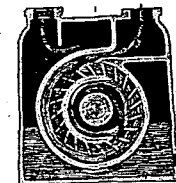
Nothing to leak or wear.

Less motor load.

No permanent water supply needed.

One air inlet and one air outlet.

No leaky stuffing boxes.



The air follows the arrow

BELL. BROAD 2594

Farley Sleeve & Hanger Co.

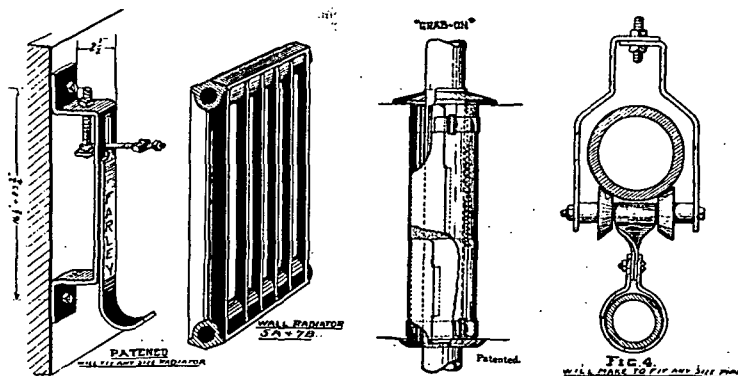
J. W. FARLEY, Manager

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.

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)

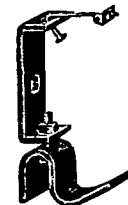
There is a Gleockle Radiator Bracket for every requirement in heating factories, office and public buildings, churches, stores and residences where radiation must be hung on walls, ceilings, etc. Every Gleockle bracket is of sturdy wrought iron—servicable and durable. Several styles, and their application are shown.



No. 1 Gleockle

Wall Radiator Bracket Supports 7' and 9' Vertical Wall Radiators.

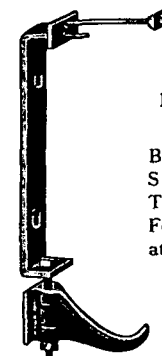
List Price, \$2.50



No. 2 Gleockle

Wall Radiator Bracket supports 5', 7' or 9' Horizontal or 5' Vertical Wall Radiators.

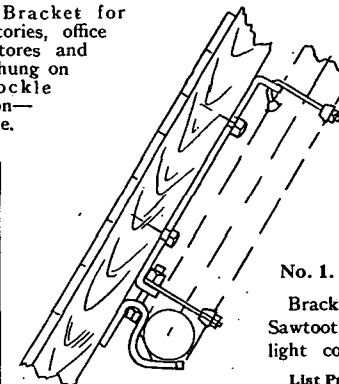
List Price, \$2.50



No. 9 Gleockle

Column Radiator Bracket. Made to Support Single, Two, Three and Four Column Radiators.

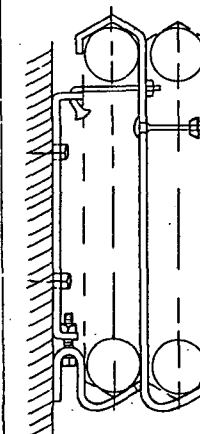
List Price, \$2.50



No. 1. Gleockle

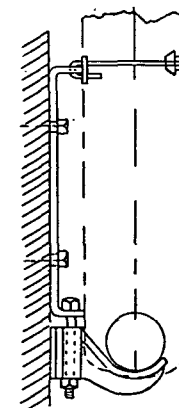
Bracket used on Sawtooth or Skylight construction.

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 Minneapolis, Minn.

AGENTS IN THE FOLLOWING CITIES
UNITED STATES

ATLANTA, GA., CHARLOTTE, N. C., RICHMOND, VA., PITTSBURGH, PA., INDIANAPOLIS, IND.,
SAN FRANCISCO, CALIF., SEATTLE, WASH., SPOKANE, WASH., NEW YORK CITY, DENVER,
COLO., SIOUX FALLS, S. D., DES MOINES, IA., DETROIT, MICH., AMSTERDAM, N. Y., CHICAGO,
ILL., CINCINNATI, O., TOLEDO, O., ST. LOUIS, MO., BIRMINGHAM, ALA., KANSAS CITY, MO.,
OMAHA, NEB., WICHITA, KAN., DALLAS, TEXAS, MILWAUKEE, WIS., BUFFALO, N. Y.,
DAVENPORT, IA., PHILADELPHIA, PA., BOSTON, MASS., CLEVELAND, O., COLUMBUS, O., LOS
ANGELES, CALIF., BALTIMORE, MD., WASHINGTON, D. C., MEMPHIS, TENN., LA CROSSE, WIS.,
IRONWOOD, MICH., NASHVILLE, TENN., BUTTE, MONT.

CANADA

TORONTO, VANCOUVER, HALIFAX, MONTREAL, WINNIPEG, OTTAWA, CALGARY

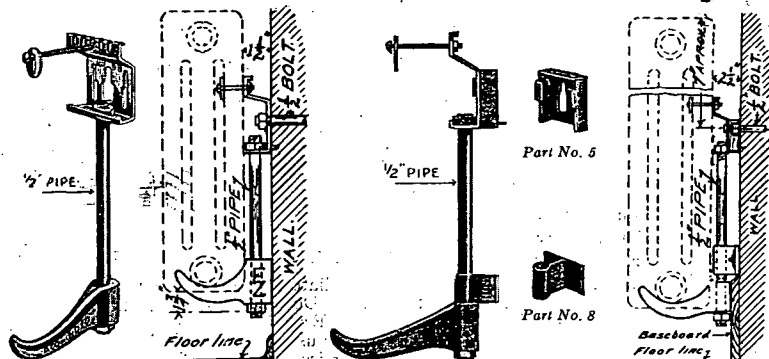
Manufacturers of E-Z Radiator Hangers

Write Dept. 565, Plymouth Bldg.

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 $1\frac{1}{2}$ in. from wall, but is not adjustable for baseboard. Convertible, with parts No. 5 and No. 8, into Style "H", which places radiator $2\frac{1}{2}$ in. from wall and provides for baseboard adjustment.



Style "R" Hanger, Without baseboard adjustment

Style "H" Hanger, with baseboard adjustment

Fowler & Wolfe Mfg. Co.

Originators of Wall Radiation

Bulletin Building

Philadelphia, Pa.

FOWLER & WOLFE WALL RADIATORS

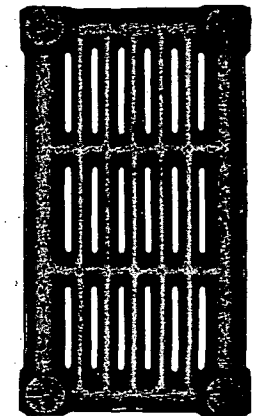
Made in six sizes—

10 sq. ft. section;	24" x 13 $\frac{1}{4}$ " x 3 $\frac{1}{8}$ "
9 sq. ft. "	24" x 13" x 3 $\frac{1}{4}$ "
7 sq. ft. "	24" x 12 $\frac{1}{2}$ " x 3"
6 sq. ft. "	21" x 12 $\frac{1}{2}$ " x 3"
5 sq. ft. "	17" x 12 $\frac{1}{2}$ " x 3"
3 $\frac{3}{4}$ sq. ft. "	17" x 9 $\frac{1}{2}$ " x 3"

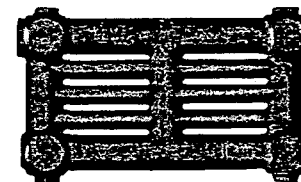
All made in vertical and horizontal forms; 9 sq. ft. and smaller sizes in Plain or Ornamental patterns; 10 sq. ft. Plain only.

Test pressure, water, regular—100 lb. Special up to 400 lb.

For Bay Windows of practically any angle, and curves of radius of not less than 6 ft.



9 Ft. Plain Section



3 $\frac{3}{4}$ Ft. Bath Room Radiator

17" x 9 $\frac{1}{2}$ " x 3"; Plain and Ornamental Patterns.

No. 30 (Cast Iron) Adjustable Hanger—For radiators of vertical or horizontal sections.

Has swinging hook providing for expansion and contraction of radiator and is adjustable, upward or downward, 1 in. by means of set screw, before or after placing radiator in position. Cross head is slotted for bolt to secure radiator to hanger.



No. 30 Hanger

Our Catalog fully illustrates and describes our Wall Radiators; also an extensive variety of Hangers and Supports, adjustable and non-adjustable, to meet practically any requirement.

Refrigerating Equipment

The Brecht Company

1201 Cass Avenue

ST. LOUIS, MO.

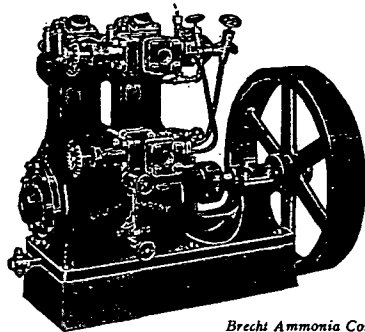
New York, N. Y.

Chicago, Ill.



Buenos Aires

Hamburg



Brecht Ammonia Compressor

MECHANICAL REFRIGERATION

You are continually confronted with the problem of selecting mechanical refrigeration which will meet the needs of each individual cooling installation you are called upon to design. It is frequently your desire to call in a refrigeration engineer for suggestions, diagrams and plans.

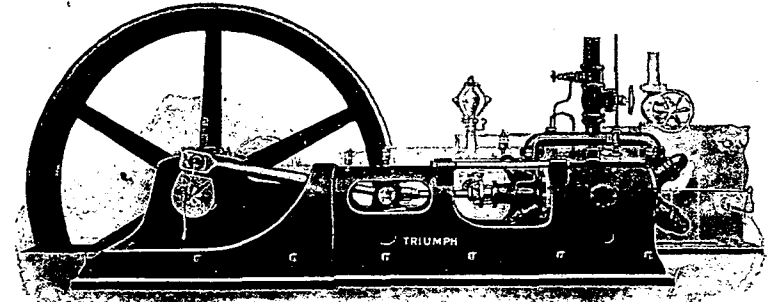
Having the facilities to manufacture both refrigeration machinery and coolers, we take the initiative of recommending the most appropriate and practical solution for each problem. The Brecht Company is always at your service. Our engineering staff is immediately available for consultation.

Brecht Products and Service include Pipe Coils, Motors, Control Apparatus, Insulating Materials, Cooling Towers, Valves and Specialties.

Refrigerating Equipment

Pennsylvania Engineering Co.

Office and Works—1119-21 North Howard St.
Philadelphia, Pa.



Engine Driven Compressor

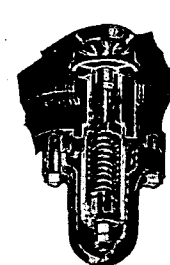
Engineers, manufacturers and builders of "The Famous Pennsylvania" Refrigerating and Ice-Making plants. Complete plans for refrigerating and Ice-making plants. All materials for such plants, especially Ammonia Fittings, which are carried in stock at all times.

We manufacture "The Famous Pennsylvania" refrigerating equipment in sizes suitable to any ordinary requirement, for steam, gas or electric drive. Our machines are made in both horizontal and vertical types for belt drive, or direct-connected to Corliss or slide valve engines.

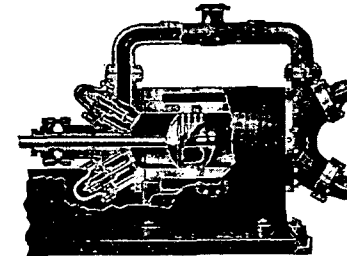
Every part of our machinery is of such generous proportions that we have never had a broken shaft, bed-plate, cylinder or bearing. All machinery which we furnish is guaranteed against defective material or workmanship, for a period of one year.

Our Suction and Discharge Valves and Stuffing Boxes are of special design, insuring long life and permanence of adjustment. In addition to the time-tried mechanical equipment itself, we offer to prospective purchasers of refrigeration a broad and comprehensive experience in the application of refrigerating machinery; an experience embracing hundreds of installations for widely varied purposes.

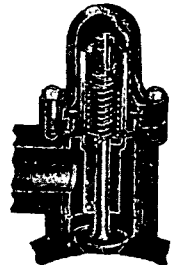
We will be glad to send upon request, an illustrated booklet showing many of our installations and containing detailed data upon design, construction, size and dimensions of our machines.



Suction Valve



Exterior of Cylinder
EXTERIOR OF CYLINDER



Discharge Valve

Showing arrangement of piston, valves and water jacket. The piston is made of steel in one piece and cored out to reduce the weight to a minimum.

Carrier Construction Company

750 Frelinghuysen Ave.
Newark, N. J.

SHEET METAL ARTISANS
Design, Fabrication and Installation

Light Machine Work, Acetylene and Electric Welding.

Special Work requiring Unusual Facilities and Expert Workmanship:
Carrier Diffuser Outlets and Aertite Doors.

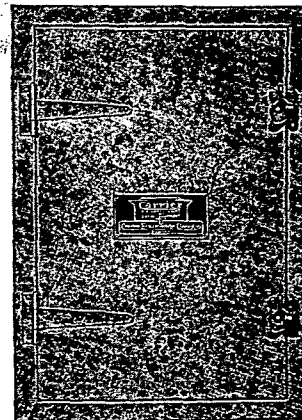
The Carrier Construction Co. is equipped with every facility for the fabrication and installation of sheet metal work, light machine work, acetylene and electrically welded work, pipe work, and special apparatus involving work of this general character.

We are not in position to accept contracts for standard pieces, except in large quantities, nor do we solicit small repair or maintenance work. But we are especially well fitted to undertake new work of special nature, such as duct systems for heating and ventilating installations; exhaust systems for buffing and grinding wheels, and for the removal of shavings, dust, fumes, gases, or vapors; collecting systems; and similar work involving the fabrication of sheet metal up to 1/4-in. plate—and heavier in certain instances.

We are experienced in design as well as construction, so that we can undertake to collaborate with the client in the fabrication of special apparatus.

We invite correspondence and we will be glad to send descriptive catalog upon request.

We manufacture in quantity, for sale to the trade, the Carrier Diffuser Outlet and the Carrier Aertite Door. Both are die-stamped of best galvanized metal and furnished ready for installation.

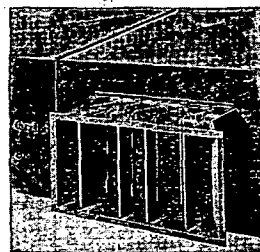


Carrier Aertite Door

The Aertite Door is neat, strong and air-tight. It adds greatly to the appearance of the job and is so easily installed, by merely clinching the flanges, that the saving in labor practically pays for the door. Made in three sizes, 10x16 in., 16x24 in. and 24x36 in.

The scientifically designed Diffuser Outlet, with adjustable volume vanes, not only improves the appearance of the whole job, saves labor and installation expense, but affords uniform air diffusion over entire area of outlet, at any degree of opening. Made in five sizes, 9x10 in., 10x15 in., 15x15 in., 15x21 in. and 15x27 in.

Prices upon request. Prompt delivery from stock.



Carrier Diffuser Outlet
Top "phantomed"

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

Cover and trimmings of valve highly polished making very neat appearance.

Double diaphragm of tempered phosphor bronze allows wide range of travel with minimum strain. Factory adjusted.

Seat passes maximum amount of dirt. Designed so that no dirt or scale can accumulate.

Lugs located under threads.

Free and direct passageway prevents clogging with dirt.

Tail piece made long for easy connection to radiators.

Tail piece and union nut made extra heavy to prevent breakage. Strength where strength is required.

Made of best grade cast composition throughout.

Thermostatic
Return Valve

Smallest size valve (1/2") made with 3/4" outlet connection so that no 1/2" pipe need be used on the installation.

Dark finish coca bola wood handle free to turn so that it cannot bind and split.

Non-rising spindle—easy turning—quick opening. Polished trimmings making very neat appearance.

Large dial—easy to see what pointer indicates.

Tail piece made long for easy connection to radiator.

Tail piece and union nut made extra heavy to prevent breakage. Strength where strength is required.

Lugs located under threads.

Renewable disc.

Generous and unobstructed passages so that scale and dirt cannot lodge.
Made of best grade cast composition throughout.
Does not require repacking.

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

THE RESULT OF TWENTY-FIVE YEARS EXPERIENCE

The Bishop & Babcock Co.

The Massachusetts Blower Co.

General Offices

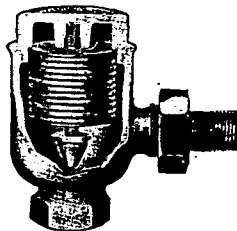
NEW YORK, 444 Lafayette Street
CINCINNATI, 1025 Central Avenue
DENVER, 1724 Lawrence Street
PITTSBURGH, 412 Third Avenue
DALLAS, 1106 Commerce Street

CLEVELAND

ST. PAUL, 680 E. Minnehaha Street
ST. LOUIS, 210-212 South Broadway
ATLANTA, 60 W. Mitchell Street
CHICAGO, 112 West Austin Avenue

The B & B Line

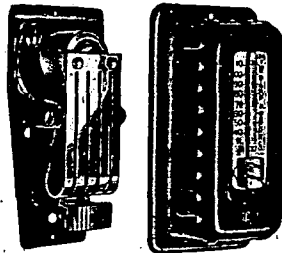
The World's Most Complete Line of Heating Specialties



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
1/2"	200	250	2 1/2
3/4"	500	600	3
1"	1,000	1,100	3 1/2



Positive or Graduate Type Thermostat

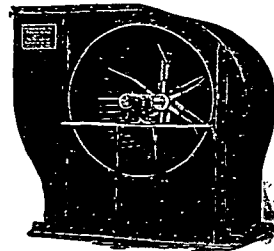
THE B & B LINE OF ALL-METAL THERMOSTATS

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

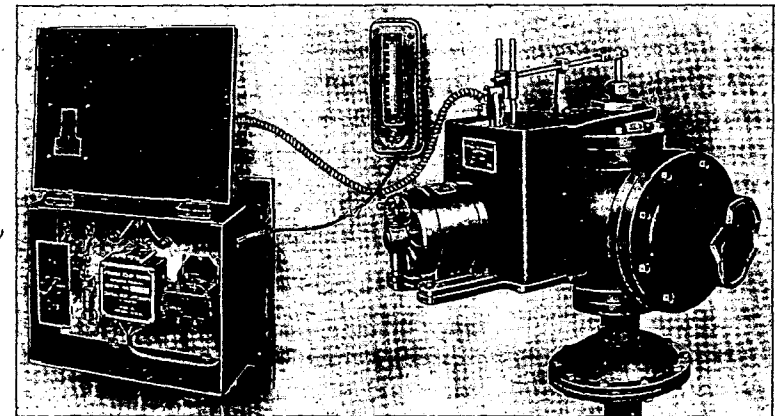
The Modified Squirrel Cage Fan is made single width, single inlet, when it is used as an exhaustor. When used as a blower, fans ranging from size No. 1 1/2 and up can be equipped with two inlets with housing of single width. Fans with two inlets have a different characteristic from single inlet as the tip speed will average about 5 per cent lower for a given volume and pressure.

Central Heat Appliances

J. C. Hornung, Engineer

343 South Dearborn Street, Chicago, Ill.

REPRESENTATIVES IN PRINCIPAL CITIES



Hornung Pressure and Temperature "Master Control"

PRODUCTS

Pressure and Temperature Control Valves. Steam Traps; Expansion Joints; Pipe Coverings; Line Material; Hornung Differential System of Hot Water Heating by Forced Circulation for Central Stations and Industrial Plants. Designs furnished.

HORNUNG PRESSURE AND TEMPERATURE CONTROL VALVES—MASTER CONTROL

The Master Control was designed for control of steam heat as served from a Central Heating Plant. It is a combination of two valves in one, in which the lower diaphragm operates to control the pressures while the motor mounted on top of the valve operates to close off the steam when no heat is required in the building. These valves are made interchangeable so that the *Motor Driven Temperature Control* may be attached to the *Pressure Control* at any time. The temperature control is also furnished without the pressure control diaphragm.

The list given below covers the pressure valve, Style P, furnished with either rubber or metal diaphragm; the pressure and temperature control valve, Style P and T

(illustrated above), furnished with either metal or rubber diaphragm; and temperature control valve, Style T.

HORNUNG REMOTE CONTROL

The Hornung Control can also be used very successfully as a remote control of steam or water, and may be actuated from a distance by a hand switch instead of a thermostat.

Quotations and other details supplied on request.

TABLE OF VALVE ASSEMBLIES WITH THERMOSTAT EQUIPMENT

Size of Valve Inches	Capacity Radiation	Weight Style P	Weight Style P & T	Weight Style T
1	300	30	105	90
1 1/4	450	32	107	92
1 1/2	750	36	110	95
2	1500	40	115	100
2 1/2	2500	45	120	105
3	4000	75	150	135
3 1/2	5500	85	160	140
4	7000	100	175	155
4 1/2	8500	115	190	170
5	10,000	135	210	190
6	12,000	160	235	205
7	13,500	200	275	235
8	15,000	260	335	285
10	17,500	320	395	355
12	20,000	430	505	455

Combustion Specialties Corporation

Manufacturers of

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.)



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

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

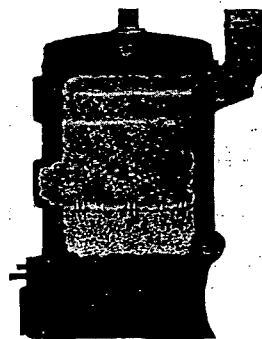
"Perhaps the most important feature of Combusto is the resistance to the flow of air through

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.)

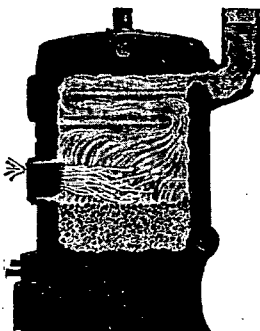
"Combusto is of cast iron cellular structure, the air is heated on passing through this structure and is then discharged through a large number of small apertures over the fire bed. The amount of air thus admitted having been carefully computed for the required conditions, the result is practically perfect 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 \$150.00 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.)

Garford Motor Truck Co.
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

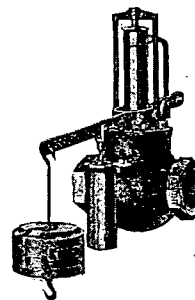
407 MILWAUKEE AVE., CHICAGO, ILL.

Since 1875 Manufacturers of Better Valve Specialties

Davis Piston Type Regulator

For reducing high pressure steam down to any service pressure. Patented inner valve design insures proper regulation regardless of velocity.

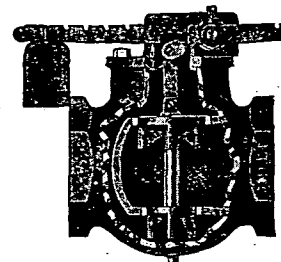
Lever gives visible operation and makes hand testing possible. Oil dash pot insures steady action. Sizes ½ to 14 in.



Davis Piston Type
Pressure Regulator
(Any service pressure)

Davis Back Pressure Valve

The original semi-balanced exhaust line valve for maintaining a given back pressure. Has double seated piston disc—operates noiselessly—requires comparatively small counterweight, patented disc and seat construction prevents sticking. May be used horizontally or vertically. Sizes 2 to 30 in. Angle valves made to order.



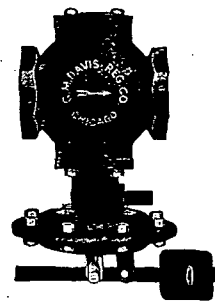
Davis Back Pressure Valve

Davis Steam Trap

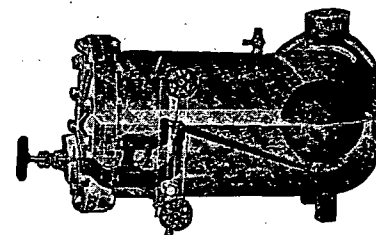
Double cone shaped balanced valves give continuous flow—unusually large capacity—handle any pressure—take care of widely fluctuating load. All vital parts are renewable and quite accessible. Sizes ½ to 3 in.

Other Davis Valves

A 64 Page catalog showing a number of pressure regulating devices not here illustrated will be sent on request. Tell us about your special problems in pressure control—we may be able to be of service.



Davis
Diaphragm
Type
Pressure
Regulator
(Low Service
Pressure)



Davis Steam Trap

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 York, 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

FOREIGN SALES OFFICES:

London, England

St. John's, Newfoundland
King's Road and Gower Street

Distributors: Munsing & Co.

Paris, France
47 Rue Fontaine-au-roi

Manufacturers of Specialties for The Dunham Systems of Heating

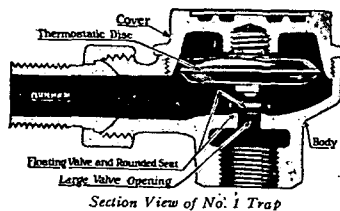


This Service is delivered through 70 Branch and Local Sales Offices throughout the United States and Canada, back of which organization are two modern and complete factories. Dunham Heating Service co-operates intimately with Consulting Engineers, Architects and Heating Contractors.

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 on connection with one-pipe steam systems.

These specialties are Dunham Radiator Traps; Dunham Blast Traps; Dunham Air Line Valve; Dunham Return Traps; Dunham "D" Style Medium Pressure Traps; Dunham Packless Radiator Valves; Dunham Reducing Pressure Valve; Dunham Vacuum Pump; Dunham Vacuum Pump Governor; Dunham Air Eliminators; Dunham Air Check; Dunham Oil Separator; Dunham Suction Strainer; Dunham Air Vent; Dunham Damper Control; Dunham Gauges.



Section View of No. 1 Trap

Dunham Radiator Trap

The Dunham Radiator Trap is distinctive in the simplicity of its construction.

It consists of two major parts, a body and a cover. The operating member, the Thermostatic Disc, is securely placed in the cover. The Trap has a very large valve opening lift. There are no detached loose parts in the path of flow, nor sliding contacts, nothing to gum up, and no guide or pin to obstruct the valve opening. The action of the disc is positive and the valve seats squarely. The body is standardized, also the cover and disc, giving the further advantage of interchangeable parts.

The traps conform with the standard dimension of 3 1/4 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.

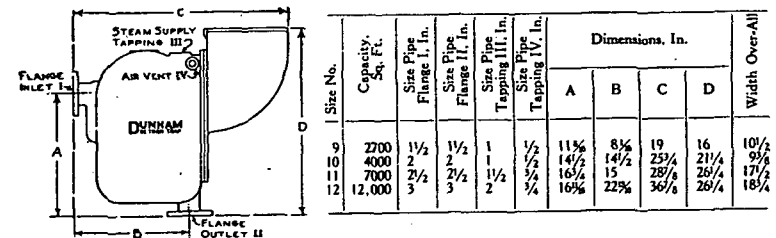
The working part of the Trap, the Thermostatic Disc, is fully exposed to the actual conditions within the radiator and it, therefore, responds instantly to any change taking place therein, preventing waste of unused steam, backing up of water and air binding.

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 pipe coils, 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

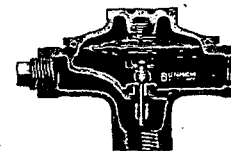
Used to separate the air and water discharged into the dry return piping by the Dunham Radiator Traps, to release the air, and to automatically return the water to the boiler. For use on installations where the boiler steam pressure does not exceed 10 lb. gage.



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, "D" STYLE

This embodies the principle so successfully used in the Dunham Radiator Trap, and is just as simple and satisfactory.



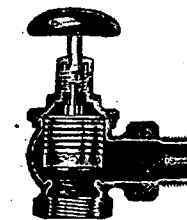
Size	Pipe Connection, In.	Capacity, Water per Hour, Lb.
No. 13	1/2	100
No. 14	3/4	200
No. 15	1	400

Always state operating pressure when ordering.

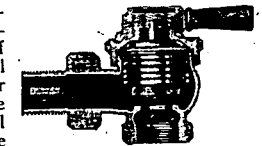
Designed for steam pressures higher than those used in heating systems. It handles air and condensate. Adapted for process work, hospital sterilizers and distilling apparatus, steam tables and kitchen equipment where a steam pressure of not less than 10 or more than 50 lb. is used.

DUNHAM PACKLESS RADIATOR VALVE

A bona fide packless radiator valve, not dependent on springs and packing rings. The Dunham "built-up" bellows makes this possible. This built-up sectional construction admits of uniformity of thickness of metal throughout all corrugated parts, and provides for the in-and-out movement to take place from the flat of the metal instead of at the inside and outside edges. Valve may be open or closed in seven-eighths turn.



Type 140—Wheel Handle



Type 100—Lever Handle

Made in lever handle, wheel handle and lock and shield models in following sizes:

Lever 1/2, 3/4, 1, 1 1/4 in.

Wheel 1/2, 3/4, 1, 1 1/4, 1 1/2, 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 special extension stems for use on radiators behind grilles, seats, etc., or on ceiling of the room.



No. 1. All Patterns
Tapping $\frac{1}{2}$ "; Capacity 100 sq. ft. Rad.

1
Trap No. 1



No. 2. All Patterns
Tapping $\frac{1}{2}$ "; Capacity 350 sq. ft. Rad.

2
Trap No. 2

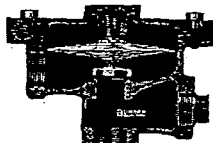


No. 3. All Patterns
Tapping $\frac{3}{4}$ "; Capacity 450 sq. ft. Rad.

3
Trap No. 3



4
Trap No. 4

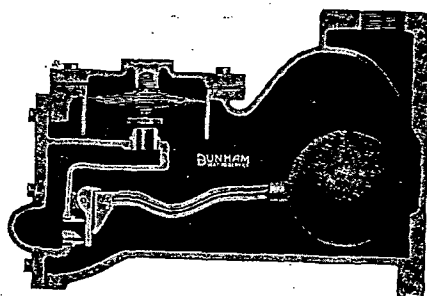


5
Trap No. 6

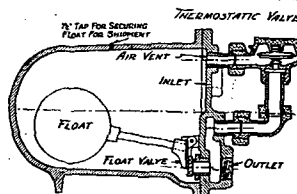
No. 4. Angle and Straightway
Tapping $\frac{3}{4}$ "; Capacity 1500 sq. ft. Rad.

No. 5. Angle and Straightway
Tapping 1"; Capacity 3000 sq. ft. Rad.

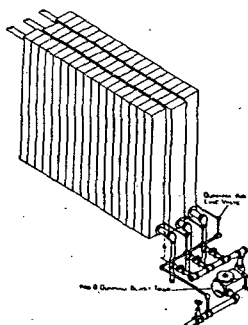
DUNHAM BLAST TRAP



Sectional View of Blast Trap, No. 8, Showing the Thermostatic Disc Valve and the Auxiliary Float Valve



Sectional Detail of Blast Trap No. 16



Typical connections for the Thermostatic and Float Trap. Omit additional Vents on stacks of 16 sections and less

This trap is designed for draining blast heating coils. In selecting capacities, be sure and reduce blast coil radiation to equivalent direct radiation by multiplying the actual surface of coil by a factor ranging from 6 to 10, depending on temperature, velocity and volume of air blown over coils.

The operation of traps No. 6 and 7 is similar to that of the radiator trap, using the thermostatic principle, while Nos. 8, 16, 17, 18, 19 traps combine the Dunham thermostatic principle with the float. They handle large volumes of water successfully. Made only for pressures up to 10 lb. on vacuum or gravity systems.

Size	Pipe Connection, In.	Capacity, Direct Radiation, Sq. Ft.
*No. 6	$\frac{3}{4}$	1,500
*No. 7	1	3,000
No. 16	$\frac{3}{4}$	6,000
No. 17	1	7,000
No. 18	$1\frac{1}{4}$	9,000
No. 19	$1\frac{1}{2}$	11,000
No. 8	2	16,000

*Made in angle and straightway patterns.

Dunham Reducing Pressure 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 $\frac{1}{2}$ 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.

Capacity for 2000 sq. ft. radiation.

Dunham Oil Separator

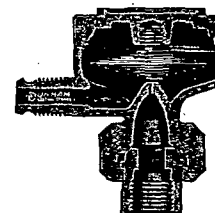
Made in all sizes from $2\frac{1}{2}$ to 6 in. Flanged connections.

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 $\frac{3}{4}$ 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 $\frac{1}{8}$ or $\frac{1}{4}$ -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 adapt-

able 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.

Hoffman Specialty Co., Inc.

Waterbury, Conn.

GENERAL SALES DEPARTMENT

25 West 45th Street :-: NEW YORK, N. Y.

HOFFMAN HEATING SPECIALTIES

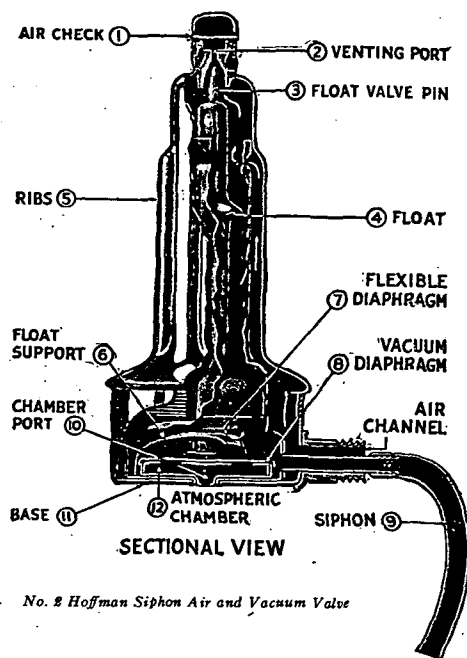
Hoffman Venting, Modulating and Thermostatic Valves
Hoffman "Controlled Heat"—Hoffman Differential Loops

HOFFMAN VENTING VALVES

In the Hoffman line of air vents there is a specially designed 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 conditions for which designed.



No. 2 Hoffman Siphon Air and Vacuum Valve

HOW THE HOFFMAN VACUUM VALVES OPERATE

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 prevents return of air for a short period until the vacuum formed in the valve permits atmospheric pressure, acting in chamber (12) to force diaphragm (8) upward, raising the float and doubly closing the vent port.

HOFFMAN VENTING VALVES
ALL-METAL—NON-ADJUSTABLE—THERMOSTATIC

The No. 1 Hoffman Siphon Air Valve

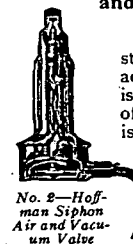


No. 1—Hoffman Siphon Air Valve

The No. 1 Hoffman Siphon Air Valve is designed for systems of the one-pipe gravity type. Through its use all air is vented from the radiator without loss of steam, maximum heating efficiency is assured and leakage from water-logged radiators prevented. 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, $\frac{1}{8}$ in.

Maximum guaranteed operating pressure, 15 lb.

The No. 2 Hoffman Siphon Air and Vacuum Valve



No. 2—Hoffman Siphon Air and Vacuum Valve

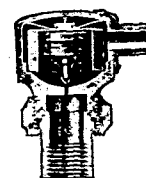
This valve is similar in construction to the No. 1, but in addition, when the radiator is once freed from air, return of air through the vent port is prevented.

Through its use an ordinary one-pipe steam system may be changed into a vacuum type.

Radiator connection, $\frac{1}{8}$ in.

Maximum guaranteed operating pressure, 10 lb.

The No. 3 Hoffman Air Line Valve



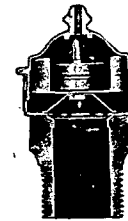
No. 3—Hoffman Air Line Valve

The No. 3 Valve is a compact, well-constructed valve 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, $\frac{1}{8}$ in.; Air Line connection, $\frac{1}{4}$ in.

Maximum guaranteed operating pressure, 10 lb.

The No. 4 Hoffman Quick Vent Valve



No. 4—Hoffman Quick Vent Valve

For use in venting mains, risers, vent stacks, coils, etc. All air is freely vented through a $\frac{1}{2}$ in. vent port without steam loss, but valve does not close against water.

Standard connection, $\frac{3}{4}$ in., can also be supplied with $\frac{1}{4}$ in. connection.

Maximum guaranteed operating pressure, 10 lb.

The No. 5 Hoffman Quick Vent Float Air Valve



No. 5—Hoffman Quick Vent Float Air Valve

Especially adapted for use in venting: The ends of steam mains. The 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.

In its functioning it distinguishes between steam and heated air, and closes instantly when steam or water comes in contact with the float.

Pipe connection, $\frac{3}{8}$ in.; vent port for less than 3 lb. is $\frac{1}{4}$ in.; for 3 lb. and over is $\frac{1}{2}$ in.

Maximum guaranteed operating pressure, 10 lb.

The No. 6 Hoffman Quick Vent Float Air and Vacuum Valve



No. 6—Hoffman Quick Vent Float Air and Vacuum Valve

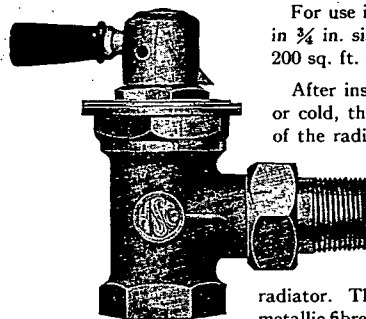
The No. 6 is similar in design and application to the No. 5 with the additional feature of the Air Check or Vacuum starter above vent port and vacuum diaphragm in base.

Pipe connection, $\frac{3}{8}$ in.; vent port for less than 3 lb. is $\frac{1}{4}$ in.; for 3 lb. and over is $\frac{1}{2}$ in.

Maximum guaranteed operating pressure 10 lb.

HOFFMAN "CONTROLLED HEAT" EQUIPMENT

The No. 7 Hoffman Adjustable Modulating Valve



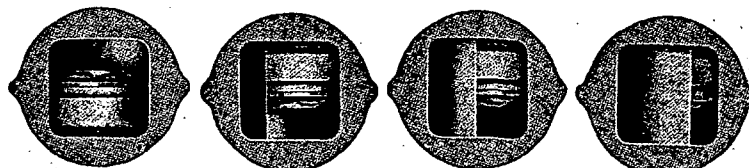
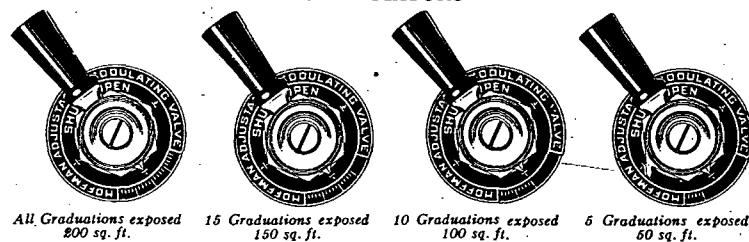
No. 7—Hoffman Adjustable Modulating Valve

For use in Vapor or Vapor Vacuum systems, is made in $\frac{3}{4}$ 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.

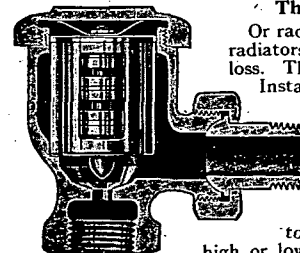
POSITIONS OF TOP DIAL PLATE FOR VARIOUS SIZES OF RADIATORS



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 foreseen 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.

The No. 8 and 9 Hoffman Return Line Valves



No. 8 Hoffman Return Line Valve

Or radiator traps, freely relieve air and condensation from radiators in Vapor or Vapor Vacuum systems without steam loss. They are also used as steam traps in industrial work.

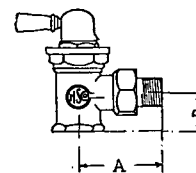
Installed in systems where steam is supplied through a reducing valve, proper trap operation is assured even if reducing valve fails to function and admits high pressure steam to the system because the trap operates with the same degree of sensitivity.

These Valves are absolutely non-adjustable and thermostats can be changed from one body to another; likewise the valve may be used under either high or low pressure without adjusting.

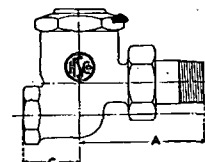
The No. 8 Valve is made in $\frac{1}{2}$ in. size only, in Angle, Straightway, Right-and-Left Hand Offset Patterns. The normal capacity is 200 sq. ft. of direct cast-iron radiation. Port diameter, $\frac{1}{4}$ in., all styles.

The No. 9 Valve is made in $\frac{3}{4}$ in. size Angle Pattern only, and has a normal capacity of 600 sq. ft. of direct cast-iron radiation. $\frac{3}{8}$ in. port for pressure under 15 lb.; $\frac{1}{2}$ in. port for higher pressures.

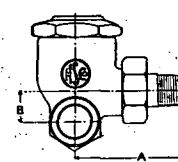
Maximum guaranteed operating pressure, 50 lb.



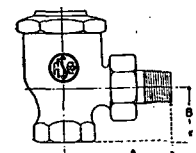
No. 7 Angle Pattern



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.....	$\frac{3}{4}$	..	200	$2\frac{1}{4}$	$1\frac{1}{2}$	...
No. 17 Angle.....	$\frac{3}{4}$	..	200	$2\frac{1}{4}$	$1\frac{1}{2}$	...
No. 8 Angle.....	$\frac{1}{2}$	$\frac{1}{4}$	200	$2\frac{1}{4}$	$1\frac{1}{2}$	...
No. 8 Straightway.....	$\frac{1}{2}$	$\frac{1}{4}$	200	$2\frac{1}{4}$	$1\frac{1}{2}$	$1\frac{1}{2}$
No. 8 Offset.....	$\frac{1}{2}$	$\frac{1}{4}$	200	$2\frac{1}{4}$	$1\frac{1}{2}$	$1\frac{1}{2}$
No. 18 Angle.....	$\frac{1}{2}$	$\frac{1}{4}$	100	$2\frac{1}{4}$	$1\frac{1}{4}$	$1\frac{1}{2}$
No. 18 Straightway.....	$\frac{1}{2}$	$\frac{1}{4}$	100	$2\frac{1}{4}$	$\frac{3}{4}$	$1\frac{1}{2}$
No. 18 Offset.....	$\frac{1}{2}$	$\frac{1}{4}$	100	$2\frac{1}{4}$	$\frac{3}{4}$	$1\frac{1}{2}$
No. 9 Angle.....	$\frac{3}{4}$	$\frac{3}{8}$	600	$3\frac{1}{4}$	$1\frac{1}{2}$	...

*No. 9 Valve furnished with $\frac{1}{2}$ in. port for pressures above 15 lb.

The No. 10 Hoffman Vapor Valve



No. 10 Hoffman Vapor Valve

It 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 $\frac{3}{4}$ in. in diameter.

For preventing the escape of water the Valve has a large buoyant float which has a double valve, one disc controlling a $\frac{3}{4}$ in. port and the other an auxiliary port $\frac{1}{8}$ in. diameter. When water recedes from the Valve and pressure is maintained the $\frac{1}{8}$ in. port is first opened and as the air pressure is relieved, the $\frac{3}{4}$ in. port opens and full venting area is obtained.

The thermostat is located above the float chamber and controls the vent port upon contact with steam.

The Valve is of rugged construction, nickel-plated all over. Pipe connection, $\frac{3}{4}$ in. Maximum guaranteed operating pressure, 15 lb.

The No. 11 Hoffman Vapor Vacuum Valve

This 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, $\frac{3}{4}$ in.

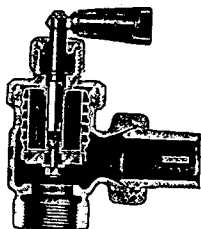
Maximum guaranteed operating pressure, 15 lb.

No. 17 and 18 Hoffman Valves are two new products recently added to the Hoffman line of specialties and were designed particularly for the heating engineer and contractor who requires a well-constructed, quickopening radiator valve and a small efficient trap for use in office buildings, apartments and other places where the operating pressure is not over 15 lb.

No. 17 Hoffman Radiator Valve

This valve is made in $\frac{3}{4}$ 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.



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 $\frac{3}{4}$ in. size only. Capacity, 200 sq. ft. C. I. Radiation.

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.

BODY—High Grade Steam Metal Casting.

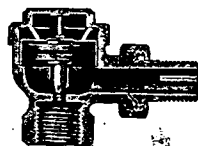
CAP—Hot Brass Forging.

NUT—Rod Brass.

TAIL PIECE—Hot Brass Forging.

THERMOSTAT—Hoffman Diaphragm Metal.

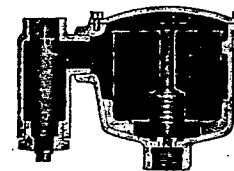
Made in $\frac{1}{2}$ in. size only. Capacity, 100 sq. ft. C. I. Radiation.



The No. 18 Hoffman Trap

The No. 12 Hoffman Blast Trap is especially well adapted for draining condensation from:

Indirect Radiators Dryers and Drums
Blast or "Vento" Stacks Hot-Water Generators
Ends of Steam Mains and Risers Unit Heaters, etc.



No. 12 Hoffman Blast Trap

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.	$\frac{1}{2}$	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 $\frac{1}{4}$ 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, $1\frac{1}{4}$ in.; outlet, 1 in.

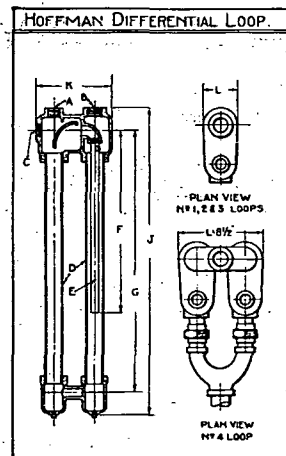
The Hoffman Vapor Damper Regulator is automatic in operation and after it has once been set at the correct pressure requires no attention. It controls the dampers. Extremely sensitive in its action, retarding or accelerating the fire; and so not only assures heat, but conversely conserves fuel when there is little or no demand for steam from the radiators.

It will fit any type boiler, and is equipped with lever, weights, chain and pulleys.

The Hoffman Gage is an unusually accurate instrument which shows at all times the steam pressure in the boiler, measured in ounces. It enables one to regulate the fire and heat with precision.



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.

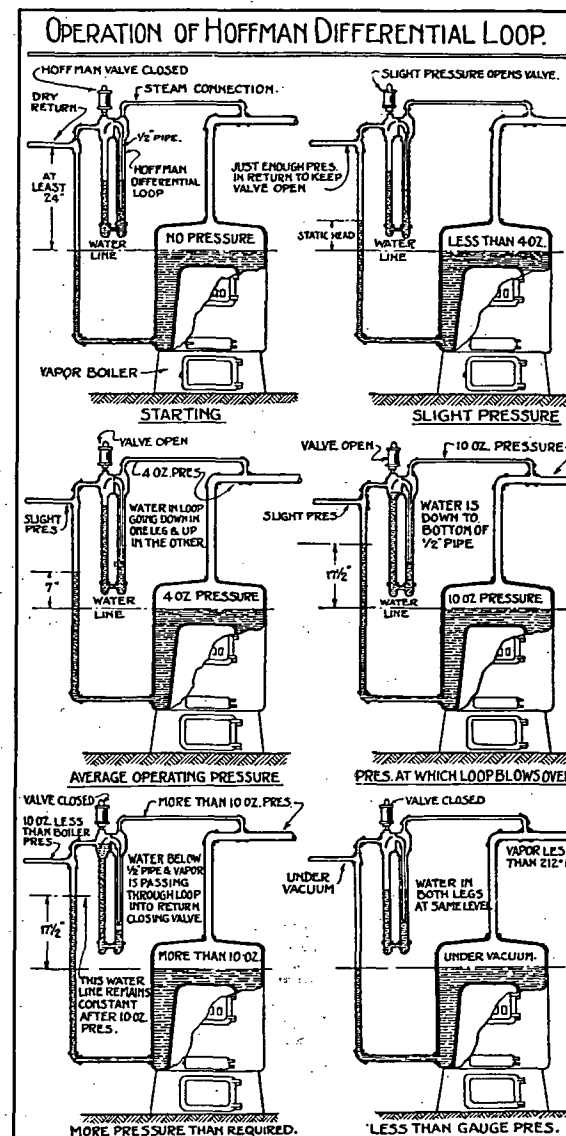
Differential Loops are made in four sizes, having a capacity up to 15,000 sq. ft. of radiation. For larger systems the No. 4 Loops can be installed in a battery or the return mains divided so as to have their load come within the capacity of standard loops.

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.

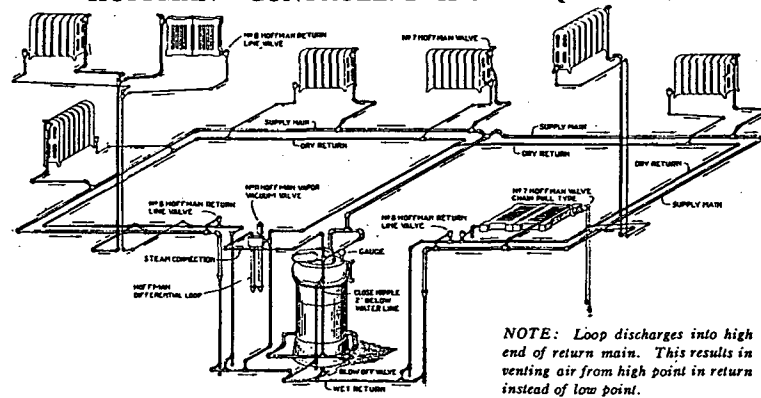
DIMENSIONS AND CAPACITIES OF LOOPS

Loop No.	A	B	C	D	E	F	G	J	K	L	Capacity Sq. Ft. Rad.
1	3/4"	1 1/4"	1 1/4"	1 1/4"	1 1/4"	18 1/4"	26"	30 5/8"	7 3/4"	3"	2000
2	3/4"	1 1/4"	1 1/4"	1 1/4"	1 1/4"	18 1/4"	26"	30 5/8"	7 3/4"	3"	3500
3	3/4"	1 1/4"	1 1/4"	1 1/4"	1 1/4"	25"	32"	37 1/4"	10"	3 1/4"	7500
4	3/4"	1 1/4"	1 1/4"	1 1/4"	1 1/4"	25"	32"	37 1/4"	10"	8 1/2"	15000

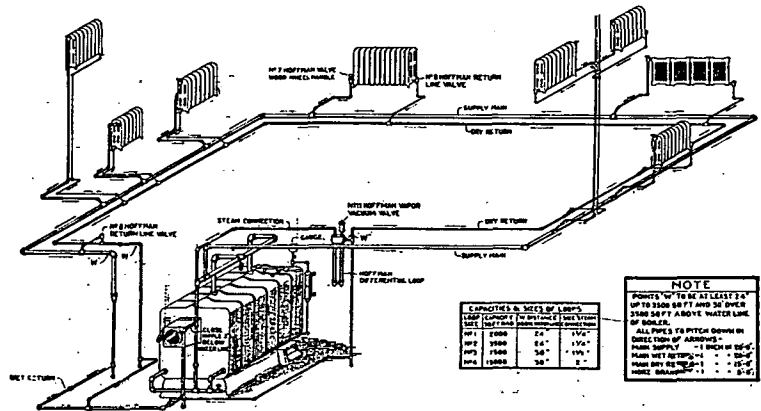
Printed matter and complete data and prices on application. Hoffman Specialties distributed through manufacturers and jobbers of plumbing and heating supplies.



TYPICAL INSTALLATIONS HOFFMAN "CONTROLLED HEAT" EQUIPMENT

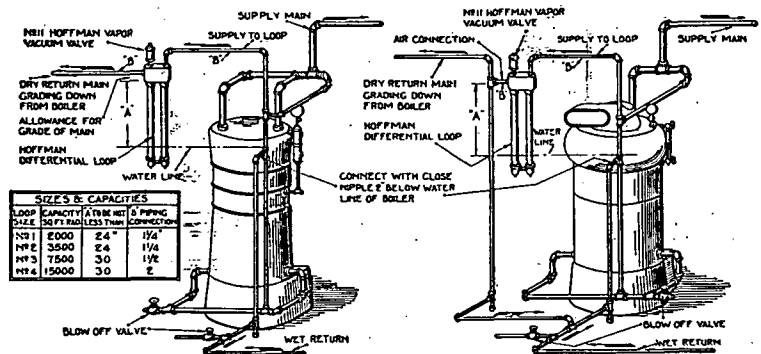


NOTE: Loop discharges into high end of return main. This results in venting air from high point in return instead of low point.



NOTE

5' W TO BE AT LEAST 24
SOS 8 FT AND 36" OVER
8 FT ABOVE WATER LINE
ER.
PES TO PITCH DOWN ON
ION OF ARROWS -
SUPPLY - 1 INCH IN DE-
ET AFTER - 1 - 10-
RY RE - 1 - 15-
BRANCH - 1 - 8-



LOOP SIZE	CAPACITY SQ FT RAD	A TO BE MET LESS THAN	B PER COMP
Nº1	2000	24"	
Nº2	3500	24	
Nº3	7500	30	
Nº4	15000	30	

400

The McAlear Mfg. Co.

1901-1907 So. Western Avenue

Power and Heating Specialties for Controlling Pressures and Flow of Steam, Water, Air or Gas

CHICAGO

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. 185 Single Seated Valves on dead end service where reduced pressure is below 10 lb.

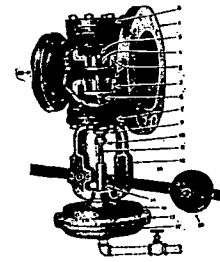
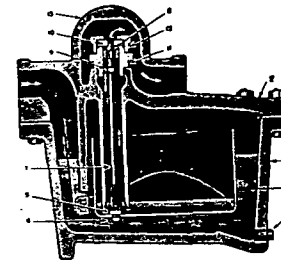


Fig. 245 Spring Weighted type for initial pressures up to 150 lb. and reducing to service pressures above 10 lb. Fig. 265 Single Seated Valves for dead end service such as cooking tables, kitchen utensils, laundry mangles, etc.

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.

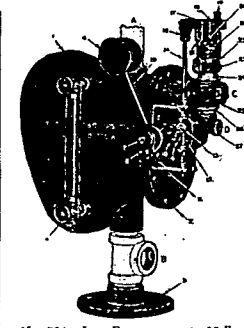
Fig. 695 for pressures up to 125 lb.

Fig. 705 for pressures above 125 lb.

Fig. 715 for special low pressures.

McAlear Heating and Power Plant Specialties include Oil Separators, Oil and Grease Traps, Dirt Strainers, Suction Strainers, Vacuum Pump Governors, Boiler Feeders, Damper Regulators, Steam Separators, Back Pressure and Atmospheric Relief Valves, Radiator Traps, Packless Valves, Air Vents, Stop and Check Valves and many other devices.

Catalog No. 27 covering our complete line gladly furnished upon request.

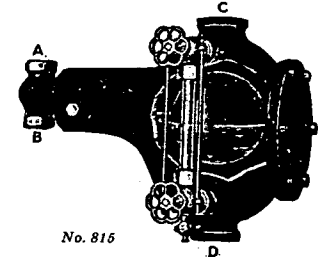


No. 781—Low Pressure, up to 25 lbs.

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	3/4	1,000
1	1 1/4	1 1/4	1	3/4	2,000
2	1 1/2	1 1/2	1	3/4	4,000
3	2	2	1	3/4	6,000
4	2 1/2	2 1/2	1	3/4	10,000
5	3	3	1 1/4	1	15,000
6	3	3 1/2	1 1/4	1	20,000



No. 815

Rapid Feed Water Feeders are for maintaining water levels in low pressure steam boilers, receiving tanks, storage tanks, etc., where a large or small amount of make-up water is necessary.

Very accurate and will hold water level almost stationary.

Regular type for 30 lb. pressure. Water pressure must at all times be at least 10 or 15 lb. greater than the steam pressure.

Strainers furnished with all feeders.
 Sizes, in., $\frac{3}{4}$ to 2.

Specialties include Oil Separators, Oil and
Strainers, Vacuum Pump Governors, Boiler
Relief Valves, Back Pressure and Atmospheric Relief
Valves, Stop and Check Valves and many

401

Illinois Engineering Company

General Offices and Factory: CHICAGO

Branches and Representatives

ATLANTA	CLEVELAND	HARRISBURG	MILWAUKEE	PEORIA	SCRANTON
BALTIMORE	COLUMBUS	HOUSTON	MINNEAPOLIS	PHILADELPHIA	SEATTLE
BIRMINGHAM	DALLAS	INDIANAPOLIS	NASHVILLE	PORTLAND	SPokane
BOSTON	DENVER	KANSAS CITY	NEW ORLEANS	PROVIDENCE	ST. LOUIS
BUFFALO	DETROIT	LOS ANGELES	NEW YORK	RICHMOND	SAN FRANCISCO
CEDAR RAPIDS	ERIE	MEMPHIS	OMAHA	ROCHESTER	WICHITA
CHATTANOOGA					

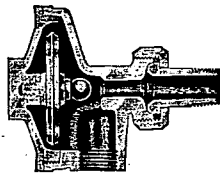
PRODUCTS—Illinois Heating Systems—Eclipse Steam Specialties

Illinois Heating Systems

Successfully installed in thousands of buildings—are the result of over 20 years of special work in this line, and are the ultimate in efficiency and economy.

Illinois Thermo Trap

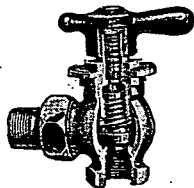
The original vertical seat trap. Dirt does not lie on seat—self cleaning, non-adjustable, positive in operation; durable, will stand 50 lb. steam pressure which shows the great strength of the diaphragm, which is the reason for the long life and durability of these Traps. Thousands in operation for 11 and 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 lb. pressure. Large diameter of thread spoon 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.

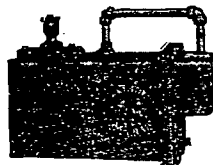
Illinois Vapor Systems

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 hr. 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 RETAINER—Browne Patent, a device which marks an epoch in the heating art.

Illinois Heat Retainer

This improved device not only vents air from the System on $\frac{1}{8}$ 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.

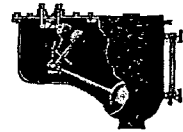


Illinois Heat Retainer

No dirt or scale can reach the valve of the Retainer, 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, and 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 are given—before shipment.

Pressure Reducing Valves, for all pressures and services.

Back Pressure, and Atmospheric Relief Valves.

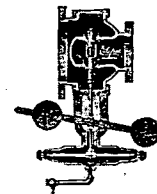
Separators, Oil and Steam, Cast Iron and Steel.

Steam Traps, all pressures.

Non-Return or Stop and Check Valves.

Pump Governors, Balanced Valves.

Float Valves, Expansion Joints, Pipe Strainers.



Reducing Valve

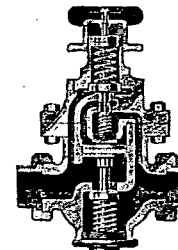
Fig. 71—Reducing Valves. In general use on Vacuum or low pressure Heating Systems. Will reduce to 4 oz. pressure from even 150 lb. initial pressure.

The large diaphragm insures sensitive operation.

Made in both straight-way and expanded outlet bodies.

Sizes $\frac{1}{4}$ in. to 12 in.

Eclipse Master Reducing Valve

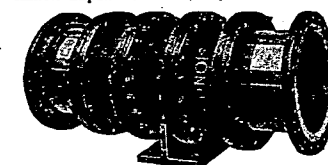


A pilot type valve will reduce from any pressure up to 250 lb. down to 10 lb. and hold reduced pressure constant at all times—even against a "dead end" pipe.

Made of Bronze with monel valves and trimmings.

Sizes $\frac{1}{4}$ 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.

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.

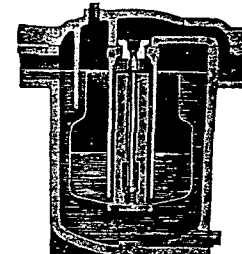
No. 302—Steam Traps.

No. 452—Non-Return Valves.

No. 502—Separators—Oil and Steam.

No. 703—Float and Balanced Valves.

Eclipse Steam Trap (Patent Applied for)



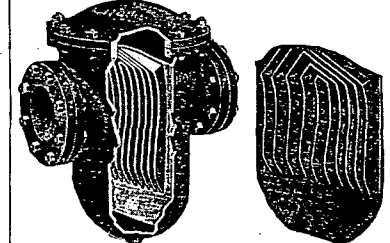
Something new in Steam trap design. The valve and stem are separate from the bucket and only operated by the bucket at its extreme top and bottom travel—Result—

Valve is always either full, open or tight closed.

Therefore no wire drawing or cutting of valve and seat, which are of Monel.

Steam tight and long life. 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.

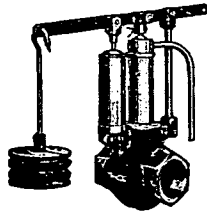
Size 4 in. to 36 in.

Klipfel Manufacturing Co.

2641-59 West Harrison St.

Chicago, Ill.

Manufacturers of Pressure Regulating Appliances—
for the Automatic Control of Steam, Air or Water

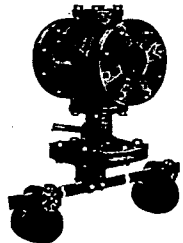


No. 1 Pressure Regulator—
Piston Type

Sizes, $\frac{3}{4}$ to 14 in., inclusive. Bronze bodies in sizes $1\frac{1}{2}$ 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. 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.

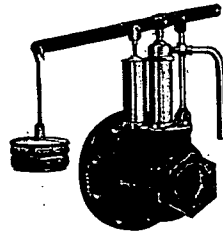
Nos. 1 AND 2 PRESSURE REGULATORS Piston Type

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

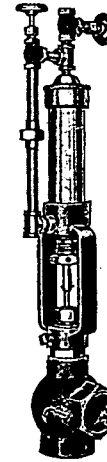
Sizes: 1 x 2, to 12 x 24 in. inclusive. Bronze bodies in sizes $1\frac{1}{2}$ x $2\frac{1}{4}$ in. and under. Iron bodies with bronze inner valves and trimmings in sizes above. Unless otherwise specified, Nos. 2 and 4 will be shipped with inlet screwed and outlet flanged in sizes $1\frac{1}{2}$ x 3 to 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.

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, roughing-in dimensions and valve sizes of our entire 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.

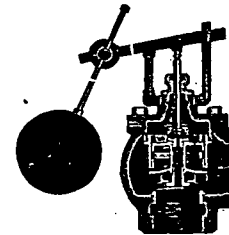
IMPROVED PUMP GOVERNORS

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, $\frac{3}{4}$ to 12 in., inclusive. Bronze bodies in sizes $1\frac{1}{2}$ 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 or closed 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.

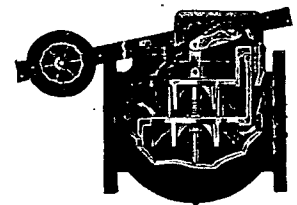


No. 7 Float Valve

Sizes, $\frac{3}{4}$ to 8 in., inclusive. All bronze in sizes $1\frac{1}{2}$ in. and under. Iron bodies with bronze trimmings in sizes 2 in. and above. Sizes, $\frac{3}{4}$ in. to 6 in., inclusive, screwed ends only; sizes 8 in., flanged ends only.

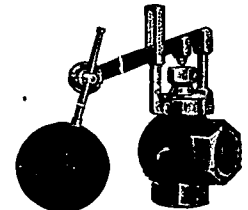
No. 7 FLOAT VALVES

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. Angle patterns only.



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.



No. 6 Balanced Float Valve

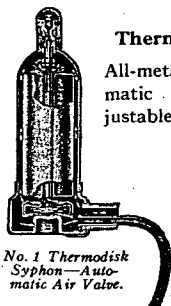
Sizes, $\frac{3}{4}$ to 20 in., inclusive. Bronze bodies in sizes $1\frac{1}{2}$ in. and under, screwed ends only. Iron bodies in sizes 2 in. and above. Sizes 2 to 6 in., inclusive, made screwed or flanged ends, but screwed ends will be shipped unless specified otherwise. Sizes 7 in. and above, made 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.

Jas. P. Marsh & Company

Established 1865

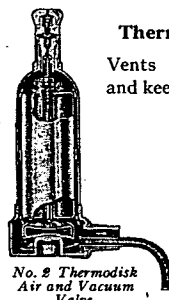
114-124 S. Clinton St. - CHICAGO, ILL.

SALES AGENCIES IN MOST PRINCIPAL CITIES



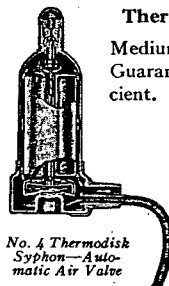
No. 1 Thermodisk Syphon—Automatic Air Valve.

Thermodisk
All-metal Automatic non-adjustable.



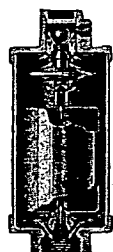
No. 2 Thermodisk Air and Vacuum Valve.

Thermodisk
Vents the air and keeps it out.



No. 4 Thermodisk Syphon—Automatic Air Valve

Thermodisk
Medium priced. Guaranteed efficient.



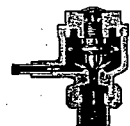
No. 7 Thermodisk Air Eliminator

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.

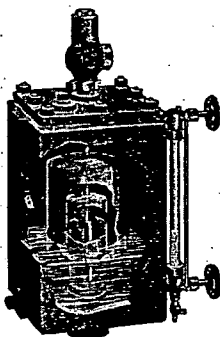
Sizes and capacities for every requirement.



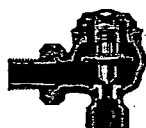
No. 5 Thermodisk Rapid Vent



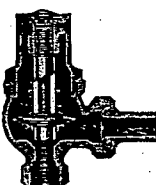
No. 3 Thermodisk Air Line Valve



Marsh Automatic Syphon Return Trap



No. 1 Reflux Trap



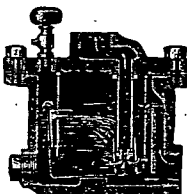
No. 3 Reflux Trap

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.

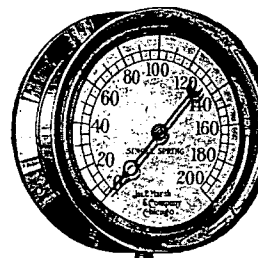


No. 2 Reflux Trap

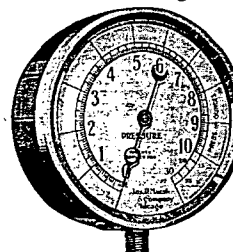


Marsh Blast Trap

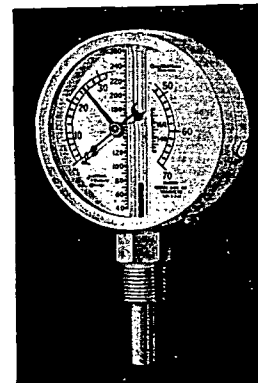
Marsh Indicating Gauge



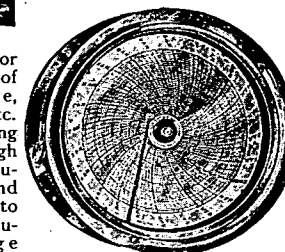
Low Pressure Ounce Gauge



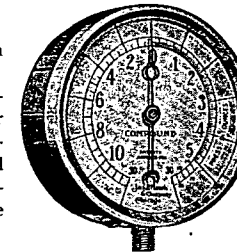
Marsh Ther-Alti-Meter



Marsh Recording Gauge



Compound Ounce Gauge



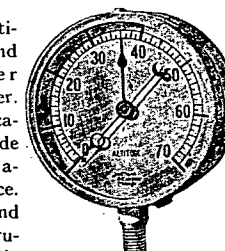
Marsh Gauges for every requirement of indicating Pressure, Vacuum, Altitude, etc. Marsh Recording Gauges where a high grade, accurate instrument is required and where it is desired to match other instruments on Gauge Boards, etc.

We specialize in Gauge Board outfits complete with all instruments.

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.

Marsh Hot Water Thermometer and Altitude Gauge



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.

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.

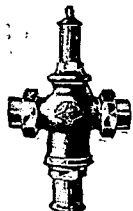
Mason Regulator Company

Boston, Mass.

San Francisco, Calif. Montreal, Canada

Manufacturers of

Pressure Regulators and Steam Specialties



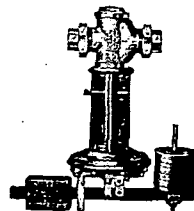
Standard Type for General Use
Sizes 1/2"-8"

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.

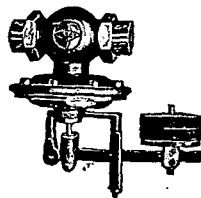


No. 229 Type
Sizes 1/2"-1 1/4"

FOR HEATING AND OTHER LOW-PRESSURE SYSTEMS



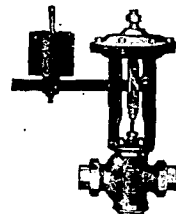
Lever Type
Sizes 1/2"-16"



Vacuum Regulating Valve
Sizes 1/2"-4"

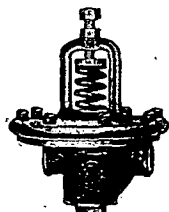
For regulating the amount of vacuum on separate branches of a main vacuum system.

Catalog
GENERAL CATALOG
GIVING FURTHER IN-
FORMATION AND DETAILS
OF THESE AND OTHER
TYPES OF REGULATORS,
WILL BE GLADLY SENT
UPON REQUEST.



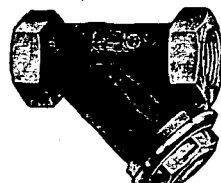
Vacuum Pump Regulators
Sizes 1/2"-4"

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.



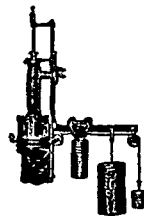
Household Water Pressure Regulator
Sizes 1/2"-1"

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 1/2"-8"

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.



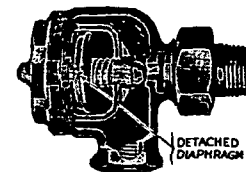
Monash-Younger Co., Inc.

ESTABLISHED 1900

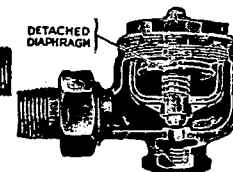
CHICAGO

NEW YORK

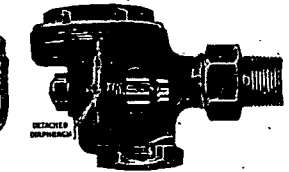
MONASH THERMOSTATIC RETURN LINE TRAPS



No. 35-A-1/2 in.



No. 35-B-1/2 in.



No. 37-1/4 in.

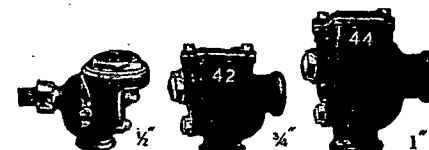
The distinctive feature of the MONASH Thermostatic Line of Traps, is the *Diaphragm*, a separate and independent unit, so constructed and so held in place that friction and strain on the *Diaphragm* is reduced to a minimum: overcoming the hazard of fracture and rupture of the *Diaphragm*.

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 1/2 in. pipe size, capacity 200 sq. ft. 65 lb. of water per hour.

The MONASH No. 37 Radiator Trap, is made only with vertical seat, and *Diaphragm* out of the Steam Chamber. Body of close-grained, gray iron, nickel plated; brass coupling nut, nipple and cover, nickel plated. Pipe size 3/4 in., capacity 600 sq. ft.; 200 lb. of 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	1/2	3/4	1
Sq. Ft. of Radiation	350	1500	5000
Water per Hour	108	475	1560
Net Weight	3.25	5.00	7.50

Monash Guaranteed Automatic Air Valves

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.



No. 1

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

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 1/2 in., 1 lb. net weight.



No. 27

Monash Thermostatic Air Line Valves

for drip or air line systems; also for venting vents to 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 1/2 x 1/2 in., the No. 3 is 1/2 x 3/4 in., 1 lb. net weight.



No. 2

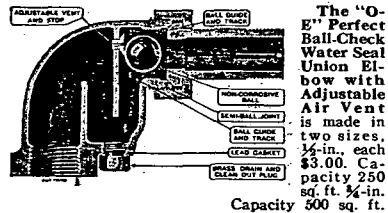
O-E Specialty Mfg. Co.

5-7-9 Keefe Ave., MILWAUKEE, WIS.

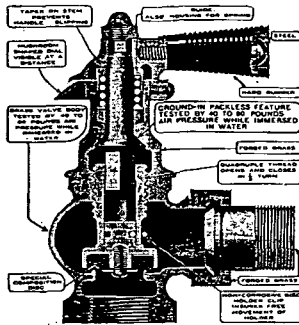
Packless Graduated Valves, Ball-Check Return Elbows, Thermo-Nickel Return Traps, Air Exhausters, Vacuum Valves, Vacuum Pressure Gages, Differential Return Traps and Balanced Swing Check Valves.

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 1/2-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.

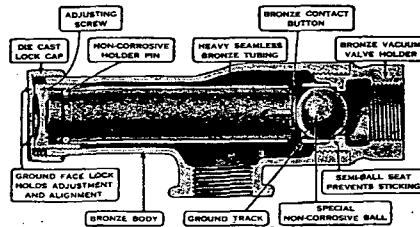
An air vent is tapped in the slot of the screw stop in the return elbow which not only allows air to escape freely into return system when Supply Valve is open, but also equalizes the pressure on both sides of Water Seal, thus preventing it from syphoning out, which it might otherwise do. All air and 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.



The "O-E" Perfect Ball-Check Water Seal Union Elbow with Adjustable Air Vent is made in two sizes, 1/2-in., each \$3.00. Capacity 250 sq. ft. 3/4-in., each \$3.00. Capacity 500 sq. ft.



List Prices—1/2 in., \$6.00; 3/4 in., \$7.50.



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., each \$10.00. Capacity 2,500 sq. ft.

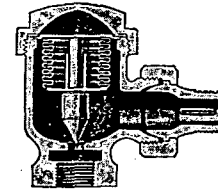
We also announce the Thermo-Nickel Return Trap, a combination thermostatic trap with a ball-check and many new features. Ask for descriptive bulletin.

Sarco Co., Inc.

233 Broadway, NEW YORK

Boston Buffalo Philadelphia Cleveland Detroit Chicago
RADIATOR, BLAST AND STEAM TRAPS, TEMPERATURE CONTROL

RADIATOR TRAP SARCO



Radiator Trap Sarco

The Sarco Radiator Trap is operated by the expansion and contraction of a very sensitive liquid.

A slight change of temperature causes a wide open movement of the valve.

Its positive action keeps radiators thoroughly drained, preventing water hammer and air binding and increasing the heating value of every pound of coal burned.

The life of the spirally corrugated expansion element in the Sarco exceeds many times that of annularly corrugated tubes because its movement at any point of the tube is so slight that it is hardly perceptible due to the stress in expansion and contraction being distributed evenly over the entire surface.

Even if scale does reach the seat, it is practically impossible for it to collect there, for line contract only is had between the cone and seat of the valve.

The Sarco can be shipped without elements so that when operating as a gravity system all the scale and dirt can be washed out. The elements can then be easily dropped into place and the trap will function perfectly.

Removing the elements does not affect the adjustment because they are not attached to the body or cap. The Sarco is factory adjusted.

Brass castings are free from blow-holes or other defects and are exceptionally

SARCO RADIATOR TRAP SPECIFICATIONS

Size inches	1/2	3/4
Length over all inches	3 3/8	3 3/8
Distance, center of Inlet to face of Outlet, inches	1 1/2	1 1/2
Distance, center of Valve to face of Inlet, inches	3 3/4	3 3/4

Write for Steam Trap Bulletin.

heavy. There is no danger of cracking or straining the trap when connecting same. Made in 1/2, 3/4 and 1 in. sizes for vacuum, vapor and steam heating systems at pressures up to 25 lb.

Booklet 112 on request.

SARCO TEMPERATURE REGULATOR

Operated by an extremely sensitive liquid, the Sarco Temperature Regulators are instantly responsive to the slightest fluctuations in the temperature of atmosphere or liquids.

They are entirely self-contained and operated. No electrical, compressed air or other outside attachments are required for their operation. There are no rubber or leather diaphragms or complicated perishable parts.

The Sarco costs less than any other dependable control and is easily installed. There is no cost for operating.

Sarco Regulators operate steam, water and gas valves 1/2 to 6 in. They have 6 ft. of connecting tubing between elements, which can be increased where conditions necessitate. Supplied for any temperature between 30 and 300 deg. Fahr. Ask for Booklet 77.



Type T. R. 21 for Air Ducts and Tanks

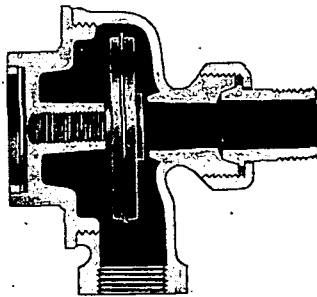
TEMPERATURE CONTROL SPECIFICATIONS

Size In.	Weight Lbs.	Face to Face of Valve, In.	List Price T. R. 21	List Price K. R. 14
1/2	8	2 3/4	\$75.00	\$60.00
3/4	8	2 3/4	80.00	65.00
1	9	3 3/8	85.00	70.00
1 1/4	13	4 1/2	90.00	75.00
1 1/2	22	5	95.00	85.00
2	28	6	100.00	95.00
2 1/2	37	7 1/4	115.00	110.00
3	51	8 3/4	130.00	125.00
4	81	13 1/4	170.00	165.00
5	132	15 3/4	225.00	215.00
6	158	18	275.00	265.00

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 diaphragm 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.

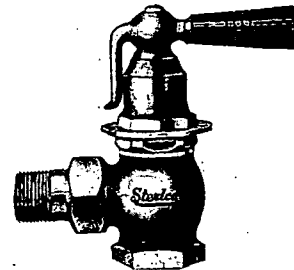
Capacities and Sizes

No.	Size	Capacity
2	1/2"	Up to 200 sq. ft. rad.
3	3/4"	200 to 500 sq. ft. rad.
4	1"	500 to 1000 sq. ft. rad.

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	Min. Height Return above Water Line	Length Overall	Shipping Weight	List Price
1	2000	1 1/2"	3/4"	1/2"	14"	20 1/2"	150	\$100.00
2	4000	2"	1"	3/4"	16"	26"	190	125.00
3	6000	2 1/2"	1 1/4"	1"	18"	32"	250	150.00

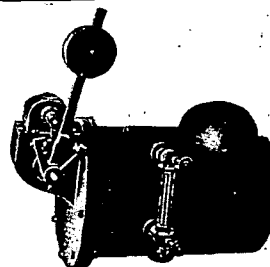


STERLCO GRADUATED PACKLESS VALVE

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

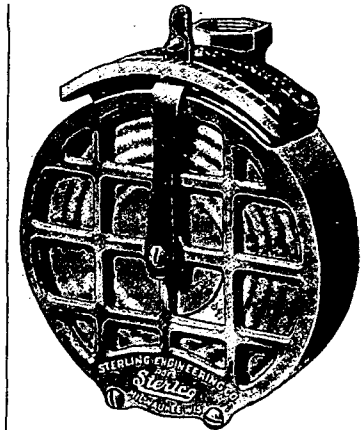
Size	Capacity
1/2" x 1/2"	0 to 20 sq. ft. rad.
3/4" x 3/4"	20 to 50 sq. ft. rad.
1" x 1"	50 to 100 sq. ft. rad.
1 1/4" x 1 1/4"	100 to 200 sq. ft. rad.
1 1/2" x 1 1/2"	200 to 300 sq. ft. rad.



STERLCO-ROYS TEMPERATURE CONTROL

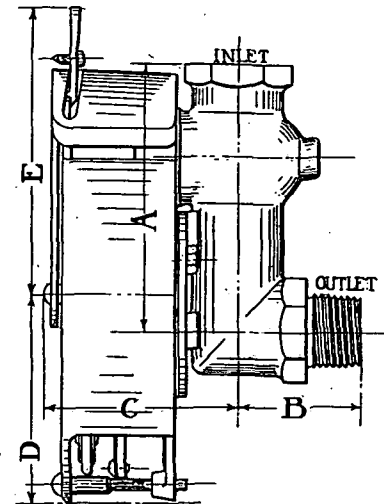
Description and Operation

The Sterlco-Roys Temperature Control 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 from 60 to 80 deg. The regulator can be set to operate at any desired temperature marked on the scale by moving the lever through a slot in the scale.



We Manufacture the following Sterlco Products:

Thermostatic Traps,
Packless Radiator Valves,
Air Line Valves,
Return Traps,
Air Eliminators,
Vacuum Pumps,
Condensation Pumps and Receivers,
Air Line Vacuum Pumps,
Strainers,
Temperature Regulators.



SIZE	CAPACITY					
	Sq. Ft. of Radiation	A	B	C	D	E
1/4"	Up to 60 sq. ft.	3/4"	1 1/8"	2 3/8"	3 1/8"	4 1/8"
1"	61 to 125 sq. ft.	4"	2 1/8"	2 3/4"	3 3/8"	4 3/8"
1 1/4"	126 to 200 sq. ft.	4 1/4"	2 3/8"	2 7/8"	3 3/8"	4 1/8"

VAPOR-VACUUM DIVISION
(See also Pump Division)

The Trane Company

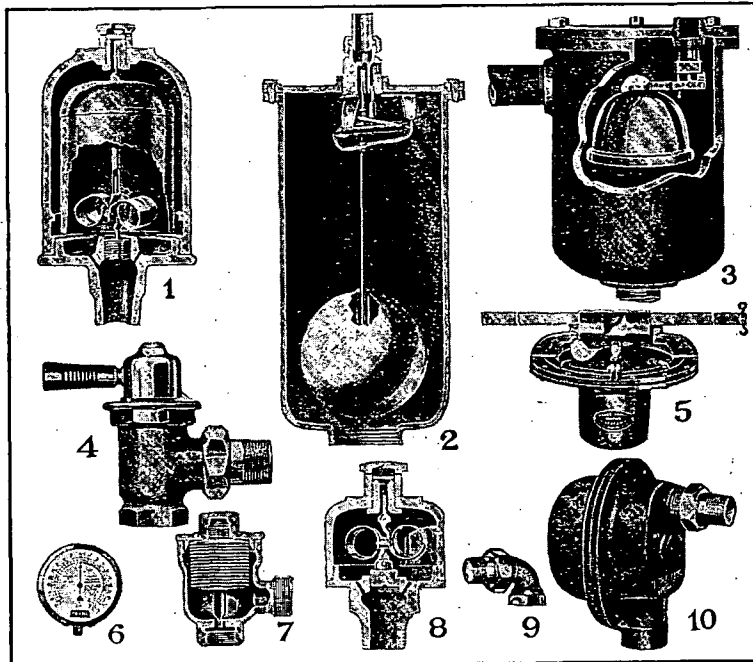
La Crosse, Wis.

BRANCH OFFICES

NEW YORK	BUFFALO	CHICAGO	MINNEAPOLIS	FT. WAYNE
BOSTON	DETROIT	SEATTLE	SALT LAKE CITY	PORTLAND, ORE.
PHILADELPHIA	CLEVELAND	ALBANY	ATLANTA	GREENSBORO, N. C.

England—22-23 CLERKENWELL CLOSE, LONDON, E. C. 1.
Canada—THOMAS ROBERTSON & CO., LTD., 134 CRAIG ST., WEST, MONTREAL
THE GRANT E. COLE CO., 23 RIVER ST., TORONTO

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 $\frac{1}{4}$ in. venting ports. $\frac{3}{4}$ inch pipe connection only. Weighs 4 lb.

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 of the boiler under all operating conditions. Two sizes: 400 and 2,000 sq. ft.

No. 4 Trane Graduated Vapor Valves are identified as the sleeve valves with the Jenkins' Discs. Furnished in $\frac{1}{2}$, $\frac{3}{4}$, 1 and $1\frac{1}{4}$ -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.

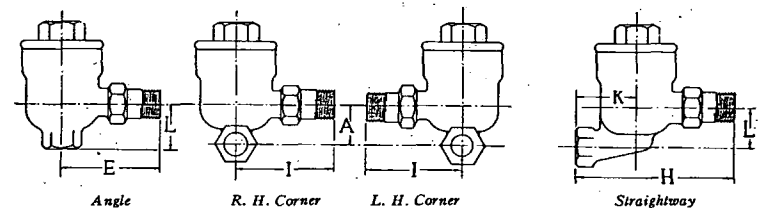
No. 6 Trane Pressure-Vacuum Gauges register to 30 lb. pressure and 18 in. vacuum. Also furnished to register to 30 in. vacuum only over entire scale. $4\frac{1}{2}$ -in. face. $\frac{1}{4}$ -in. pipe connection.

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.

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. $\frac{3}{4}$ -in. pipe connection.

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 Float Drip Traps will drip mains without regard to temperature of the water. Rated capacity, 500 sq. ft. with pressure difference of $\frac{1}{4}$ lb. Capacity increases with increased pressure difference to 20 lb. Float tested for 150 lb. Trap is made in $\frac{3}{4}$ -in. size only.



Style	Size Inches	Capacity Sq. Ft. 4 oz. Pres. Difference	DIMENSIONS, INCHES					
			A	E	L	H	I	K
No. B2	$\frac{1}{2}$	125	$1\frac{1}{8}$	$\frac{3}{4}$	$1\frac{1}{8}$	$5\frac{1}{8}$	$\frac{3}{4}$	$1\frac{1}{8}$
No. B3	$\frac{3}{4}$	375	$1\frac{1}{8}$	$\frac{3}{4}$	$1\frac{1}{8}$	$5\frac{1}{8}$	$\frac{3}{4}$	$1\frac{1}{8}$
No. B4*	1	750	...	$3\frac{1}{8}$	$1\frac{1}{8}$	...	...	...

*Made in angle pattern only.

Sizes conform to recommendations of Heating and Piping Contractors' National Association.

Stickle Steam Specialties Co.

Main Office and Works, INDIANAPOLIS, IND.

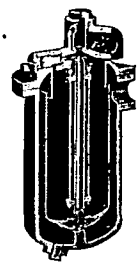
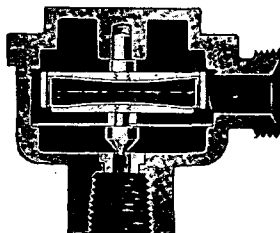
NEW YORK OFFICE
46 E. 41st St.

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.

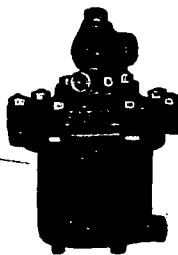
STICKLE THERMOSTATIC RADIATOR TRAP

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 valve has a free movement of $\frac{1}{4}$ in. attached to plate on which the diaphragm rests suspended centrally by flat leaf bronze spring making a positive valve action supplementing the spring action of the diaphragm.



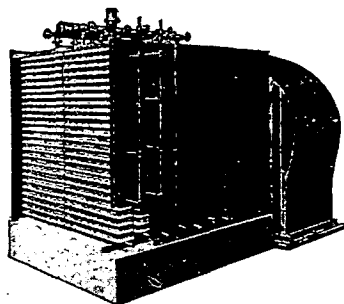
STICKLE THERMIC VACUUM TRAPS

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 in. 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.



WARREN WEBSTER & COMPANY

ESTABLISHED 1888

CAMDEN, NEW JERSEY, U. S. A.

BRANCH OFFICES AND REPRESENTATIVES

Atlanta	Cincinnati	Easton	Minneapolis	Raleigh, N. C.	Spokane
Atlantic City	Cleveland	Grand Rapids	New Orleans	Richmond	Tampa, Fla.
Baltimore	Columbus, Ohio	Indianapolis	New York	Rochester	Toledo
Birmingham	Dallas	Kansas City	Omaha	Saginaw	Tulsa
Boston	Denver	Los Angeles	Philadelphia	St. Louis	Washington
Chattanooga	Des Moines	Louisville	Pittsburgh	San Francisco	Wilkes-Barre
Chicago	Detroit	Milwaukee	Portland, Ore.	Seattle	

Sole Representatives and Manufacturers for Canada

DARLING BROTHERS, Limited

Montreal Toronto Halifax Ottawa Winnipeg Calgary Vancouver Quebec
London, England: THE ATMOSPHERIC STEAM HEATING CO., Ltd.

MANUFACTURERS OF SPECIALTIES FOR WEBSTER SYSTEMS OF STEAM HEATING—OVER 30,000 INSTALLATIONS

Webster Products

Webster appliances for use with Webster Vacuum and Modulation Systems of Steam Heating include:

- Siphon Traps (701)
- Siphon Attachments (801, 804, 851)
- Modulation Supply Valves (705-3)
- Siphon Quick-Opening Packless Supply Valves (705-51)
- Double-Service Valves (722)
- Number Seven Traps (diaphragm type) (702)
- Dirt Strainers (709)
- Heavy-Duty Traps (706-2)
- Water Accumulators (725)
- Expansion Joints (packed type) (1100)
- Siphon Expansion Joints (packless type) (1151-1)
- Lift Fittings (713)
- Suction Strainers (707)
- Damper Regulators (718)
- Vent Traps and Vent Valves (717)
- Boiler-Return Traps (726)
- Vacuum-Pump Governors (708)
- Hy-lo Traps and Controllers (710)
- Gauges (pressure and vacuum) (B-500)
- Grease Traps (401A)
- Air-Separating Tanks (714)
- Hydro-Pneumatic Tanks (715)

Each Webster appliance has been designed to meet specific conditions arising in connection with installations of Webster Systems of Steam Heating.

Other Webster Products include:

- Steam Separators (301-A)
- Oil Separators (401-A)
- Steam Traps (bucket type)
- Feed-Water Heaters (cast-iron) (wrought-iron) (102)
- Webster-Lea Heater Meter (200)

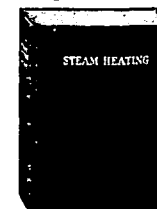
Detailed catalogue data concerning Webster Products may be had on request. Catalogue numbers are noted alongside name of product listed above.

Webster Service

Is an integral part of every Webster System, delivered through branch offices in each of the cities listed above.

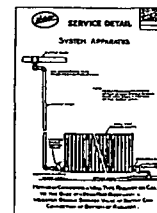
Webster Service places the accurate, comprehensive information resulting from the extensive experience of this organization at the disposal of consulting engineers, architects and heating contractors. The close co-operation of the Webster organization, and the services described in the next column are available without obligation to all engineers.

Steam Heating



A manual of practical data compiled by the General Engineering Committee of the Company. Not a catalogue, but a text book on the subject that has been highly praised by many engineers and adopted as text in several universities.

Service Details



Webster Service Details show 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. As new methods and equipment are developed, new Details are issued to all holders, making this engineering data of maximum usefulness. The use of Webster Service Details saves a substantial amount of the designers time in laying out a system and insures correct installation of each job.

Catalogue Bulletins

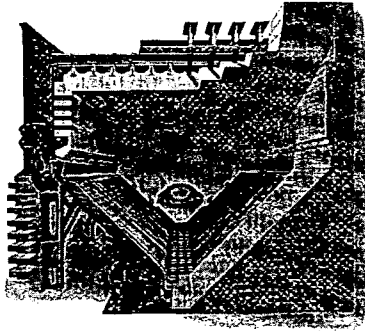
Webster Catalogue Bulletins describe Webster appliances from the standpoint of the engineer, providing complete tables, drawings and other technical data. Issued in standard loose-leaf catalogue size for convenient reference.

Detroit Stoker Company

Underfeed Forced Draft and Overfeed Natural Draft Stokers

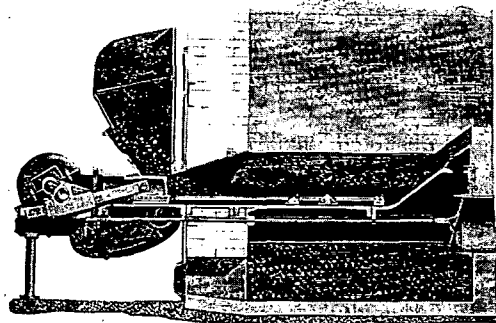
369 General Motors Bldg.

Detroit, Michigan



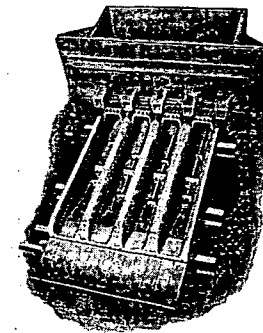
Detroit "V" Type Natural Draft Stokers for boilers from 50 up to 600 H. P. Successfully burns all grades of bituminous coal, wet tan bark, wood refuse, etc. Widely used in heating, hundreds being installed in schools, public and office buildings, large apartments, hotels, etc.; insuring complete combustion 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.



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.



Detroit Multiple Retort Underfeed Stoker is "Built on Advanced Engineering Principles." While designed for large units and high ratings it is equally well adapted for boilers of 300 H. P. and upwards. Burns Illinois, Indiana and all Eastern bituminous coals, with high efficiency.

Design makes possible ash removal at boiler room floor level and in many cases eliminates the basement or ash tunnel construction.

Outstanding features are: The level fuel bed, which, with positive control of fuel movement eliminates avalanching and regulates combustion; mechanically driven adjustable rams. Ask for Bulletin 169.

Aero-View Detroit Multiple Retort Stoker

Sanford Riley Stoker Co.

"RILEY"
Underfeed Stokers

"JONES"
Underfeed Stokers
WORCESTER, MASS.

"MURPHY"
Automatic Furnaces

BOSTON CINCINNATI NEW YORK CHICAGO PHILADELPHIA ST. PAUL PITTSBURGH KANSAS CITY BUFFALO DENVER CLEVELAND CHARLOTTE DETROIT DALLAS
THE UNDERFEED STOKER COMPANY OF CANADA, LTD., TORONTO

The Murphy Furnace

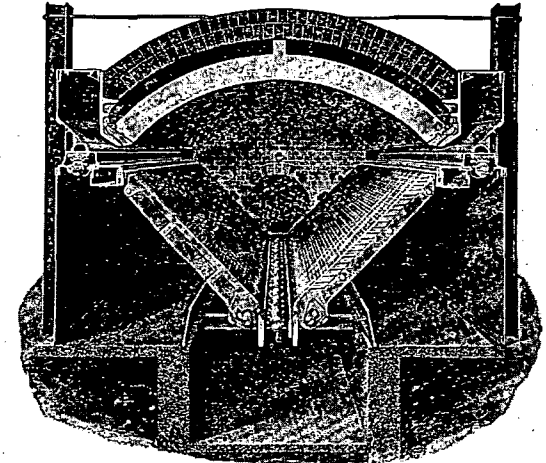
The Murphy Automatic Furnace is particularly adapted for use in office buildings, hotels and schools. It saves 15 to 25% of coal over hand-fired methods—it eliminates the smoke problem. The labor saving depends on the number of men employed. Where only one man is employed there is, of course, no saving, but he can devote more of his time to other duties.

Description

The correctness of the principle upon which the construction of the MURPHY AUTOMATIC FURNACE is based has been demonstrated by 44 years of stoker experience. Improvements have been made from time to time which have increased its efficiency and durability. With the MURPHY AUTOMATIC FURNACE, complete combustion prevents smoke and ensures high CO₂ results. 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 for opening furnace doors and thereby eliminates the admission of cold air; the coal supply to the furnace is under absolute control and automatic regulation; it is a Natural Draft Furnace and requires no expensive fan or blower equipment.

Adaptability

The Murphy Furnace is designed for any type of boiler in units from 50 h.p. up. It is exceedingly flexible and efficiently handles variable loads and overloads up to 200% of boiler rating with minimum attention and without forced draft.



The Murphy Automatic Furnace

Maintenance

Maintenance cost is low; averaging about 10 cents per B. H. P. per year. The magazines and fronts are protected by fire brick; the coking plates by air passing under them; and the clinker grinder, grate bearer and grates by exhaust steam and air, thus ensuring ample protection to all working parts.

Installations

A few of the many Murphy installations in office buildings, hotels and schools. Hamm Building, St. Paul, Minn. Cleveland Discount Bldg., Cleveland, O. State Office Building, Lansing, Mich. Parliament Building, Ottawa, Canada. Edison Building, Chicago, Ill. Lafayette Hotel, Buffalo, N. Y. Blackstone Hotel, Chicago, Ill. Union Bank Bldg., Pittsburgh, Pa. Congress Hotel, Chicago, Ill. Statler Hotels, Cleveland, O., Detroit, Mich. Phillips Andover Academy. University of Chicago. 76 School buildings in Detroit. 33 Schools in Cleveland.

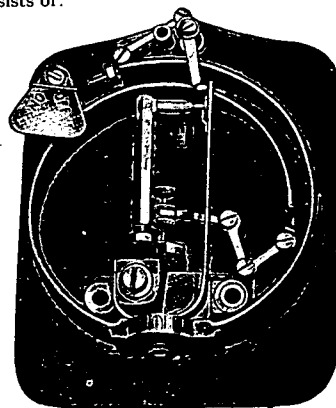
Heat Control Service Co., Inc.

759 Park Place

BROOKLYN, N. Y.

Manufacturers of
Automatic Temperature and Humidity Control Systems

Uniform heating of a building is best accomplished with a dependable system of automatic temperature control and this company has developed and perfected an air pressure dual system of high efficiency, accuracy and durability. The system consists of:



"Thermatrol"

- (1) An all metal dust proof and fool proof Thermostat—the "Thermatrol"—without springs, diaphragm or delicate mechanism to get out of adjustment.
- (2) A Diaphragm Supply Valve on each Radiator to be controlled, or diaphragm motor controlling dampers on heat ducts.
- (3) An air compressor and tank—All connected to a system of concealed air piping.

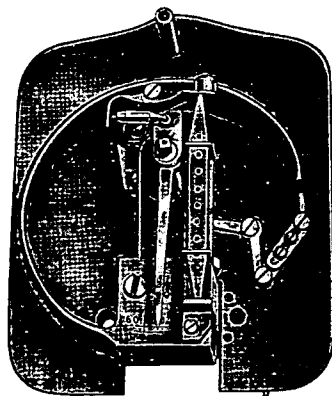
An all metal system throughout.

This system operates through the maintenance of an air pressure, which is variable 10 lbs. or 15 lbs. respectively, obtained in the boiler room from the compressed air tank and controlled by a reducing valve and pressure gauge.

The unique and most important feature in the operation of the "Thermatrol" is the unit control which positively assures the following temperatures—a high of 70 deg. when the room is in use and a low of 35-40 deg. (in freezing or zero weather) when not in use, without additional adjustment and without effecting the sensitive-

ness or accuracy of the "Thermatrol" in any way. The unit control makes it possible to shut off the heat in any room, automatically, while all other rooms in the building are heated. Thus absolute control of the temperature in any room in the entire building is given.

Unit control works as follows: mounted on each "Thermatrol" is a Bourdon tube directly connected with the air pressure system, so that this tube is directly affected by an increase or decrease in air pressure. During the day, an air pressure of 15 lbs. is carried on the system, which operating through the "Thermatrol" allows heat to enter the radiators and maintain an even temperature of 70 deg. At night a pressure of 10 lbs. is carried causing the Bourdon tube to contract and close the Diaphragm valve so that no heat enters the radiator until the temperature 35-40 deg. is reached, then the "Thermatrol" will function. If heat is required in the room at night, at the higher temperature move the indicator on the "Thermatrol" to the "on" position and this instrument will then function at the temperature at which it is set and heat the room accordingly. This indicator will automatically return to the "off" position when the air pressure is again raised to 15 lbs. Should it be necessary



"Humitrol"

to heat a room every night, the indicator can be locked in the "on" position which will prevent automatic re-adjustment. Locking the "Thermatrol" in the "on" position would be termed "Season Control" and is particularly effective in buildings where certain rooms are to be heated every night.

The Dualstat is made for controlling two different units at two different temperatures; for instance—one will control direct radiation at 68 deg. and the other will operate the damper motor at 70 deg.

These systems are in successful operation in schools, offices, hotels, residences,

drying units and central stations. Forty schools in New York have been equipped with this system of control.

The "Humitrol" operates on exactly the same principle and is as efficient, dependable and accurate as our "Thermatrol." The control apparatus is practically the same, with this exception, the bi-metal element is replaced with a specially prepared piece of hard maple which is just as sensitive and responsive to slight changes in humidity as the bi-metal element is to temperature change. We are able with this moisture regulator to control the degree of moisture in the air at all times and under any conditions.

Why The "Thermatrol" Insures Economical Heating

School Buildings: One or more rooms may be heated without heating the entire building. Lavatories, shower rooms, offices, assemblies, gymnasiums, etc. may be heated individually.

In rooms where the temperature has a tendency to fall below the average temperature of nearby rooms, same may be heated during the night by concentrating the heat on these rooms only. This allows the general heating of the building to be delayed to a later hour in the morning. This means that all of the heat produced does effective work and therefore the value of every B.t.u. of fuel burned is realized.

Office Buildings: In average winter weather all rooms in use are heated to a temperature of 70 deg. while those not in use are kept at 45 deg. After 6 p. m. only those rooms which are in use are heated. Any tenant desiring heat, however, may press the button on the thermostat and obtain a temperature of 70 deg.

When the lower floors are used for banking purposes it is often desirable to have these heated in mild

weather although the upper floors do not require it. Such an arrangement is possible with our system. If exhaust steam is used to heat a building a unit of proper size should be operated to carry the power load efficiently, the exhaust from same will be sufficient to heat the rooms in use. This means economy in first cost and in service.

Hotels, Apartments, etc: The Unit Control provides a temperature of 70 deg. in all rooms in use, and 45 deg. in the others from 6 a. m. to 1 a. m. From 1 a. m. to 6 a. m. heat is shut off in the entire hotel with the exception of the office, lobby, and halls, but any guest may have heat by pressing the button on his thermostat.

Churches, Offices, halls, meeting room, etc. may be heated during the week without heating the entire building. This means constant comfort in the rooms used and saves a large amount of fuel, for the peak load comes only intermittently.

Our engineering department is ready to cooperate in solving your problems.

Johnson Service Company

Milwaukee, Wis..

BRANCHES:

ALBANY, N. Y., 279 S. Manning Boulevard
ATLANTA, GA., 72 Marietta Street
BOSTON, MASS., 31 Waltham Street
BUFFALO, N. Y., 2 Erie County Bank Bldg.
DALLAS, TEXAS, 324 N. Ervay Street
CHICAGO, ILL., 1355 Washington Blvd.
CINCINNATI, OHIO, 319 Gwynne Building
CLEVELAND, OHIO, 2028 East 22nd Street
DENVER, COLO., 1228 California Street
DES MOINES, IOWA, 210 Masonic Temple
DETROIT, MICH., 42 Montcalm Street, West
INDIANAPOLIS, IND., 111 Pembroke Arcade

KANSAS CITY, MO., 411 East Tenth Street
MILWAUKEE, WIS., 149 Michigan Street
LOS ANGELES, CAL., 605 Van Nuys Bldg.
MINNEAPOLIS, MINN., 308 Third Ave., South
NEW YORK, N. Y., 118 East Twenty-eight Street
PHILADELPHIA, PA., 258 S. Van Pelt
PITTSBURGH, PA., Century Building
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

CANADIAN REPRESENTATIVE:

Johnson Temperature Regulating Company of Canada, Limited

OFFICES:

CALGARY, ALTA, 605 Second Street, West
VANCOUVER, B. C., 550-6th Avenue, West
MONTREAL, QUE., 127 Madison Ave., Notre Dame de Grace

TORONTO, ONT., 145 Wellington 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.

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 and Rubber Diaphragm Valves.

Low Pressure, Limited Capacity, Electric Air Compressors.

Low Pressure, Limited Capacity, Hydraulic Air Compressors.

Air and Water Reducing Valves.

Pneumatic Switches or Push Buttons.

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—Specify Johnson Metal Diaphragm Model Thermostat, size, $4\frac{1}{2} \times 2 \times 1$ 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 com-

pressor 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.

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 Positive Acting Metal Diaphragm Thermostat

The only thermostat on the market provided with positive snap action for closing and opening the radiator valve quickly, positively and fully, which is necessary with steam heat.

Indicator and Cut-off

It is the only thermostat having an indicator which will show at a glance whether the thermostat has the heat turned on or off. A cut-off is provided for shutting the heat off permanently when desired.

Johnson Graduated Acting Thermostat

This thermostat is ideal for controlling mixing dampers admitting hot and tempered air to the room in which the thermostat is located. The graduated action consists in automatically maintaining the hot and tempered air blades of the mixing damper at just the



Model Positive Metal Diaphragm Thermostat

right relative position to deliver a mixture of air that will keep the rooms at a uniform temperature. When the temperature reaches the point at which the thermostat is set to operate, it will hold the mixing dampers in an intermediate position.

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.

The P type is a pressed metal cover, very finely finished but not as ornamental 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.

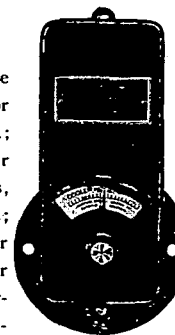


Model R. I. Cover
 4 1/4" x 2" x 1 1/4" deep

This thermostat is made either positive or graduated acting.

Applications

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.



Pneumatic Insertion Thermostat

Johnson Calibrated Thermostat

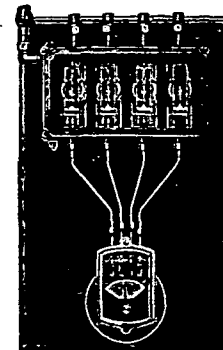
This is an especially high grade insertion thermostat for use where it is desired to change frequently the adjustment to operate at different temperatures. It is operated by compressed air at 15 lb. per sq. in., and used to control temperatures of liquids and air by automatically opening and closing 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.

Humidity Control

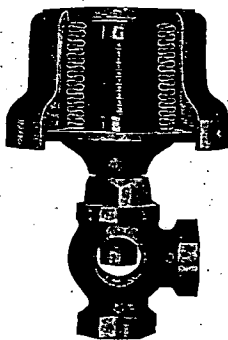
The supplying of moisture to the heated air in buildings and the automatic control of the percentage of moisture in this air are recognized by authorities to be as important as maintaining proper temperatures.

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

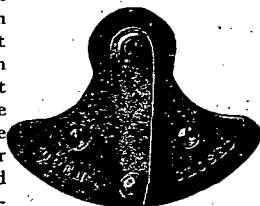
This valve having an indestructible 1-piece metal diaphragm, is permanent and requires no repairs. Its value for the control of steam is obvious and particularly so in connection with steam coils, registers in wall boxes where excessive heat would destroy rubber diaphragms.



"Sylphon" Metal Diaphragm Valve

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.

Time Valve Control

Simple device for automatically and periodically opening and closing a diaphragm valve.

Has many applications, such as periodically flushing of toilets, etc. Being simpler and more powerful in action, it is much superior to float tanks. Eight-day clock valve mechanism operates diaphragm valve on water supply by means of compressed air. Valve may be operated from 1 to 4 times per hour and for periods of 15 seconds to 5 minutes.

The Powers Regulator Co.

33 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.
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.

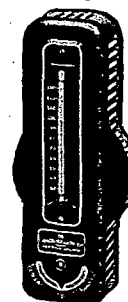
THE CANADIAN POWERS REGULATOR CO., LTD., TORONTO, ONT.

BRANCHES
CALGARY, MONTREAL, WINNIPEG, VANCOUVER

Products and Services

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 condition of artificial heating where uniform temperature is desired. Automatic Temperature Devices for controlling hot water and other tank heaters, hot water lines, shower baths, mixing hot and cold water, cold water and steam, and other operations of a similar character.

Heating systems, and the requirements for temperature control, vary widely in detail. Special study should be given each case, so that its particular requirements may be intelligently handled. Much of the dissatisfaction experienced with some temperature regulating apparatus 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.



K Thermostat

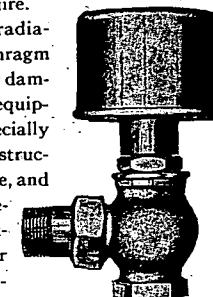


D Thermostat

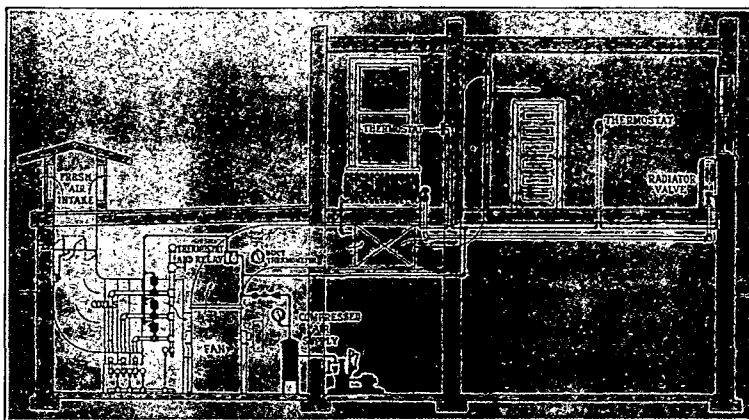
Temperature Controlling Appliance

Powers thermostats are accurate in their working and will maintain their adjustment. They are of the vapor disc type, exclusive with Powers regulators, and is not thrown out of adjustment by extremes of temperature or long disuse. For over 30 years this 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.



All-Metal Radiator Valve



Application of Powers Control to Combination (Split) System—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.

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.

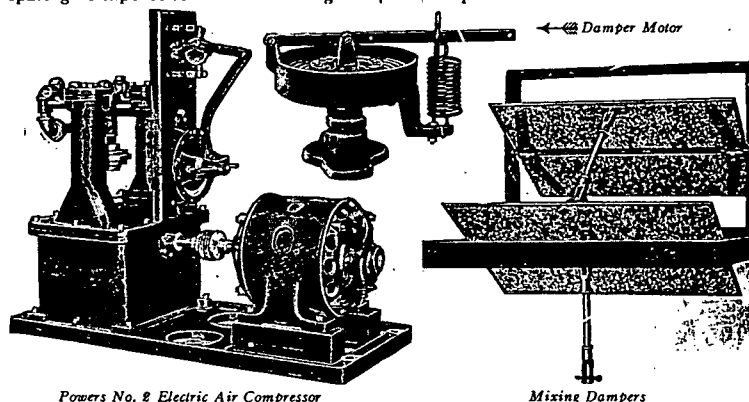
Installations

Installations of Powers systems are invariably made by this 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 as efficient and economical. Customers are served with the sole aim of getting results for them; and experience shows that satisfactory



Powers No. 2 Electric Air Compressor

Mixing Dampers

service from a temperature controlling system is of much more importance than its first cost.

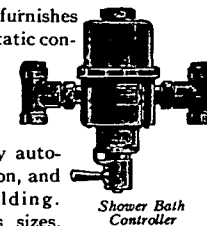
Specifications

An opportunity is solicited 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.

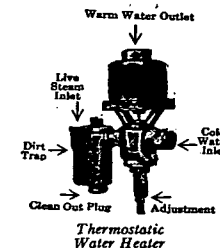
Shower Bath Controller

This device furnishes absolute thermostatic control of water supply to shower baths, either singly or in gangs. Entirely automatic in operation, and safe against scalding. Made in various sizes, up to 20 shower heads. Maximum temperature 110° F. unless otherwise specified. Bulletin 124 gives full information and prices.



Thermostatic Water Heater

Heats water with high pressure steam. Thermostatically controlled. Used to heat water for washrooms, sinks, and shower baths in factories, and on all industrial processes where an instantaneous supply of warm water is desired. Bulletin 137 shows its application, prices, etc.



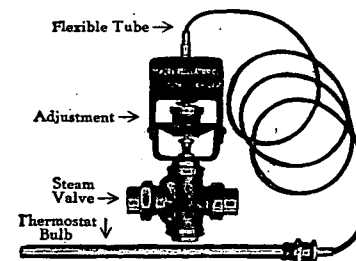
Tank Temperature Regulation

No. 11 Regulator controls temperature of liquids of all kinds under all conditions. Self-contained; requires no water or other auxiliary operating power. All metal. Of great durability, guaranteed accurate and positive in action. Easily installed. Used

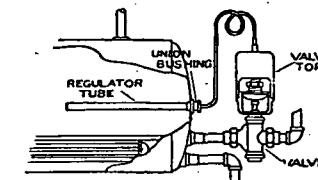
on hot water tanks and heaters, glue heaters, paraffin and grease tanks, etc.

No. 12 Regulator, same as No. 11, with lever instead of spring adjustment. On request, it is furnished complete with chains and pulleys, for control of dampers of auxiliary coal burning tank heaters, both heat sources being controlled with one regulator.

For more detailed information, send for Bulletin 129.



Powers No. 11 Tank Regulator



Application of Tank Regulator

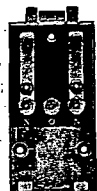
Honeywell Heating Specialties Company

Wabash, Indiana

Manufacturers of Honeywell Temperature Regulators for Residential or other Heating Plants—Hot Water, Vapor, Steam, or Hot Air.



Model S 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

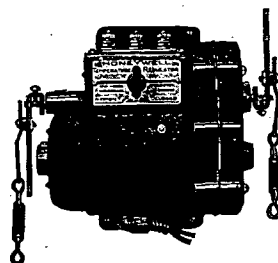
MODEL G-4, Plain non-automatic night-to-day temperature regulation	\$38.00
MODEL G-6, One-day clock pattern thermostat, automatic night-to-day temperature regulation	45.00
MODEL G-8, Eight-day automatic thermostat, automatic night-to-day and day-to-night temperature regulation	58.00

Spring Motor Models

MODEL 4, Plain non-automatic night-to-day temperature regulation	\$45.00
MODEL 6, One-day clock pattern thermostat, automatic night-to-day temperature regulation	52.00
MODEL 8, Eight-day automatic thermostat, automatic night-to-day and day-to-night temperature regulation	65.00

Electric Motor Models

MODEL 14, Plain non-automatic night-to-day temperature regulation	\$70.00
MODEL 16, One-day clock pattern thermostat, automatic night-to-day temperature regulation	77.00
MODEL 18, Eight-day automatic thermostat, automatic night-to-day and day-to-night temperature regulation	90.00



New Type Electric Motor

The Heating 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.

Readers

Heating and Ventilating Engineers.

Board of Education Engineers.

Superintendents of Central Station Heating Plants and the big Heating and Piping Contractors throughout the United States.

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.

Reader Interest

The reader interest is keen and genuine as evidenced by a circulation obtained without a subscription solicitor or agent. It is maintained by a well-rounded editorial program devoted to progress in the heating and ventilating field. The program includes and provides for the publication of original articles by recognized engineers describing the latest ideas successfully applied in heating, ventilating and air conditioning. Another important feature is the monthly publication of four pages of standard Heating and Ventilating data for use by Engineers in the design and layout of heating and ventilating systems.

Rates

Single insertion.....\$69.00 per page
Twelve consecutive insertions..... 58.00 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.

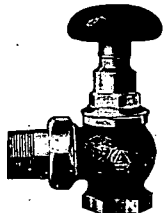
DETROIT LUBRICATOR COMPANY

DETROIT, U. S. A.

NEW YORK

CHICAGO

Largest Manufacturers of Radiator Valves in the World



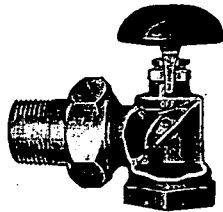
Detroit Packless Radiator Valve

The "Genuine Detroit" Spring and Disc Packless Radiator Valve has been developed to fulfill the need for a radiator valve that will not leak around the stem nor need repacking. It does away with the trouble and expense of leakage to which ordinary valves are subject and its construction makes it particularly adapted for use on vacuum systems where tightness is essential.

Its handsome appearance harmonizes with good surroundings and makes it suitable for use in homes, office buildings, hotels, etc.

Complicated parts are eliminated, so that the valve is simple in construction and so substantial that it carries the assurance of satisfactory service over a period of years. It is quick opening—opens and closes with less than a full turn of the handle—is easy turning and is equipped with a new type of non-breakable round handle, with a permanent, black, hard rubber finish.

Manufactured in angles, corners and globes $\frac{1}{2}$ to 2 in. sizes. In satin nickel finish with polished trimmings.



Detroit No. 101
Quick Opening Hot Water Valve
Pat'd June 26, 1923

The "Genuine Detroit" No. 101 Quick Opening Hot Water Radiator Valve, Packed Type, is designed to overcome the difficulties of hard turning, always encountered with shell type valves. It operates on the principle of an elliptic swinging plate—set at 45 deg. angle—which is attached to the stem. By revolving the handle one-half turn to the left, the valve is opened, while one-half turn to the right closes it. The narrow edge of the plate presents a very small area of contact with the body, so that any corrosion or encrustation—due to impurities in the water—is easily broken away. This construction insures the valve turning easily even after years of service.

The interior plate is concave so that a passage of true elbow shape through the valve is developed when the plate is in full open position. This shape offers much less resistance to the flow than is the case with valves of the shell type, where the liquid is forced to turn at a right angle.

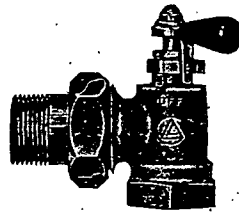
It is particularly sturdy in design with a stem which will stand hard usage and is equipped with a new type of non-breakable handle, handsome in appearance, and with a permanent, black, hard rubber finish.

An indicator attached below the handle travels between two stops on the body marked "off" and "on" so a glance shows whether the valve is opened or closed.

The stuffing box is of gland form and easily adjusted to prevent leakage around the stem.

The "Genuine Detroit" Equalizing Hot Water Radiator Valve is a valve of the above type equipped with a movable stop collar mounted on the neck and which provides a means of securing a uniform flow through each radiator, and permits the systems to be easily and accurately balanced, and perfect circulation insured. The handle pointer engages this collar, creating the "on" position. The adjustment is a very simple exterior one easily made by the fitter after the valve is installed and the system is in operation.

Specify "GENUINE DETROIT" Valves and get insurance of constant satisfaction.



Detroit No. 105
Equalizing Hot Water Valve

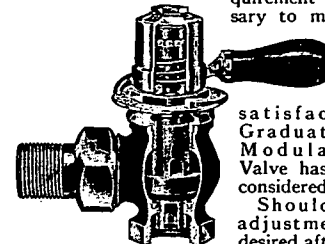
The Dole Valve Company

1923-1933 Carroll Avenue, CHICAGO, ILL.

Manufacturers of a Complete Line of High Grade Packless Radiator Valves and Automatic Air Valves

DOLE GRADUATED PACKLESS RADIATOR VALVES

A short study of the sectional view shown will indicate that in designing the Dole Packless Graduated Valve every requirement necessary to make a



Lever Handle Type of Dole Packless
Fig. S 218

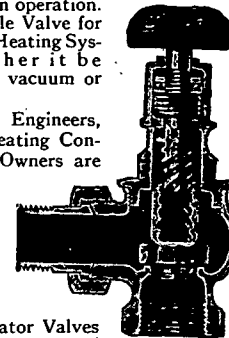
satisfactory Graduated or Modulating Valve has been considered.

Should any adjustment be desired after the valve is installed merely loosen octagon nut on top of dial with special wrench which is furnished for the purpose, turn dial to left to the desired point, then tighten nut.

Vapor or Vacuum Systems are an acknowledged modern method of Scientific Heating.

Dole Packless Graduated Valves have proven particularly valuable in the proper functioning of many of the most successful systems now in operation. There is a Dole Valve for every type of Heating System—whether it be steam, vapor, vacuum or hot water.

Mechanical Engineers, Architects, Heating Contractors and Owners are becoming better acquainted, as time goes on, with the quality and satisfaction which Dole Packless Radiator Valves offer. The majority of the above-mentioned endorse Dole Valves in the most hearty manner, realizing that quality, satisfaction and price are the three outstanding features of the Dole Packless Radiator Valve—the valve with the exclusive feature, Ball-Bearing Construction.



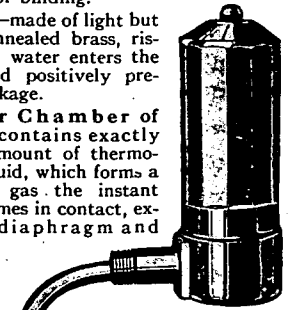
Knob Handle Style of Dole Packless
Fig. S 100

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.

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



Dole Syphon Air Valve
Fig. 600

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.

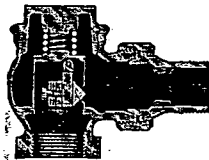
Syphon—made of one-piece annealed brass tubing, formed to perfect shape to fit inside of radiator column. Assembled into valve free from obstruction, thus permitting air valve to be attached to radiator syphon. Always hanging in proper position inside of radiator.

DONNELLY SYSTEMS COMPANY

9 Murray Street NEW YORK, N. Y.

TEMPERATURE CONTROL BY REGULATION OF SUPPLY
AND DISTRIBUTION OF STEAM OR VAPOR

**Impulse Check Valves, Thermo-Differential
Valves and other Specialties for One and Two-
pipe Vapor and Vacuum Return Line Systems.**



Impulse Check Valve

The general theory of design and control of the steam circulation in all Donnelly Systems is based upon the recognized principle that in small systems there are, for short runs and for a limited number of automatic return valve devices, no appreciable differences or losses in pressure. In other words, small systems have always proved simpler and more satisfactory in operation than larger systems.

Therefore all Donnelly gravity and vacuum return line plants are divided into groups of convenient and restricted size. The former are provided with a Thermo-Float Air Valve and the latter with a Thermo-Differential Valve for each group.

The early recognition of this principle led to the design of the Impulse Check Valve, which is used at the return outlets of all radiators and coils in all Donnelly Systems, preventing any water or steam from entering the radiator from the return piping.

It is an Automatic Needle Valve, the size of the orifice through the seat being properly proportioned to the pipe size and to the rated capacity of the valve. The normal operation of the valve is the same in all systems, the weight over area of the disc and the size of the orifice being such that a complete discharge of the air and water is at all times effected and a constant

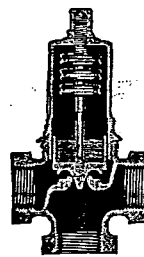
difference in pressure between the branch steam and return lines of one-half pound is always maintained.

The entire operative mechanism of the Impulse Valve is enclosed in a heavy removable tube which is inserted in a standard valve body and the valves are guaranteed for five years.

The Thermo-Differential Valve, used in Vacuum Return Line Systems is constructed as shown. It is made with a standard safety valve body and has a restricted seat which is proportioned to the capacity of the valve. The valve disc is provided with an impact surface, as in the Impulse Valve, and with a cup-shaped portion for holding the weights, together with a central rod which acts as a guide for the vaporizing fluid thermostat. The opening in the bottom of the valve is intended as a cleanout and should be provided with a nipple and cap. A small leakage opening is provided in the seat so that the system will drain when shut down.

A Thermo-Differential Valve is installed in each branch return so that no water, air or steam can pass into the main return without being properly regulated in pressure and flow.

Send for information on latest developments in Temperature Control. Catalogs and bulletins describing our specialties and their application will be gladly furnished on request.



Thermo-Differential Valve

Valves

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

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—Valve Discs; Jenkins '96 and Jenaro Sheet Packing, Gaskets, Pump Valves; Compressed Asbestos Joining.

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.

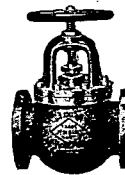


Fig. 142, Iron Body Globe, Flanged



Fig. 106, Bronze Globe, Screwed



Fig. 562, Bronze Swing Check Valve



Fig. 168, Bronze Radiator Angle, Screwed



Fig. 167, Bronze Radiator Globe, with Union



Fig. 370, Bronze Gate, Screwed



Fig. 168, Radiator Angle, with Union



Fig. 585, Iron Body Gate, Screwed

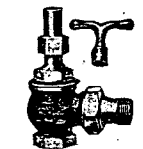


Fig. 170, Bronze Lock Shield Radiator Angle, with Union



Fig. 170-G, Bronze Lock Shield Radiator Globe, with Union

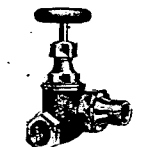


Fig. 180, Bronze Offset Corner Radiator with Union

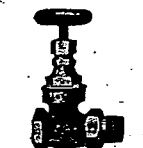


Fig. 351, Bronze Radiator Gate, Screwed



Fig. 165, Bronze Radiator Globe, Screwed

The Fulton Company Knoxville, Tennessee

NEW YORK
Hudson Terminal Bldg.
50 Church Street
PHILADELPHIA
Drexel Bldg.
4th and Chestnut Streets

BRANCHES:
DETROIT
Book Bldg.
Washington Boulevard
REPRESENTATIVES IN ALL PRINCIPAL CITIES

CHICAGO
Wrigley Bldg.
Michigan Boulevard
BOSTON
Pope Bldg.
221 Columbus Avenue

Patentees and manufacturers of Sylphon products. Sylphon Temperature and Pressure Regulators, Thermostats for regulating temperatures of homes by warm air furnaces, steam or hot water boilers; Temperature Regulating Radiator Covers; Automatic Air and Vent Valves; Packless and Leakless Valves 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 1½ to 12 in. O. D.

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.)

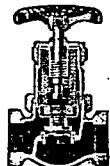
No. 536 Sylphon Radiator Air Valve

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.

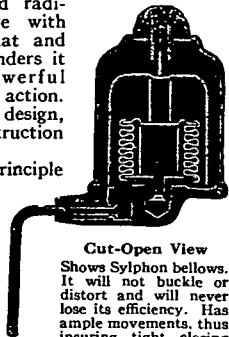
The active principle is the Sylphon bellows which for many years has been used by this company in all of its heating boiler specialties.

Ask for Bulletin RAV-3

Sylphon



Cut Open View



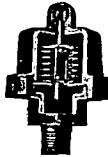
Cut-Open View
Shows Sylphon bellows. It will not buckle or distort and will never lose its efficiency. Has ample movements, thus insuring tight closing of the valve. It is so durable that, practically speaking, it will never wear out.

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 ½ in. diameter. Valve connection ¾ in. pipe thread.

Ask for Bulletin RAV-3



No. 22 Steam Damper Regulator

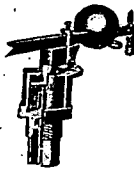
Used to control the dampers on steam heating boilers. A simple, accurate regulator which will control the draught so as to maintain a constant steam pressure up to 5 lb. This regulator is sensitive, positive in action and will last a life time, due to the Sylphon one-piece, seamless, solderless, flexible metal bellows which it contains.

Ask for Bulletin RD-3



No. 45-A Hot Water Damper Regulator

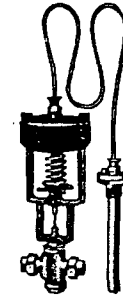
Used to control the dampers on hot water heating boilers. Simple, accurate regulators which will control the draft so as to maintain a constant temperature of the water at any point between 120 deg. and 220 deg. fahr. They prevent the temperature of the water from rising higher than necessary, insuring faucet water of even temperature every hour of the day. 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



The Fulton Company

No. 930 and No. 931 Temperature Regulators

For nearly all requirements where liquids are heated by steam, and especially industrial uses. Regulators are regularly furnished with a temperature range of 140 deg. to 180 deg. fahr. Special regulators can be furnished with adjustment for 20 deg. above or below the operating point for temperatures not lower than 20 deg. nor higher than 320 deg. fahr.



No. 930 Regulator is the same as No. 931, except that it has lever and weight method of adjustment instead of spring type shown. The extreme sensitiveness, positive action and simplicity of these regulators make them specially suitable for control of hot water service tanks, and hundreds of other uses. No. 931 Regulators are furnished regularly in sizes from ½ to 2½ in. inclusive, and the No. 930 Regulator in sizes from ½ to 8 in. inclusive.

Upon application, a chart will be furnished showing size of regulator for any given condition.

Ask for Chart and Bulletin TR-3

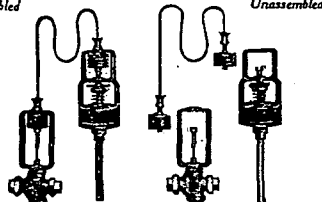
No. 980 and No. 981 Temperature Regulators

For automatic control of air temperatures. Same as 930 and 931 except bulb, of our own patented design, which is "star shaped," giving greatest area of exposed surface to cubical content and mass of any design known. Ask for Bulletin TR-3

No. 932 Temperature Regulator

Detachable Tube Type: This is the latest development in self-contained regulators. This regulator is composed of

Assembled



Unassembled

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

"Specification Data"—Send for our "Specifications of Value" which gives complete engineering data in regard to the above products.

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.

This regulator is specially applicable when steam line is awkwardly located or at considerable distance from point of control.

Ask for Bulletin TR-3

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 wide by 7½ in. long.

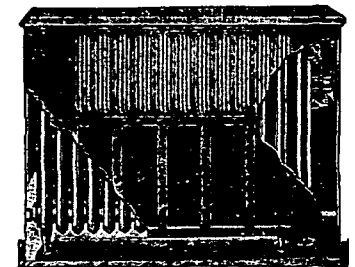
Ask for Bulletin RR-3

The Ja-Nar Radiator Cover

Made of fine furniture steel, lined with heat insulating material. Completely covers 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

Gorton & Lidgerwood Co.

96 Liberty St.,

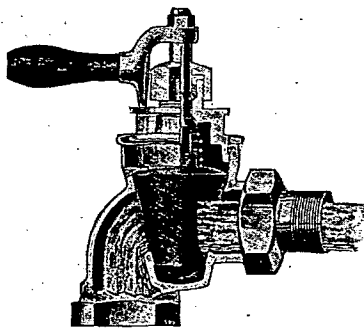
NEW YORK, N. Y.

Gorton Quarter Turn Packing Lock Valves

For all Systems of

Steam, Hot Water, Vapor and Vacuum Heating
Steam and Hot Water Boilers

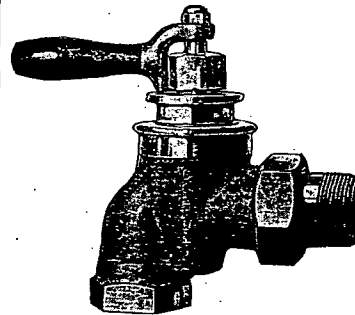
The Gorton Quarter Turn Packing Lock Radiator Valve is applicable to all systems noted above.



The plug or disc, is the important part of the valve, in fact, it might be called the heart of the valve, for it is the feature that has made the advantages of the valve practicable. It is made of a mineral composition, not a metal, as metal to metal in this type of valve is inclined to corrode and stick. Our disc being made of a mineral composition will not corrode nor stick, and under ordinary working conditions there is no reason why the disc will not last as long as the valve body.

The disc and stem are connected by a loose joint which makes it impossible to throw the disc out of its seat. A hole is drilled in the valve body to allow the steam or water to come on top of the disc keeping it seated when in operation, the area of the downthrust being greater than the area of uplift, so that neither grit nor dirt can get in between the disc and the seat. The light bronze spring shown in cut is used only to keep the disc seated during transportation.

Our packing device is simple and effective. The stem has a groove just above the bottom of the packing box. A special asbestos packing ring is forced into this



groove by screwing down the packing box nut, which makes a "packing lock." The stem also has a ball shoulder which seats on the underside of the bonnet. This ball shoulder seat and "packing lock" make a packing device that eliminates all possibility of a leak.

The "quarter turn" feature is of great importance because it makes the valve so easy to operate—simply a turn of the wrist will open or close the valve.

VAPOR HEATING

We take pleasure in calling your attention to our Single Pipe Vapor System which meets the demand for a Vapor System of moderate cost, that can easily be installed in any building usually heated with steam.

The Gorton Single Pipe Vapor System operates on a Vapor pressure of 4 to 12 oz. as Vapor will circulate and fill all radiators on just enough pressure to overcome friction in the pipes.

Our Vapor System gives the same Economy and Efficiency as a two-pipe vapor system because our Supply Valve is as easy to operate as a modulating valve—Simply a turn of the wrist will open or close our Quarter Turn Packing Lock Radiator Valve. In fact, it was this valve that made our Single Pipe Vapor System possible.

Gorton & Lidgerwood Co.

Specifications—When specifying Gorton Quarter Turn Packing Lock Valves please include the following: "Gorton Schedule of Valve sizes acceptable for Gorton Valves."

The Gorton Quarter Turn Packing Lock Valve has a full sized unobstructed horizontal passageway through it, which allows the steam and water to flow freely through the valve, with practically no friction; therefore one size smaller valve is used than of the ordinary type. That is, a 1 in. Gorton Quarter Turn Packing Lock Valve is used on a 60 ft. radiator for single pipe connection instead of the 1½ in. valve required of the ordinary type. That also applies in vapor and Vacuum Heating.

ALWAYS USE THIS SCHEDULE FOR VALVE SIZES

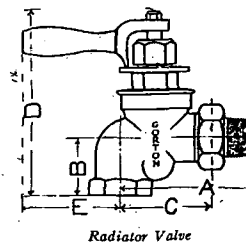
Steam Heating Single Pipe Connections		Vapor and Vacuum Heating Two Pipe Connections	
Radiators up to 25 ft.	¾ in. valve	Radiators up to 90 ft.	¾ in. valve
From 25 to 60 ft.	1 in. valve	From 90 to 180 ft.	¾ in. valve
From 60 to 100 ft.	1½ in. valve	From 180 to 360 ft.	1 in. valve
From 100 to 200 ft.	1½ in. valve	From 360 to 540 ft.	1½ in. valve
		From 540 to 720 ft.	1½ in. valve

The full size of pipe is run to elbow below valve, where reduction is made to valve size.

HOT WATER HEATING

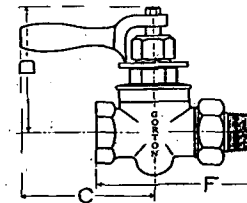
Use The Regular Size of Valves According To The System Installed

ROUGHING-IN MEASUREMENTS



Radiator Valve

Size	½"	¾"	1"	1¼"	1½"
A	3½	3⅞	4⅜	5	5¾
B	1⅝	2	2⅜	2⅞	2⅝
C	2¼	2⅝	3	3½	4
D	5⅝	6	6⅝	7⅞	7½
E	3	2⅞	3¼	3⅞	2⅞



Straightway Valve With Union

Size	½"	¾"	1"	1¼"	1½"
F	4	4⅝	5¼	5⅞	6⅞
C	3⅝	3⅞	4⅜	4⅞	4⅞
D	4	4¼	4¾	4⅞	5⅞

HEATING BOILERS

The Gorton Boilers are of steel, built according to the A. S. M. E. Boiler Code. They are of the vertical tube type, self-contained, require no brick setting. They are self-feeding, insuring a steady supply of heat for 10 to 12 hour with one firing. They are built for both steam and hot water systems.

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
Radiator valves, high pressure valves, hot water valves, hot water thermometers, pressure gages.

The Pierce Packless Valve

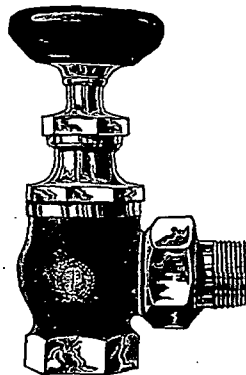
A Few of Its Outstanding Features

The stem disc (See the illustration) is made of fibre and is heat, steam and moisture proof. It is carried on a stem seat which is an integral part of the stem. This stem seat receives uniform pressure from a spring thereby seating and sealing the disc on the machined under-surface of the valve top. Steam and water cannot escape.

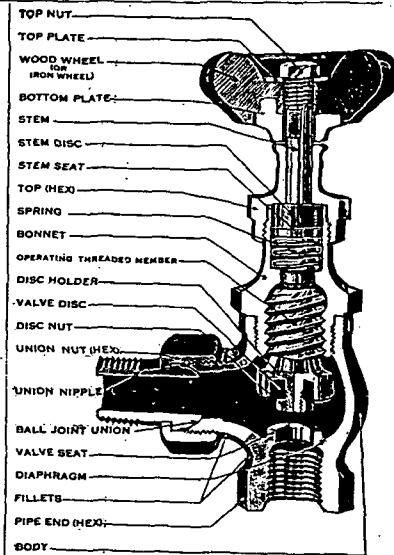
The stem disc can be renewed in a few minutes (if after years of service there appears need of renewal) without shutting off or interfering with the steam line.

The valve opens and closes with one turn of the handle. The type provided with lever handle graduated dial is widely used on vapor systems. Provision is made for modulation with exact relation to conditions.

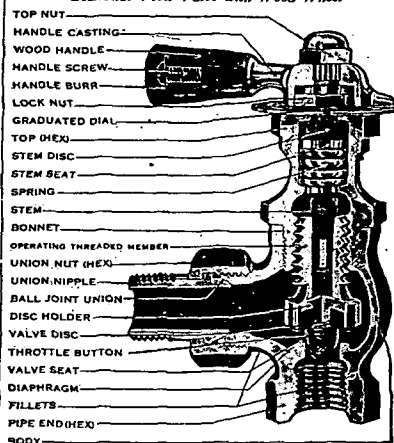
The Pierce Valve is of heavy proportions with strong hex's and walls. It is made from high grade bronze castings and nickel plated before assembly, thereby avoiding deposits of nickel salts in working parts. Its joints are graphited before setting up and are accordingly easy to take apart. All parts are machined to precision under gage limits and inspection.



Pierce Packless Valve



Sectional View Valve with Wood Wheel



Valve with Lever Handle and Graduated Dial

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 Impingment Ventilator



The Pul-Air Ventilator

A good practical roof ventilator of the mushroom type, consisting of a double-cone top. Scientific storm band and impingment 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, Impingment; 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 impingment. 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 copies of tests conducted by Carnegie Institute of Technology, and Massachusetts Institute of Technology.

Send for catalogue and prices.

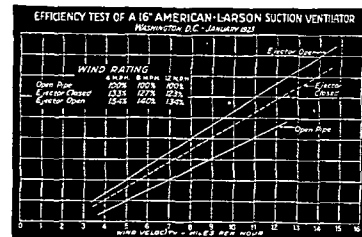
American-Larson Ventilating Co.

324 Fourth Ave., PITTSBURGH, PA.

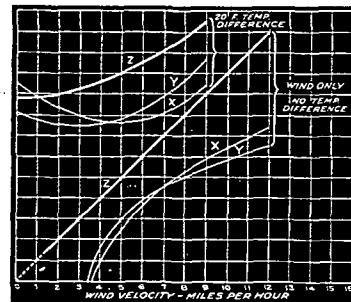
Product: American-Larson Rotary Suction Ventilators—proven, by competitive tests, to be the most efficient ventilator on the market.

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 3 1/2 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 diminishes 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
Picking rooms	15 to 20
Tanneries, paint rooms	15 to 20
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.

$$(100 \times 35 \times 28 \text{ ft.}) \times 5 \text{ changes hr.} = 98,000 \text{ cu. ft. 5 ventilators}$$

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.

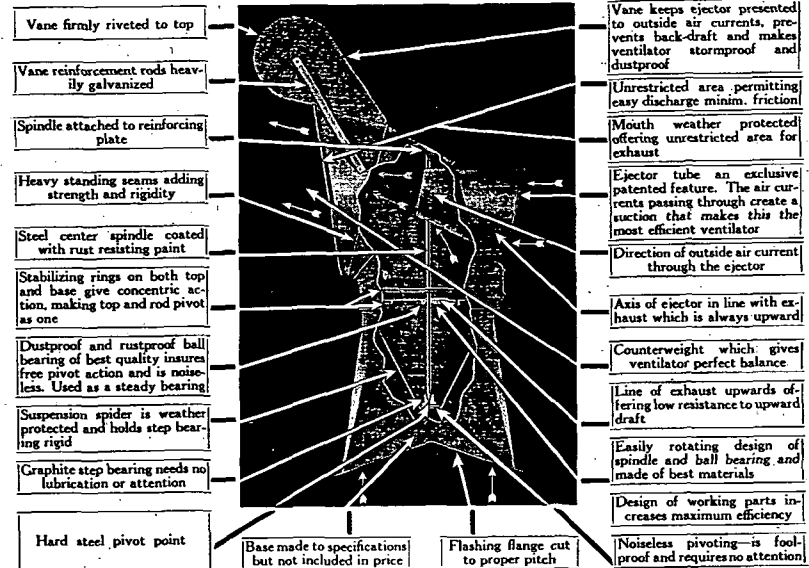
Note 1:

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

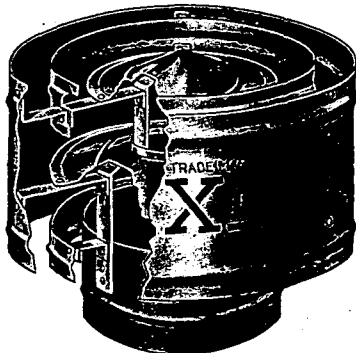
Ventilators

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. Head 80 per cent greater in diameter than shaft of ventilator.
2. Width of storm band 80 per cent of diameter of shaft and so placed as to exclude external air from ventilator head.
3. Area for air leaving ventilator head 75 per cent greater than cross sectional area of shaft.
4. Air from central section of pipe specially provided for in second opening through frustum of cone which permits of reduction in diameter of top cone and thereby decreases resistance to air leaving from central portion of ventilator.

Guaranteed exhaust and storm proof.
Liberal discounts.
Damper and base prices on request.

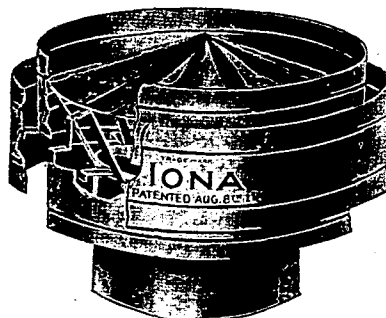
EXHAUST DATA CARD OF "XIT" VENTILATORS

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	258,800	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.	Out-side Dia. In.	Height In.	Gauge Iron or Metal	Approx. Finished Weights Lbs.	Gauge Cop-per Oz.	List Prices
6	10	6	26	3	16	\$ 3.40
8	14 1/2	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



Water Treatment Apparatus

COCHRANE CORPORATION

Formerly Harrison Safety Boiler Works

3120 North 17th Street

PHILADELPHIA, PA.

"COCHRANIZE THE HEATING SYSTEM"

The Cochrane Deaerating Heater expels oxygen and other gases from water and thereby prevents corrosion in hot water heating and service piping, economizers and boilers. The water is delivered at any temperature above 140 deg. Fahr. The steam can be expanded in a turbine or engine down to a vacuum corresponding to the temperature at which the deaerated water is delivered.

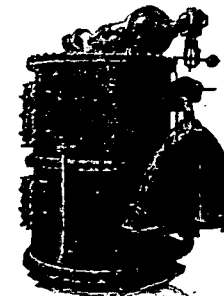
The Cochrane Steam-Stack and Cut-Out Valve Heater and Receiver for use with exhaust steam heating or drying systems, does the work of a heater and of the independent separator ordinarily installed in a by-pass around the heater. The combination saves the cost of installing an independent separator.

The Cochrane Integrating Flow Meter is a simple, reliable and accurate device for measuring water, steam or air flowing in pipes. There are no working parts in the pressure chambers and no stuffing boxes. The chart divisions are uniform. The pressure connections are included in the orifice plate, eliminating errors from faulty connections.

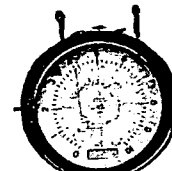
The Cochrane Multiport Back-Pressure Valve differs from the ordinary back-pressure valve in that a number of small discs are used instead of one large disc, thus reducing the size, weight and travel of the discs. Pressure easily adjustable but predetermined back pressure cannot be exceeded.

The Cochrane Oil Separator. of oil by passing through a Cochrane Oil Separator is worth as much pound for pound, as live steam at the same pressure for heating buildings, heating water, etc. The condensed returns will be free of oil.

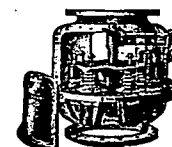
The Cochrane Drainers or Traps remove condensate or drips from piping, heating or drying coils, radiators, jackets steam and oil separators, etc. The low pressure drainer has balanced cylindrical valve with large ports, and large capacity at low operating pressure. The high pressure trap is built of the best materials for pressures up to 250 lb. Parts are few, simple and easily accessible.



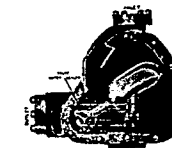
Deaerating Heater



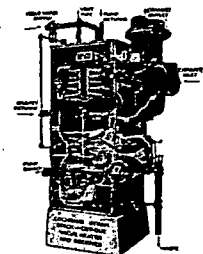
Flow Meter



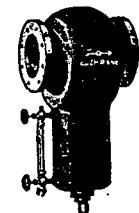
Back Pressure Valve



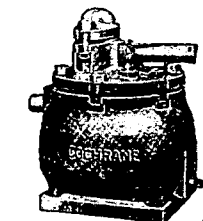
Drainer



Steam Stack Heater



Oil Separator



High Pressure Trap

Index to Modern Equipment

AMERICAN SOCIETY OF HEATING and VENTILATING ENGINEERS GUIDE 1924-25

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.
Drying Systems, Inc.
Fleisher, W. L., & Co., Inc.
Grinnell Co., Inc.
Ilg Electric Ventilating Co.
Mid-west Air Filters, Inc.
New York Blower Co.
Reed Air Filter Co., Inc.
Skinner Bros. Mfg. Co., Inc.
Sturtevant, B. F., Co.
York Heating & Ventilating Corp.

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

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 Construction Co.
Carrier Engineering Corp.
Clarage Fan Co.
Fleisher, W. L., & Co., Inc.
Ilg Electric Ventilating Co.
Mid-west Air Filters, Inc.
New York Blower Co.
Reed Air Filter Co., Inc.
Sturtevant, B. F., Co.

AMMONIA COILS (See Coils, Ammonia)

ASBESTOS AND INSULATING PRODUCTS

Brecht Co.
Johns-Manville, Inc.
Norristown Magnesia & Asbestos Co.
Ric-wil Co.

ASBESTOS—Sheet

Brecht Co.
Johns-Manville, Inc.
Norristown Magnesia & Asbestos Co.

AUTOMATIC FURNACES (See Furnaces, Automatic)

BAKING EQUIPMENT

Drying Systems, Inc.
Westinghouse Electric & Mfg. Co.

BLAST GATES (See Gates, Blast)

BLOWERS—Centrifugal

American Blower Co.
Buffalo Forge Co.
Clarage Fan Co.
Hersh Brothers Co.
Ilg Electric Ventilating Co.
New York Blower Co.
Sturtevant, B. F., Co.
York Heating & Ventilating Corp.

Fan

American Blower Co.
Bayley Mfg. Co.
Bishop & Babcock Co.
Clarage Fan Co.
Hersh Brothers Co.
Ilg Electric Ventilating Co.
Nash Engineering Co.
New York Blower Co.
Sturtevant, B. F., Co.
York Heating & Ventilating Corp.

Pressure

American Blower Co.
Bayley Mfg. Co.
Buffalo Forge Co.
Nash Engineering Co.
New York 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.
New York Blower Co.
Sturtevant, B. F., 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.

Feed Pumps (See Pumps)

Headers (See Headers)

Liquid

"X" Laboratories

Scale Remover (See Scale Remover, Boiler)

BOILERS—Heating (Coal Fired)

Abendroth Bros.
American Radiator Co.
Ames Iron Works
Brownell Co.
Burnham Boiler Corp.
Continental Heater Corp.
Cox, Abram, Stove Co.
Fitzgibbons Boiler Co., Inc.
General Boilers Co.
Gorton & Lidgerwood Co.
International Heater Co.
Kewanee Boiler Co.
Molby Boiler Co., Inc.
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.

Smith, H. B., Co.
Standard Heater Co.
Titusville Iron Works Co.
XXth Century Heating & Ventilating Co.
U. S. Radiator Corp.
Utica Heater Co.
Weil-McLain Co.

Heating (Gas Fired)

American Radiator Co.
Ames Iron Works
Brownell Co.
Bryant Heater & Mfg. Co.
Continental Heater Corp.
General Boilers Co.
Heggie Simplex Boiler Co.
Oil City Boiler Works
Page, Wm. H., Boiler Co.
Pierce, Butler & Pierce Mfg. Corp.

Heating (Oil Fired)

American Radiator Co.
Ames Iron Works
Brownell Co.
Bunting Iron Works
Continental Heater Corp.
Cox, Abram, Stove Co.
General Boilers Co.
Heggie Simplex Boiler Co.
Hornung, J. C.
Kewanee Boiler Co.
Oil City Boiler Works
Page, Wm. H., Boiler Co.
Pierce, Butler & Pierce Mfg. Corp.
Richmond Radiator Co.
Sturtevant, B. F., Co.
Weil-McLain Co.

Tubular

Ames Iron Works
Brownell Co.
Bryant Heater & Mfg. Co.
Burnham Boiler Corp.
Fitzgibbons Boiler Co., Inc.
Gorton & Lidgerwood Co.
Heggie Simplex Boiler Co.
Kewanee Boiler Co.
Oil City Boiler Works
Pierce, Butler & Pierce Mfg. Corp.
Standard Heater Co.
Titusville Iron Works Co.

BRACKETS (See Hangers, Pipe and Radiator, and Radiator Brackets)

BURNERS—Oil (For Heating Boilers and Furnaces)

Bunting Iron Works
Winslow Boiler & Engineering Co.

CALORIMETERS—Steam

Ellison, Lewis M.

CEMENT—Asbestos (See Asbestos and Insulating Products)

Fire Brick

Johns-Manville, Inc.

Pipe Joint

Crane Co.
Grinnell Co., Inc.
Johns-Manville, Inc.

Water Proof

Brecht Co.
Johns-Manville, Inc.

CENTRIFUGAL DRYERS (See Drying Apparatus)

COAL SAVER

Combustion Specialties Corp.

COCKS—Air

Crane Co.
Detroit Lubricator Co.
Mueller Co.

Boiler Drain

Detroit Lubricator Co.
Mueller Co.

Boiler Supply

Mueller Co.

Gage

Bishop & Babcock Co.
Brecht Co.
Detroit Lubricator Co.
Jenkins Bros.
Marsh, Jas. P., & Co.

COILS—Ammonia

Brecht Co.
Crane Co.
Grinnell Co., Inc.
Pennsylvania Engineering Co.

Blast

New York Blower Co.
Stickie Steam Specialties Co.
York Heating & Ventilating Corp.

Pipe

American Blower Co.
Bayley Mfg. Co.
Brecht Co.
Crane Co.
Grinnell Co., Inc.
Pennsylvania Engineering Co.
Thermal Appliance Co.

Tank

Brecht Co.
Kewanee Boiler Co.

COLLECTORS, DUST (See Dust Collectors)

COLUMNS—Water

American Radiator Co.
Crane Co.
Page, Wm. H., Boiler Co.

COMPOUNDS—Boiler

"X" Laboratories

COMPRESSORS

Bishop & Babcock Co.
Brecht Co.
Nash Engineering Co.
Powers Regulator Co.
Trane Co.

CONDENSERS

Alberger Heater Co.
Brecht Co.
Buffalo Steam Pump Co.
Carrier Construction Co.
Carrier Engineering Corp.
Pennsylvania Engineering Co.

CONDUIT—Underground

Hornung, J. C.
Johns-Manville, Inc.
Ric-wil Co.

CONTROL SWITCHES (See Switches, Control)

CONTROLLERS—Boiler

Heat Control Service Co., Inc.
Sterling Engineering Co.
Stickie Steam Specialties Co.

Electric Heat

Johnson Service Co.
Powers Regulator Co.
Taylor Instrument Companies
Westinghouse Electric & Mfg. Co.

INDEX TO MODERN EQUIPMENT

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.
Stickie Steam Specialties Co.
Taylor Instrument Companies

Motor

Brecht 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.
Klipfel Mfg. Co.
Mason Regulator Co.
McAlear Mfg. Co.
Sterling Engineering Co.

Shower Bath

Mueller Co.
Powers Regulator Co.

Tank

Davis, G. M., Regulator Co.
Klipfel Mfg. Co.
Mason Regulator Co.
McAlear Mfg. Co.
Powers Regulator Co.
Taylor Instrument Companies

Temperature (See Regulators, Temperature)

CONVEYING SYSTEMS (See Systems, Dust Collecting and Exhaust)

COOLING TOWERS

Brecht Co.
Carrier Construction Co.
Carrier Engineering Corp.

COVERING—Boiler (See Asbestos and Insulating Products)

Magnesia

Johns-Manville, Inc.
Norristown Magnesia & Asbestos Co.

Pipe and Tank

Johns-Manville, Inc.
Ric-wil Co.

DAMPER—Quadrants

Dalzell Bros. Co.
York Heating & Ventilating Corp.

DAMPER REGULATORS

(See Regulators, Damper)

DEAERATORS

Cochrane Corp.

DEHUMIDIFYING APPARATUS

American Blower Co.
Atmospheric Conditioning Corp.
Bayley Mfg. Co.
Buffalo Forge Co.
Call, John, Co.
Carrier Engineering Corp.
Fleisher, W. L., & Co., Inc.
New York Blower Co.
Skinner Bros. Mfg. Co., Inc.
Stickie Steam Specialties Co.
Sturtevant, B. F., Co.

DIFFERENTIAL LOOPS

Hoffman Specialty Co., Inc.

DIFFUSERS—Air

Knowles Mushroom Ventilator Co.

DRAFT GAGES (See Gages, Draft)

DRYING APPARATUS

American Blower Co.
American Foundry & Furnace Co.
Bayley Mfg. Co.
Buffalo Forge Co.
Call, John, Co.
Carrier Engineering Corp.
Clarage Fan Co.
Drying Systems, Inc.
Fleisher, W. L., & Co., Inc.
Grinnell Co., Inc.
Ilg Electric Ventilating Co.
Moncrief Furnace Co.
New York Blower Co.
Stickie 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 Construction Co.
Carrier Engineering Corp.
Hersh Brothers Co.
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

Crane Co.
Detroit Lubricator Co.
Fulton Co.

ELECTRIC MOTORS (See Motors, Electric)

ELIMINATORS—Air

Bishop & Babcock Co.
Dunham, C. A., Co.
Hoffman Specialty Co., Inc.
Marsh, Jas. P., & Co.
McAlear Mfg. Co.
Mouat Vapor Heating Co.
New York Blower Co.
O-E Specialty Mfg. Co.
Sterling Engineering 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 Co.

INDEX TO MODERN EQUIPMENT

EQUALIZING LOOPS

Marsh, Jas. P., & Co.
U. S. Radiator Corp.

EXHAUST FANS (See Fans, Exhaust)

EXHAUST HEADS

Buffalo Forge Co.
Carrier Construction Co.
McAlear Mfg. Co.
Patterson-Kelley Co.
Skinner Bros. Mfg. Co., Inc.
Sturtevant, B. F., Co.
Taylor Machine Works

EXHAUST SYSTEMS

American Blower Co.
Bayley Mfg. Co.
Buffalo Forge Co.
Call, John, Co.
Carrier Construction Co.
Clarge Fan Co.
Fleisher, W. L., & Co., Inc.
Ilg Electric Ventilating Co.
New York Blower Co.
Skinner Bros. Mfg. Co., Inc.
Sturtevant, B. F., Co.
York Heating & Ventilating Corp.

EXPANSION JOINTS (See Joints, Expansion)

FANS—Blower (See Blowers, Fan)

Exhaust

American Blower Co.
Bayley Mfg. Co.
Bishop & Babcock Co.
Buffalo Forge Co.
Carrier Construction Co.
Clarge Fan Co.
Hersh Brothers Co.
Ilg Electric Ventilating Co.
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.
Clarge Fan Co.
Hersh Brothers Co.
Ilg Electric Ventilating Co.
New York Blower Co.
Skinner Bros. Mfg. Co., Inc.
Stickle Steam Specialties Co.
Sturtevant, B. F., Co.
Wing, L. J., Mfg. Co.
York Heating & Ventilating Corp.

FILTERS—Air

Bayley Mfg. Co.
Call, John, Co.
Drying Systems, Inc.
Midwest Air Filters, Inc.
Reed Air Filter Co., Inc.

Water

Cochrane Corp.

FIRE BRICK CEMENT (See Cement, Fire Brick)

FITTINGS—Flanged

Crane Co.
Grinnell Co., Inc.

Furnace

Grinnell Co., Inc.
International Heater Co.
Langenberg Mfg. Co.
XXth Century Heating & Ventilating Co.

Pipe

Crane Co.
Grinnell Co., Inc.
International Heater Co.

Union

Crane Co.
Grinnell Co., Inc.

FOG ELIMINATORS

Wing, L. J., Mfg. Co.

FURNACES—Automatic

Riley, Sanford, Stoker Co.

Gas

Cox, Abram, Stove Co.
XXth Century Heating & Ventilating Co.

Pipeless

Cox, Abram, Stove Co.
International Heater Co.
Langenberg Mfg. Co.
Moncrief Furnace Co.
XXth Century Heating & Ventilating Co.

Warm Air

American Foundry & Furnace Co.
Cox, Abram, Stove Co.
Dalzell Bros. Co.
International Heater Co.
Langenberg Mfg. Co.
Moncrief Furnace Co.
New York Blower Co.
Sturtevant, B. F., Co.
XXth Century Heating & Ventilating Co.

GAGE—Boards

Bishop & Babcock Co.
Brecht Co.
Dunham, C. A., Co.
Marsh, Jas. P., & Co.
Webster, Warren, & Co.

Cocks (See Cocks, Gage)

Glasses (See Glasses, Gage)

Valves (See Valves, Gage)

GAGES—Draft

Ellison, Lewis M.

Pressure

Bishop & Babcock Co.
Brecht Co.
Crane Co.
Donnelly Systems 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.
Webster, Warren, & Co.

Steam

American Radiator Co.
Crane Co.
Dunham, C. A., Co.
Marsh, Jas. P., & Co.
O-E Specialty Mfg. Co.
Pierce, Butler & Pierce Mfg. Corp.
Taylor Instrument Companies
Trane Co.
U. S. Radiator Corp.
Webster, Warren, & Co.

Vacuum

Bishop & Babcock Co.
Crane Co.
Donnelly Systems Co.
Dunham, C. A., Co.
Marsh, Jas. P., & Co.
O-E Specialty Mfg. Co.
Taylor Instrument Companies
Trane Co.
U. S. Radiator Corp.
Webster, Warren, & Co.

Water

American Radiator Co.
Crane Co.
Detroit Lubricator Co.
Marsh, Jas. P., & 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

Crane Co.
Brownell Co.
Page, Wm. H., Boiler Co.
Stickle Steam Specialties Co.

GASKETS—Asbestos

Crane Co.
Jenkins Bros.
Johns-Manville, Inc.
Norristown Magnesia & Asbestos Co.

Boiler

Johns-Manville, Inc.

Metallic

Crane Co.
Johns-Manville, Inc.

Rubber

Crane Co.
Jenkins Bros.

GATES—Blast

American Blower Co.
Buffalo Forge Co.
Carrier Construction Co.
Clarge Fan Co.
Hersh Brothers Co.
New York Blower Co.
Sturtevant, B. F., Co.
York Heating & Ventilating Corp.

GENERATOR COOLING SYSTEMS

American Blower Co.
Buffalo Forge Co.
Carrier Engineering Corp.
Sturtevant, B. F., Co.

GENERATORS—Electric

Reliance Electric & Engineering Co.
Sturtevant, B. F., Co.
Westinghouse Electric & Mfg. Co.

Heat (See Boilers, Furnaces and Heaters)

Hot-Water

Brownell Co.
Burnham Boiler Corp.
Excelso Specialty Works, Inc.
Page, Wm. H., Boiler Co.
Reading Heater & Supply Co.

INDEX TO MODERN EQUIPMENT

Vacuum

O-E Specialty Mfg. Co.
Trane Co.

GLASSES—Gage

Crane Co.
Detroit Lubricator Co.

GOVERNORS—Condensation

McAlear Mfg. Co.

Pump (See Regulators, Pump)

Vacuum (See Regulators, Vacuum)

GRATES—Dumping

Abendroth Bros.
Brownell Co.
Kewanee Boiler Co.
Oil City Boiler Works

Rocking

Abendroth Bros.
Brownell Co.
Kewanee Boiler Co.
Oil City Boiler Works

Shaking

Abendroth Bros.
Brownell Co.
Kewanee Boiler Co.
Standard Heater Co.
Taylor Machine Works
Thermal Appliance Co.
U. S. Radiator Corp.
Weil-McLain Co.

GRILES AND REGISTERS (See Registers and Grilles)

HANGERS—Adjustable Pipe

Crane Co.
Farley Sleeve & Hanger Co.
Grinnell Co., Inc.
Smith, H. B., Co.

Pipe

Brecht Co.
Crane Co.
Grinnell Co., Inc.
Healy-Ruff Co.
Midwest Air Filters, Inc.

Radiator

American Radiator Co.
Farley Sleeve & Hanger Co.
Fowler & Wolfe Mfg. Co.
Gleocle, A. F., Jr.
Grinnell Co., Inc.
Healy-Ruff Co.
Kewanee Boiler Co.
Smith, H. B., Co.
U. S. Radiator Corp.

HEADERS

Alberger Heater Co.
Bayley Mfg. Co.
Crane Co.
Grinnell Co., Inc.

HEAT INTERCHANGERS

American Blower Co.
Carrier Construction Co.
Carrier Engineering Corp.
Cochrane Corp.
Drying Systems, Inc.

HEATERS—Air (Electric)

Westinghouse Electric & Mfg. Co.

Automatic Hot Water

Bryant Heater & Mfg. Co.
Crane Co.
Kewanee Boiler Co.
Mueller Co.

Blast

Aerofin Corp.

Fan System

Aerofin Corp.

Feed Water

Alberger Heater Co.
Brownell Co.
Cochrane Corp.
Patterson-Kelley Co.
Stickle Steam Specialties Co.
Webster, Warren, & Co.

Gas

Bryant Heater & Mfg. Co.
Cox, Abram, Stove Co.
XXth Century Heating & Ventilating Co.

Hot Water Service

Alberger Heater Co.
American Radiator Co.
Brownell Co.
Bryant Heater & Mfg. Co.
Cochrane Corp.
Excelso Specialty Works, Inc.
Heggie Simplex Boiler Co.
International Heater Co.
Kewanee Boiler Co.
Page, Wm. H., Boiler Co.
Prox, Frank, Co.
Reading Heater & Supply Co.
Richardson & Boynton Co.
Smith, H. B., Co.
Standard Heater Co.
Taylor Machine Works
Thermal Appliance Co.
U. S. Radiator Corp.
Weil-McLain Co.

Indirect

American Blower Co.
Bayley Mfg. Co.
Bryant Heater & Mfg. Co.
Buffalo Forge Co.
Excelso Specialty Works, Inc.
Molby Boiler Co., Inc.
Skinner Bros. Mfg. Co., Inc.
Thermal Appliance Co.
York Heating & Ventilating Corp.

Industrial

Bayley Mfg. Co.
Bryant Heater & Mfg. Co.
Buffalo Forge Co.
Drying Systems, Inc.
Langenberg Mfg. Co.
Moncrief Furnace Co.
Skinner Bros. Mfg. Co., Inc.
Sturtevant, B. F., Co.
Westinghouse Electric & Mfg. Co.
Wing, L. J., Mfg. Co.

Instantaneous Hot Water

Alberger Heater Co.
Cochrane Corp.
Patterson-Kelley Co.
Thermal Appliance Co.

Room

Bayley Mfg. Co.
Buffalo Forge Co.
International Heater Co.
Langenberg Mfg. Co.
Moncrief Furnace Co.

Tank

Abendroth Bros.
Brownell Co.
Burnham Boiler Corp.
Cox, Abram, Stove Co.
International Heater Co.
Kewanee Boiler Co.
Molby Boiler Co., Inc.
Page, Wm. H., Boiler Co.
Patterson-Kelley Co.
Prox, Frank, Co.
Reading Heater & Supply Co.
Smith, H. B., Co.
Standard Heater Co.

Unit

American Blower Co.
Bayley Mfg. Co.
Buffalo Forge Co.
Clarge Fan Co.
Langenberg Mfg. Co.
Moncrief Furnace Co.
Skinner Bros. Mfg. Co., Inc.
Sturtevant, B. F., Co.
Wing, L. J., Mfg. Co.
York Heating & Ventilating Corp.

Water (Incinerator)

Kewanee Boiler Co.

HEATING AND VENTILATING APPARATUS

Abendroth Bros.
American Blower Co.
American Foundry & Furnace Co.
Bayley Mfg. Co.
Bishop & Babcock Co.
Buffalo Forge Co.
Burnham Boiler Corp.
Carrier Construction Co.
Carrier Engineering Corp.
Clarge Fan Co.
Davis, G. M., Regulator Co.
Fleisher, W. L., & Co., Inc.
Gorton & Lidgerwood Co.
Grinnell Co., Inc.
Heggie Simplex Boiler Co.
Ilg Electric Ventilating Co.
International Heater Co.
Marsh, Jas. P., & Co.
Nash Engineering Co.
New York Blower Co.
Norristown Magnesia & Asbestos Co.
Reading Heater & Supply Co.
Smith, H. B., Co.
Stickle Steam Specialties Co.
Sturtevant, B. F., Co.
U. S. Radiator Corp.
Utica Heater Co.
Wing, L. J., Mfg. Co.
York Heating & Ventilating Corp.

HEATING SPECIALTIES

American Radiator Co.
Barnes & Jones
Bishop & Babcock Co.
Buffalo Forge Co.
Burnham Boiler Corp.
Combustion Specialties Corp.
Crane Co.
Davis, G. M., Regulator Co.
Donnelly Systems Co.
Dunham, C. A., Co.
Fulton Co.
Gorton & Lidgerwood Co.
Grinnell Co., Inc.
Heggie Simplex Boiler Co.
Hoffman Specialty Co., Inc.
Honeywell Heating Specialties Co.
Hornung, J. C.
Marsh, Jas. P., & Co.
Mason Regulator Co.
McAlear Mfg. Co.
Monash-Yountker Co., Inc.
Monash-Vapor Heating Co.
O-E Specialty Mfg. Co.
Page, Wm. H., Boiler Co.
Reading Heater & Supply Co.
Sterling Engineering Co.
Stickle Steam Specialties Co.
Trane Co.
U. S. Radiator Corp.
Webster, Warren, & Co.

HEATING SYSTEMS—Gas

Bryant Heater & Mfg. Co.
Mueller Co.
O-E Specialty Mfg. Co.
Standard Heater Co.
Sturtevant, B. F., Co.
XXth Century Heating & Ventilating Co.

INDEX TO MODERN EQUIPMENT

Hot Blast

American Blower Co.
American Foundry & Furnace Co.
Bayley Mfg. Co.
Buffalo Forge Co.
Carrier Construction Co.
Carrier Engineering Corp.
Clara Fan Co.
Donnelly Systems Co.
Grinnell Co., Inc.
Ilg Electric Ventilating Co.
Langenberg Mfg. Co.
Moncrief Furnace Co.
New York Blower Co.
Skinner Bros. Mfg. Co., Inc.
Stickley 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.
Carrier Construction Co.
Cochrane Corp.
Cox, Abram, Stove Co.
D. & T. Mfg. Co.
Gorton & Lidgerwood Co.
Grinnell Co., Inc.
Heggie Simplex Boiler Co.
Honeywell Heating Specialties Co.
International Heater Co.
National Radiator Co.
Page, Wm. H., Boiler Co.
Prox, Frank, Co.
Reading Heater & Supply Co.
Richardson & Boynton Co.
Standard Heater Co.
Taylor Machine Works
XXth Century Heating & Ventilating Co.
U. S. Radiator Corp.
York Heating & Ventilating Corp.

Steam

Abendroth Bros.
American Foundry & Furnace Co.
Barnes & Jones
Bayley Mfg. Co.
Bishop & Babcock Co.
Bryant Heater & Mfg. Co.
Burnham Boiler Corp.
Carrier Construction Co.
Carrier Engineering Corp.
Cox, Abram, Stove Co.
Donnelly Systems Co.
Dunham, C. A., Co.
Gorton & Lidgerwood Co.
Grinnell Co., Inc.
Heggie Simplex Boiler Co.
International Heater Co.
Marsh, Jas. P., & Co.
National Radiator Co.
O-E Specialty Mfg. Co.
Page, Wm. H., Boiler Co.
Richardson & Boynton Co.
Standard Heater Co.
Trane Co.
XXth Century Heating & Ventilating Co.
U. S. Radiator Corp.
Webster, Warren, & Co.
Wing, L. J., Mfg. Co.
York Heating & Ventilating Corp.

Steam (Exhaust)

Barnes & Jones
Bayley Mfg. Co.
Buffalo Forge Co.
Carrier Construction Co.
Carrier Engineering Corp.

Cochrane Corp.
Donnelly Systems Co.
Dunham, C. A., Co.
Gorton & Lidgerwood Co.
Grinnell Co., Inc.
Illinois Engineering Co.
Marsh, Jas. P., & Co.
McAlear Mfg. Co.
Page, Wm. H., Boiler Co.
Smith, H. B., Co.
Sterling Engineering Co.
Trane Co.
Webster, Warren, & Co.
York Heating & Ventilating Corp.

Steam (Vacuum)

Abendroth Bros.
Barnes & Jones
Bayley Mfg. Co.
Bishop & Babcock Co.
Burnham Boiler Corp.
Carrier Construction Co.
Carrier Engineering Corp.
Cox, Abram, Stove Co.
Donnelly Systems Co.
Dunham, C. A., Co.
Gorton & Lidgerwood Co.
Grinnell Co., Inc.
Illinois Engineering Co.
Marsh, Jas. P., & Co.
McAlear Mfg. Co.
Nash Engineering Co.
O-E Specialty Mfg. Co.
Page, Wm. H., Boiler Co.
Smith, H. B., Co.
Standard Heater Co.
Sterling Engineering Co.
Stickley Steam Specialties Co.
Trane Co.
U. S. Radiator Corp.
Webster, Warren, & Co.
York Heating & Ventilating Corp.

Steam (Vapor)

Abendroth Bros.
Barnes & Jones
Bishop & Babcock Co.
Bryant Heater & Mfg. Co.
Burnham Boiler Corp.
Carrier Construction Co.
Carrier Engineering Corp.
Cox, Abram, Stove Co.
Donnelly Systems Co.
Dunham, C. A., Co.
Gorton & Lidgerwood Co.
Grinnell Co., Inc.
Illinois Engineering Co.
International Heater Co.
Marsh, Jas. P., & Co.
McAlear Mfg. Co.
Mouat Vapor Heating Co.
O-E Specialty Mfg. Co.
Page, Wm. H., Boiler Co.
Standard Heater Co.
Sterling Engineering Co.
Stickley Steam Specialties Co.
Trane Co.
XXth Century Heating & Ventilating Co.
U. S. Radiator Corp.
Webster, Warren, & Co.
York Heating & Ventilating Corp.

Warm-Air

American Foundry & Furnace Co.
Buffalo Forge Co.
Carrier Construction Co.
Carrier Engineering Corp.
Cox, Abram, Stove Co.
Dalzell Bros. 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 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.
Drying Systems, Inc.
Fleisher, W. L., & Co., Inc.
Grinnell Co., Inc.
Johnson Service Co.
New York Blower Co.
Skinner Bros. Mfg. Co., Inc.
Sturtevant, B. F., Co.
XXth Century Heating & Ventilating Co.

HUMIDITY CONTROL

American Blower Co.
Bayley Mfg. Co.
Bishop & Babcock Co.
Carrier Engineering Corp.
Drying Systems, Inc.
Fleisher, W. L., & Co., Inc.
Grinnell Co., Inc.
Heat Control Service Co., Inc.
Johnson Service Co.
Klipfel Mfg. Co.
Powers Regulator 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

Hill, E. Vernon, Co.
Marsh, Jas. P., & Co.
Sarco Co., Inc.
Taylor Instrument Companies

Recording

Marsh, Jas. P., & Co.
Taylor Instrument Companies

INSULATING MATERIALS (See Asbestos and Insulating Products)

Cold

Brecht Co.
Johns-Manville, Inc.
Norristown Magnesia & Asbestos Co.

Heat

Johns-Manville, Inc.
Norristown Magnesia & Asbestos Co.

JOINTS—Expansion

Alberger Heater Co.
Badger, E. B., & Sons Co.
Crane Co.
Fulton Co.

INDEX TO MODERN EQUIPMENT

Grinnell Co., Inc.
Hornung, J. C.
Illinois Engineering Co.
Webster, Warren, & Co.

Pipe

Crane Co.
Grinnell Co., Inc.

KILNS, DRY

American Blower Co.
Carrier Construction Co.
Carrier Engineering Corp.
Drying Systems, Inc.
New York Blower Co.
Sturtevant, B. F., Co.

LIQUID, BOILER (See Boiler Liquid)

LOOPS, EQUALIZING (See Equalizing Loops)

LUBRICATORS

Detroit Lubricator Co.

MACHINES, REFRIGERATING (See Refrigerating Machinery)

MAGNESIA PRODUCTS (See Asbestos and Insulating Products)

MECHANICAL DRAFT APPARATUS

American Blower Co.
Buffalo Forge Co.
Clara Fan Co.
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

Cochrane Corp.

Flow

Cochrane Corp.

Pilot Tube

Cochrane Corp.

V-Notch

Cochrane Corp.

Water

Johns-Manville, Inc.

Weighing

Cochrane Corp.

MICA

Westinghouse Electric & Mfg. Co.

MOISTENERS, AIR (See Humidifiers)

MOTOR CONTROLLERS (See Controllers, Motor)

MOTORS—Electric

Brecht Co.
Reliance Electric & Engineering Co.
Sturtevant, B. F., Co.
Westinghouse Electric & Mfg. Co.

NOZZLES—Brine Spray

Atmospheric Conditioning Corp.
Brecht Co.
Buffalo Forge Co.
Grinnell Co., Inc.

Spray

Atmospheric Conditioning Corp.
Badger, E. B., & Sons Co.
Bayley Mfg. Co.
Buffalo Forge Co.
Clara Fan Co.
Grinnell Co., Inc.
Sturtevant, B. F., Co.

OIL BURNERS

Bunting Iron Works
Winslow Boiler & Engineering Co.

PACKING—Asbestos

Jenkins Bros.
Johns-Manville, Inc.
New York Blower Co.

Metallic

Johns-Manville, Inc.

Rubber

Jenkins Bros.

PIPE—Bending

Badger, E. B., & Sons Co.
Brecht Co.
Crane Co.
Grinnell Co., Inc.

Cast Iron

Abendroth Bros.
Crane Co.
Grinnell Co., Inc.

Coils (See Coils, Pipe)

Covering (See Covering, Pipe and Tank; also, Conduits)

Fittings

Abendroth Bros.
Crane Co.
Grinnell Co., Inc.

Hangers (See Hangers, Pipe)

Joint Cement (See Cement, Pipe Joint)

Plugs (See Plugs, Pipe)

Wrought Iron and Steel

Crane Co.
Grinnell Co., Inc.

PIPELESS FURNACES (See Furnaces, Pipeless)

PITOT TUBES AND GAGES

Hill, E. Vernon, Co.

PLATES—Floor

Farley Sleeve & Hanger Co.

PLUGS—Fusible

Crane Co.
Detroit Lubricator Co.
Grinnell Co., Inc.

Pipe

Crane Co.
Grinnell Co., Inc.

Radiator

Fowler & Wolfe Mfg. Co.

POWER PLANT SUPPLIES

Buffalo Forge Co.
Crane Co.
Davis, G. M., Regulator Co.
Dunham, C. A., Co.
Grinnell Co., Inc.
Illinois Engineering Co.
Klipfel Mfg. Co.
Mason Regulator Co.
Norristown Magnesia & Asbestos Co.
Westinghouse Electric & Mfg. Co.

PRESSURE GAGES (See Gages, Pressure)

PROTECTORS—Radiator

American Radiator Co.
Fulton Co.
U. S. Radiator Corp.

PSYCHROMETERS

Hill, E. Vernon, Co.

PUBLICATIONS

Heating & Ventilating Magazine
Journal of the American Society of Heating and Ventilating Engineers

PUMPS—Air

Bishop & Babcock Co.
Buffalo Steam Pump Co.
Economy Pumping Machinery Co.

McAlear Mfg. Co.
Nash Engineering Co.
Sterling Engineering Co.
Trane Co.

Automatic Electric

Economy Pumping Machinery Co.
Nash Engineering Co.

Boiler Feed

Buffalo Steam Pump Co.
Economy Pumping Machinery Co.

Goulds Mfg. Co.
Grinnell Co., Inc.
Nash Engineering Co.
Skidmore Corp.
Trane Co.

Centrifugal

Brecht Co.
Buffalo Steam Pump Co.
Economy Pumping Machinery Co.

Goulds Mfg. Co.
Nash Engineering Co.
Skidmore Corp.
Taylor Machine Works
Trane Co.

Circulating

Economy Pumping Machinery Co.
Nash Engineering Co.

Condensation

Buffalo Steam Pump Co.
Economy Pumping Machinery Co.

Goulds Mfg. Co.
Nash Engineering Co.
Skidmore Corp.
Sterling Engineering Co.
Trane Co.

Electric

Buffalo Steam Pump Co.
Economy Pumping Machinery Co.

Goulds Mfg. Co.
Nash Engineering Co.
Skidmore Corp.
Trane Co.

Rotary

Buffalo Steam Pump Co.
Economy Pumping Machinery Co.

Goulds Mfg. Co.
Nash Engineering Co.

Steam

Buffalo Steam Pump Co.

INDEX TO MODERN EQUIPMENT

Sump
Economy Pumping Machinery Co.
Goulds Mfg. Co.

Turbine
Buffalo Steam Pump Co.
Economy Pumping Machinery Co.
Goulds Mfg. Co.
Nash Engineering Co.
Trane Co.

Vacuum
Buffalo Forge Co.
Buffalo Steam Pump Co.
Economy Pumping Machinery Co.
Goulds Mfg. Co.
McAlear Mfg. Co.
Nash Engineering Co.
Skidmore Corp.
Trane Co.

RADIATOR—Air Valves (See Valves, Air)

Brackets
American Radiator Co.
Continental Heater Corp.
Fowler & Wolfe Mfg. Co.
Grinnell Co., Inc.
Healy-Ruff Co.
Kewanee Boiler Co.
Smith, H. B., Co.
U. S. Radiator Corp.
York Heating & Ventilating Corp.

Covers
American Radiator 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.

Hot Water
Aerofin Corp.
American Radiator Co.
Bayley Mfg. Co.
Burnham Boiler Corp.
Continental Heater Corp.
Fowler & Wolfe Mfg. Co.
Kewanee Boiler Co.
Molby Boiler Co., Inc.
National Radiator Co.
Page, Wm. H., Boiler Co.
Pierce, Butler & Pierce Mfg. Corp.
Richmond Radiator Co.
Smith, H. B., Co.
U. S. Radiator Corp.
Weil-McLain Co.

Steam
Aerofin Corp.
American Radiator Co.
Bayley Mfg. Co.
Burnham Boiler Corp.
Continental Heater Corp.
Fowler & Wolfe Mfg. Co.
Kewanee Boiler Co.
Molby Boiler Co., Inc.
National Radiator Co.
Page, Wm. H., Boiler Co.

Pierce, Butler & Pierce Mfg. Corp.
Richmond Radiator Co.
Smith, H. B., Co.
U. S. Radiator Corp.
Weil-McLain Co.

Wall
American Radiator Co.
Burnham Boiler Corp.
Continental Heater Corp.
Fowler & Wolfe Mfg. Co.
Kewanee Boiler Co.
Molby Boiler Co., Inc.
National Radiator Co.
Page, Wm. H., Boiler Co.
Pierce, Butler & Pierce Mfg. Corp.
Richmond Radiator Co.
Smith, H. B., Co.
U. S. Radiator Corp.
Weil-McLain Co.

RECEIVERS—Air
Buffalo Steam Pump Co.
Carrier Construction Co.
Illinois Engineering Co.
Kewanee Boiler Co.
O-E Specialty Mfg. Co.
Trane Co.

Ammonia
Pennsylvania Engineering Co.

Condensation
Bishop & Babcock Co.
Illinois Engineering Co.
Mason Regulator Co.
Nash Engineering Co.
Trane Co.

REFRIGERATING MACHINERY
Brecht Co.
Carrier Engineering Corp.
Pennsylvania Engineering Co.

REFRIGERATING SECTIONS
American Radiator Co.

REGISTERS AND GRILLES
Carrier Construction Co.

REGULATORS—Damper
American Radiator Co.
Bishop & Babcock Co.
Carrier Construction Co.
Carrier Engineering Corp.
D. & T. Mfg. Co.
Dabzell Bros. Co.
Dunham, C. A., Co.
Fulton Co.
Heat Control Service Co., Inc.
Hoffman Specialty Co., Inc.
Honeywell HeatingSpecialties Co.
Marsh, Jas. P., & Co.
Mason Regulator Co.
Mouat Vapor Heating Co.
Mueller Co.
O-E Specialty Mfg. Co.
Powers Regulator Co.
Sarco Co., Inc.
Stickle Steam Specialties Co.
Taylor Instrument Companies
Trane Co.
U. S. Radiator Corp.
Webster, Warren, & Co.
York Heating & Ventilating Corp.

Feed Water
American Radiator Co.
Jenkins Bros.
Powers Regulator Co.
Taylor Instrument Companies
Webster, Warren, & Co.

Humidity
Carrier Engineering Corp.
Heat Control Service Co., Inc.
Johnson Service Co.
Klipfel Mfg. Co.
Mason Regulator Co.
Taylor Instrument Companies

Pressure
American Radiator Co.
Crane Co.
Davis, G. M., Regulator Co.
Dunham, C. A., Co.
Fulton Co.
Heat Control Service Co., Inc.
Illinois Engineering Co.
Johnson Service Co.
Klipfel Mfg. Co.
Mason Regulator Co.
McAlear Mfg. Co.
Mueller Co.
O-E Specialty Mfg. Co.
Powers Regulator 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.

Steam
American Radiator Co.
Bishop & Babcock Co.
Davis, G. M., Regulator Co.
Illinois Engineering Co.
Jenkins Bros.
Klipfel Mfg. Co.
Mason Regulator Co.
McAlear Mfg. Co.
Mueller Co.
Taylor Instrument Companies
Webster, Warren, & Co.

Temperature
American Radiator Co.
Bishop & Babcock Co.
Brecht Co.
Burnham Boiler Corp.
Carrier Engineering Corp.
Crane Co.
D. & T. Mfg. Co.
Donnelly Systems Co.
Fulton Co.
Heat Control Service Co., Inc.
Honeywell HeatingSpecialties Co.
Hornung, J. C.
Johnson Service Co.
Klipfel 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.
Illinois Engineering Co.
Klipfel Mfg. Co.
Mason Regulator Co.
McAlear Mfg. Co.
O-E Specialty Mfg. Co.
Sterling Engineering Co.
Trane Co.
U. S. Radiator Corp.
Webster, Warren, & Co.

Vapor
American Radiator Co.
Bishop & Babcock Co.
Davis, G. M., Regulator Co.
Donnelly Systems Co.
Hoffman Specialty Co., Inc.
Mason Regulator Co.
McAlear Mfg. Co.

Mouat Vapor Heating Co.
O-E Specialty Mfg. Co.
Trane Co.
U. S. Radiator Corp.

Water
American Radiator Co.
Davis, G. M., Regulator Co.
Fulton Co.
Jenkins Bros.
Mason Regulator Co.
McAlear Mfg. Co.
Mueller Co.
Reading Heater & Supply Co.
Taylor Instrument Companies
U. S. Radiator Corp.

Water Level (See Controllers)

REHEATERS—Air

Aerofin Corp.
Bayley Mfg. Co.
New York Blower 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.
Thermal Appliance Co.

SCALE REMOVER—Boiler

"X" Laboratories

SCRUBBERS, AIR
Bayley Mfg. Co.

SEPARATORS—Dust
Bayley Mfg. Co.
Call, John, Co.
Carrier Construction Co.
Carrier Engineering Corp.
Hersh Brothers Co.
New York Blower Co.
Sturtevant, B. F., Co.
York Heating & Ventilating Corp.

Steam and Oil
Bishop & Babcock Co.
Crane Co.
Dunham, C. A., Co.
Illinois Engineering Co.
McAlear Mfg. Co.
Patterson-Kelley Co.
Stickle Steam Specialties Co.
Webster, Warren, & 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.

SOFTENERS, WATER (See Water Softeners)

SPECIALTIES, HEATING (See Heating Specialties)

SPECIALTIES—Sheet Metal
York Heating & Ventilating Corp.

SPECIALTIES, STEAM (See Steam Specialties)

INDEX TO MODERN EQUIPMENT

SPRAY COOLING SYSTEMS
Badger, E. B., & Sons Co.
Bayley Mfg. Co.
Brecht Co.
Buffalo Forge Co.
Carrier Engineering Corp.
Grinnell Co., Inc.

SPRAY NOZZLES (See Nozzles, Spray)

STEAM CALORIMETERS (See Calorimeters, Steam)

STEAM ENGINES (See Engines, Steam)

STEAM HEATING SYSTEMS (See Heating Systems, Steam)

STEAM SPECIALTIES
Barnes & Jones
Bishop & Babcock Co.
Cochrane Corp.
Crane Co.
Davis, G. M., Regulator Co.
Dunham, C. A., Co.
Fulton Co.
Hornung, J. C.
Illinois Engineering Co.
Marsh, Jas. P., & Co.
Mason Regulator Co.
McAlear Mfg. Co.
O-E Specialty Mfg. Co.
Stickle Steam Specialties Co.
Taylor Machine Works
U. S. Radiator Corp.
Webster, Warren, & Co.

STOKERS
Detroit Stoker Co.
Riley, Sanford, Stoker Co.
Sturtevant, B. F., Co.
Westinghouse Electric & Mfg. Co.

STRAINERS—Oil
Davis, G. M., Regulator Co.
Mason Regulator Co.
McAlear Mfg. Co.
Mueller Co.
Sarco Co., Inc.

Steam
Bishop & Babcock Co.
Davis, G. M., Regulator Co.
Mason Regulator Co.
McAlear Mfg. Co.
Mueller Co.
Sarco Co., Inc.
Sterling Engineering Co.

Water
Davis, G. M., Regulator Co.
Dunham, C. A., Co.
Mason Regulator Co.
McAlear Mfg. Co.
Mueller Co.
Sarco Co., Inc.
Sterling Engineering Co.

SUPPLIES—Power Plant (See Power Plant Supplies)

SUPPORTS (See Hangers, Pipe and Radiator)

SWITCHES—Control-Relay
Brecht Co.
Hornung, J. C.
Trane Co.

SYSTEMS—Air Washing and Cooling (See Air Conditioning)

Domestic Hot Water
Excelso Specialty Works, Inc.
Honeywell HeatingSpecialties Co.
Smith, H. B., Co.
Standard Heater Co.
Taylor Machine Works
Thermal Appliance Co.
U. S. Radiator Corp.

Dust Collecting
Bayley Mfg. Co.
Buffalo Forge Co.
Call, John, Co.
Carrier Construction Co.
Carrier Engineering Corp.
Clarage Fan Co.
New York Blower Co.
Skinner Bros. Mfg. Co., Inc.
Sturtevant, B. F., Co.
York Heating & Ventilating Corp.

Exhaust (See Exhaust Systems)

Hot Blast
American Blower Co.
Bayley Mfg. Co.
Buffalo Forge Co.
Carrier Engineering Corp.
Clarage Fan Co.
Ilg Electric Ventilating Co.
Langenberg Mfg. Co.
Moncrief Furnace Co.
New York Blower Co.
Sturtevant, B. F., Co.
York Heating & Ventilating Corp.

Spray Cooling (See Spray Cooling Systems)

Temperature Control
Bishop & Babcock Co.
Buffalo Forge Co.
Carrier Construction Co.
Carrier Engineering Corp.
Clarage Fan Co.
Donnelly Systems Co.
Fulton Co.
Honeywell HeatingSpecialties Co.
Hornung, J. C.
Johnson Service Co.
Klipfel Mfg. Co.
Mueller Co.
Taylor Instrument Companies

Ventilating (See Ventilating Systems)

Water Softening and Purifying
Cochrane Corp.

TANK—Coils (See Coils, Tank)

Covering (See Covering, Pipe and Tank)

Heaters (See Heaters, Tank)

Regulators
Bishop & Babcock Co.
Davis, G. M., Regulator Co.
Fulton Co.
Johnson Service Co.
Mason Regulator Co.
McAlear Mfg. Co.
Mueller Co.
Page, Wm. H., Boiler Co.
Taylor Instrument Companies

TANKS—Blow-Off
Cochrane Corp.

Cast Iron
Bishop & Babcock Co.
Cochrane Corp.

Pressure
Ames Iron Works
Brownell Co.
Kewanee Boiler Co.
Klipfel Mfg. Co.

Storage
Ames Iron Works
Brownell Co.
Carrier Construction Co.
Cochrane Corp.
Kewanee Boiler Co.
Page, Wm. H., Boiler Co.
Titusville Iron Works Co.

TEMPERATURE REGULATORS (See Regulators, Temperature)

INDEX TO MODERN EQUIPMENT

THERMOMETERS

American Radiator Co.
Brecht Co.
Burnham Boiler Corp.
Hill, E. Vernon, Co.
Marsh, Jas. P., & Co.
Pierce, Butler & Pierce Mfg. Corp.
Powers Regulator Co.
Sarco Co., Inc.
Taylor Instrument Companies
U. S. Radiator Corp.

THERMOSTATS

Bishop & Babcock Co.
Burnham Boiler Corp.
Fulton Co.
Heat Control Service Co., Inc.
Honeywell Heating Specialties Co.
Hornung, J. C.
Johnson Service Co.
Klipfel Mfg. Co.
Powers Regulator Co.
Sarco Co., Inc.
Taylor Instrument Companies
Westinghouse Electric & Mfg. Co.

TRAPS—Radiator

Barnes & Jones
Bishop & Babcock Co.
Dunham, C. A., Co.
Grinnell Co., Inc.
Hoffman Specialty Co., Inc.
Illinois Engineering Co.
Johns-Manville, Inc.
Marsh, Jas. P., & Co.
McAlear Mfg. Co.
Monash-Younger Co., Inc.
Mouat Vapor Heating Co.
O-E Specialty Mfg. Co.
Sarco Co., Inc.
Sterling Engineering Co.
Stickley Steam Specialties Co.
Trane Co.
U. S. Radiator Corp.
Webster, Warren, & Co.

Return

American Blower Co.
Barnes & Jones
Bishop & Babcock Co.
Crane Co.
Dunham, C. A., Co.
Illinois Engineering Co.
Johns-Manville, Inc.
Marsh, Jas. P., & Co.
McAlear Mfg. Co.
Monash-Younger Co., Inc.
Mouat Vapor Heating Co.
O-E Specialty Mfg. Co.
Sterling Engineering Co.
Taylor Machine Works
Trane Co.
U. S. Radiator Corp.
Webster, Warren, & Co.

Return (Siphon)

Marsh, Jas. P., & Co.
American Blower Co.
Barnes & Jones
Bayley Mfg. Co.
Bishop & Babcock Co.
Cochrane Corp.
Crane Co.
Davis, G. M., Regulator Co.
Dunham, C. A., Co.
Hoffman Specialty Co., Inc.
Illinois Engineering Co.
Klipfel Mfg. Co.
Marsh, Jas. P., & Co.
McAlear Mfg. Co.
Monash-Younger Co., Inc.
O-E Specialty Mfg. Co.
Patterson-Kelley Co.
Powers Regulator Co.
Reading Heater & Supply Co.
Sarco Co., Inc.
Sturtevant, B. F., Co.
Taylor Machine Works

U. S. Radiator Corp.
Webster, Warren, & Co.

Vacuum

American Blower Co.
Barnes & Jones
Bishop & Babcock Co.
Crane Co.
Donnelly Systems Co.
Dunham, C. A., Co.
Hoffman Specialty Co., Inc.
Illinois Engineering Co.
Johns-Manville, Inc.
Marsh, Jas. P., & Co.
McAlear Mfg. Co.
Monash-Younger Co., Inc.
O-E Specialty Mfg. Co.
Sarco Co., Inc.
Sterling Engineering Co.
Stickley Steam Specialties Co.
Taylor Machine Works
U. S. Radiator Corp.
Webster, Warren, & 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.

Dryers (See Drying Apparatus)

Gages (See Gages, Vacuum)

Heating Systems (See Heating Systems, Steam Vacuum)

Pumps (See Pumps, Vacuum)

Regulators (See Regulators, Vacuum)

Specialties (See Heating Specialties)

Traps (See Traps, Vacuum)

VALVES—Air

American Radiator Co.
Bishop & Babcock Co.
Burnham Boiler Corp.
Crane Co.
Davis, G. M., Regulator Co.
Dole Valve Co.
Donnelly Systems Co.
Dunham, C. A., Co.
Fulton Co.
Gorton & Lidgerwood Co.
Grinnell Co., Inc.
Hoffman Specialty Co., Inc.
Jenkins Bros.
Marsh, Jas. P., & Co.
McAlear Mfg. Co.
Monash-Younger Co., Inc.
O-E Specialty Mfg. Co.
Page, Wm. H., Boiler Co.
Pierce, Butler & Pierce Mfg. Corp.
Smith, H. B., Co.
Sterling Engineering Co.
Trane Co.
U. S. Radiator Corp.

Angle, Check and Globe

American Radiator Co.
Crane Co.
Davis, G. M., Regulator Co.
Dole Valve Co.
Grinnell Co., Inc.
Illinois Engineering Co.
Jenkins Bros.

McAlear Mfg. Co.
O-E Specialty Mfg. Co.
Pierce, Butler & Pierce Mfg. Corp.
U. S. Radiator Corp.

Back-Pressure

Bishop & Babcock Co.
Cochrane Corp.
Crane Co.
Davis, G. M., Regulator Co.
Grinnell Co., Inc.
Illinois Engineering Co.
Jenkins Bros.
Klipfel Mfg. Co.
McAlear Mfg. Co.

Blow-Off

Crane Co.
Davis, G. M., Regulator Co.
Detroit Lubricator Co.
Grinnell Co., Inc.
Jenkins Bros.
Mueller Co.
U. S. Radiator Corp.

Float

Crane Co.
Davis, G. M., Regulator Co.
Grinnell Co., Inc.
Illinois Engineering Co.
Klipfel Mfg. Co.
McAlear Mfg. Co.
Trane Co.

Gage

Bishop & Babcock Co.
Grinnell Co., Inc.
Stickley Steam Specialties Co.
U. S. Radiator Corp.

Gate

American Radiator Co.
Brecht Co.
Crane Co.
Detroit Lubricator Co.
Dole Valve Co.
Grinnell Co., Inc.
Jenkins Bros.
Marsh, Jas. P., & Co.

Graduating

Barnes & Jones
Bishop & Babcock Co.
Burnham Boiler Corp.
Detroit Lubricator Co.
Dole Valve Co.
Grinnell Co., Inc.
Hoffman Specialty Co., Inc.
Illinois Engineering Co.
Marsh, Jas. P., & Co.
McAlear Mfg. Co.
Monash-Younger Co., Inc.
Mouat Vapor Heating 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.
Crane Co.
Davis, G. M., Regulator Co.
Detroit Lubricator Co.
Dole Valve Co.
Gorton & Lidgerwood Co.
Grinnell Co., Inc.
Jenkins Bros.
Marsh, Jas. P., & Co.
Pierce, Butler & Pierce Mfg. Corp.
U. S. Radiator Corp.

Modulating

American Radiator Co.
Barnes & Jones
Bishop & Babcock Co.
Burnham Boiler Corp.
Crane Co.
Detroit Lubricator Co.
Dole Valve Co.
Donnelly Systems Co.

Gorton & Lidgerwood Co.
Grinnell Co., Inc.
Hoffman Specialty Co., Inc.
Illinois Engineering Co.
Jenkins Bros.
Marsh, Jas. P., & Co.
McAlear Mfg. Co.
Monash-Younger Co., Inc.
Pierce, Butler & Pierce Mfg. Corp.
Sterling Engineering Co.
Trane Co.
U. S. Radiator Corp.
Webster, Warren, & Co.

Packless

American Radiator Co.
Barnes & Jones
Bishop & Babcock Co.
Burnham Boiler Corp.
Crane Co.
Davis, G. M., Regulator Co.
Detroit Lubricator Co.
Dole Valve Co.
Dunham, C. A., Co.
Fulton Co.
Gorton & Lidgerwood Co.
Grinnell Co., Inc.
Illinois Engineering Co.
Marsh, Jas. P., & Co.
McAlear Mfg. Co.
Monash-Younger Co., Inc.
Mouat Vapor Heating Co.
O-E Specialty Mfg. Co.
Pierce, Butler & Pierce Mfg. Corp.
Sterling Engineering Co.
U. S. Radiator Corp.
Webster, Warren, & Co.

Radiator

American Radiator Co.
Barnes & Jones
Bishop & Babcock Co.
Burnham Boiler Corp.
Crane Co.
Davis, G. M., Regulator Co.
Detroit Lubricator Co.
Dole Valve Co.
Donnelly Systems Co.
Dunham, C. A., Co.
Fulton Co.
Gorton & Lidgerwood Co.
Grinnell Co., Inc.
Hoffman Specialty Co., Inc.
International Heater Co.
Jenkins Bros.
Marsh, Jas. P., & Co.
Monash-Younger Co., Inc.
Mouat Vapor Heating Co.
O-E Specialty Mfg. Co.
Powers Regulator Co.
Sterling Engineering Co.
Trane Co.
U. S. Radiator Corp.
Webster, Warren, & Co.

Reducing

Bishop & Babcock Co.
Crane Co.
Davis, G. M., Regulator Co.
Dunham, C. A., Co.
Fulton Co.
Grinnell Co., Inc.
Illinois Engineering Co.
Jenkins Bros.
Klipfel Mfg. Co.
Mason Regulator Co.
McAlear Mfg. Co.
Mueller Co.
O-E Specialty Mfg. Co.
Powers Regulator Co.
Taylor Instrument Companies

Regrinding

Crane Co.
Grinnell Co., Inc.
Jenkins Bros.

Relief

Mueller Co.

INDEX TO MODERN EQUIPMENT

Return Line

American Radiator Co.
Barnes & Jones
Bishop & Babcock Co.
Crane Co.
Fulton Co.
Grinnell Co., Inc.
Hoffman Specialty Co., Inc.
Illinois Engineering Co.
Jenkins Bros.
Marsh, Jas. P., & Co.
McAlear Mfg. Co.
Mouat Vapor Heating Co.
Stickley Steam Specialties Co.
Trane Co.

Safety

American Radiator Co.
Crane Co.
Davis, G. M., Regulator Co.
Grinnell Co., Inc.
Jenkins Bros.
Marsh, Jas. P., & Co.
Mueller Co.
Titusville Iron Works Co.
U. S. Radiator Corp.

Steam Feed

Crane Co.
Grinnell Co., Inc.
Jenkins Bros.

Thermostatic

American Radiator Co.
Barnes & Jones
Bishop & Babcock Co.
Crane Co.
Dole Valve Co.
Fulton Co.
Grinnell Co., Inc.
Illinois Engineering Co.
Marsh, Jas. P., & Co.
McAlear Mfg. Co.
Monash-Younger Co., Inc.
Sterling Engineering Co.
Taylor Instrument Companies
Trane Co.

Vacuum

American Radiator Co.
Barnes & Jones
Bishop & Babcock Co.
Burnham Boiler Corp.
Crane Co.
Davis, G. M., Regulator Co.
Dole Valve Co.
Donnelly Systems Co.
Gorton & Lidgerwood Co.
Grinnell Co., Inc.
Hoffman Specialty Co., Inc.
Illinois Engineering Co.
Marsh, Jas. P., & Co.
McAlear Mfg. Co.
Monash-Younger Co., Inc.
O-E Specialty Mfg. Co.
Sterling Engineering Co.
Trane Co.
U. S. Radiator Corp.
Webster, Warren, & Co.

Vapor

American Radiator Co.
Barnes & Jones
Bishop & Babcock Co.
Burnham Boiler Corp.
Crane Co.
Davis, G. M., Regulator Co.
Dole Valve Co.
Donnelly Systems Co.
Dunham, C. A., Co.
Gorton & Lidgerwood Co.
Grinnell Co., Inc.
Illinois Engineering Co.
Marsh, Jas. P., & Co.
McAlear Mfg. Co.
Mouat Vapor Heating Co.
O-E Specialty Mfg. Co.
Sterling Engineering 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

American Blower Co.
Bayley Mfg. Co.
Buffalo Forge Co.
Carrier Construction Co.
Carrier Engineering Corp.
Clarage Fan Co.
Fleisher, W. L., & Co., Inc.
Ilg Electric Ventilating Co.
Monier Furnace Co.
New York Blower Co.
Skinner Bros. Mfg. Co., Inc.
Sturtevant, B. F., Co.
Wing, L. J., Mfg. Co.
York Heating & Ventilating Corp.

VENTILATORS—Mushroom

Call, John, Co.
Hersh Brothers Co.
Knowles Mushroom Ventilator Co.
New York Blower Co.
Sturtevant, B. F., Co.

Roof

American Foundry & Furnace Co.
American-Larson Ventilating Co.
Buffalo Forge Co.
Call, John, Co.
Carrier Construction Co.
Dalzell Bros. Co.
Hersh Brothers Co.
Ilg Electric Ventilating Co.
Iona Ventilator Co., Inc.
Johns-Manville, Inc.
New York Blower Co.
Skinner Bros. Mfg. Co., Inc.
Sturtevant, B. F., Co.
York Heating & Ventilating Corp.

Window

Call, John, Co.
Iona Ventilator Co., Inc.
Sturtevant, B. F., Co.

VENTS—Air

American Radiator Co.
Bishop & Babcock Co.
Call, John, Co.
Dunham, C. A., Co.
Hoffman Specialty Co., Inc.
Marsh, Jas. P., & Co.
Sturtevant, B. F., Co.
Trane Co.

WARM-AIR FURNACES (See Furnaces, Warm Air)

WARM-AIR HEATING SYSTEMS (See Heating Systems, Warm Air)

WATER COLUMNS (See Columns, Water)

WATER GAGES (See Gages, Water)

WATER HEATERS (See Heaters, and Gas, Water Heaters)

WATER METERS (See Meters, Water)

WATER-PROOF CEMENT (See Cement, Water Proof)

WATER SOFTENERS

Cochrane Corp.

WEATHER STRIPS—Metal

Monarch Metal Products Co.

Index to Advertisers

AMERICAN SOCIETY of HEATING and VENTILATING ENGINEERS GUIDE 1924-25

	Page
Abendroth Brothers, Port Chester, N. Y.	245
Aerofin Corporation, 750 Frelinghuysen Ave., Newark, N. J.	331-335
Alberger Heater Co., 281 Chicago St., Buffalo, N. Y.	340
American Blower Co., 6004 Russell St., Detroit, Mich.	315
American Foundry & Furnace Co., Bloomington, Ill.	327
American-Larson Ventilating Co., 204 Keystone Bank Bldg., Pittsburgh, Pa.	442-443
American Radiator Co., 1807 Elmwood Ave., Buffalo, N. Y.	246-249
Ames Iron Works, Oswego, N. Y.	283-285
Atmospheric Conditioning Corp., 477 Chestnut St., Philadelphia, Pa.	236-237
Badger, E. B., & Sons Co., 75 Pitts St., Boston, Mass.	314
Barnes & Jones, 5 Melrose St., Boston, Mass.	383
Bayley Mfg. Co., 732 Greenbush St., Milwaukee, Wis.	316
Bishop & Babcock Co., 1200 East 55th St., Cleveland Ohio.	384
Brecht Co., 12th St., and Cass Ave., St. Louis, Mo.	380
Brownell Co., Dayton, Ohio.	250-251
Bryant Heater & Mfg. Co., 952 East 72nd St., Cleveland, Ohio.	252-253
Buffalo Forge Co., Buffalo, N. Y.	317
Buffalo Steam Pump Co., Buffalo, N. Y.	365
Bunting Iron Works, 1215 First National Bank Bldg., San Francisco, Calif.	306-307
Burnham Boiler Corp., Irvington, N. Y.	254
Call, John, Co., 122-28 N. Franklin St., Philadelphia, Pa.	441
Carrier Air Conditioning Co. of America, 490 Broadway, Buffalo, N. Y.	317
Carrier Construction Co., 750 Frelinghuysen Ave., Newark, N. J.	382
Carrier Engineering Corp., 750 Frelinghuysen Ave., Newark, N. J.	238-239
Clarage Fan Co., Kalamazoo, Mich.	318
Cochrane Corporation, 3120 North 17th St., Philadelphia, Pa.	445
Combustion Specialties Corp., 250 West 54th St., New York City.	386
Continental Heater Corp., Dunkirk, N. Y.	256-257
Cox, Abram, Stove Co., American and Dauphin Sts., Philadelphia, Pa.	258-259
Crane Co., 836 S. Michigan Ave., Chicago, Ill.	362-364
D. & T. Mfg. Co., 3001 La Salle St., St. Louis, Mo.	344
Dalzell Bros. Co., 21 Holmes St., Youngstown, Ohio.	326
Davis, G. M., Regulator Co., 436 Milwaukee Ave., Chicago, Ill.	387
Detroit Lubricator Co., 5842 Trumbull Ave., Detroit, Mich.	432
Detroit Stoker Co., General Motors Bldg., Detroit, Mich.	418
Dole Valve Co., 1923 Carroll Ave., Chicago, Ill.	433
Donnelly Systems Co., 9 Murray St., New York City.	434
Drying Systems, Inc., 11 S. Desplaines St., Chicago, Ill.	312-313
Dunham, C. A., Co., 230 E. Ohio St., Chicago, Ill.	388-391
Economy Pumping Machinery Co., 122 N. Curtis St., Chicago, Ill.	368
Ellison, Lewis M., 214 W. Kinzie St., Chicago, Ill.	310-311
Excelso Specialty Works, Inc., 119 Clinton St., Buffalo, N. Y.	341
Farley Sleeve & Hanger Co., 3748 East 71st St., Cleveland, Ohio.	376
Fitzgibbons Boiler Co., 47 West 42nd St., New York City.	260-261
Fleisher, W. L., & Co., Inc., 31 Union Square West, New York City.	240
Fowler & Wolfe Mfg. Co., 521 Bulletin Bldg., Philadelphia, Pa.	379
Fulton Co., Knoxville, Tenn.	436-437
General Boilers Co., Waukegan, Ill.	255
Gleockle, A. F., Jr., 415 Bay St., Rochester, N. Y.	377
Gorton & Lidgerwood Co., 96 Liberty St., New York City.	438-439
Goulds Mfg. Co., Seneca Falls, N. Y.	366-367
Grinnell Co., Inc., 275 W. Exchange St., Providence, R. I.	346-350

INDEX TO ADVERTISERS

	Page
Healy-Ruff Co., 502 Plymouth Bldg., Minneapolis, Minn.	378
Heat Control Service Co., Inc., 759 Park Place, Brooklyn, N. Y.	420-421
Heating and Ventilating Magazine, 1123 Broadway, New York City.	431
Heggie Simplex Boiler Co., 1909 Conway Bldg., Chicago, Ill.	262-263
Henry Furnace & Foundry Co., Cleveland, Ohio.	329
Hersh Brothers Co., Allentown, Pa.	320-321
Hill, E. Vernon, Co., 64 W. Randolph St., Chicago, Ill.	353
Hoffman Specialty Co., Inc., 25 West 45th St., New York City.	392-400
Honeywell Heating Specialties Co., Wabash, Ind.	430
Hornung, J. C., (Central Heat Appliances) 343 S. Dearborn St., Chicago, Ill.	385
Ilg Electric Ventilating Co., 2850 N. Crawford Ave., Chicago, Ill.	319
Illinois Engineering Co., 21st St. and Racine Ave., Chicago, Ill.	402-403
International Heater Co., 101 Park Ave., Utica, N. Y.	264-268
Iona Ventilator Co., Inc., 2821-29 W. Dauphin St., Philadelphia, Pa.	444
Jenkins Bros., 80 White St., New York City.	435
Johns-Manville, Inc., 294 Madison Ave., New York City.	355
Johnson Service Co., Milwaukee, Wis.	422-426
Kewanee Boiler Co., Kewanee, Ill.	269-275
Klipfel Mfg. Co., 2641-2659 W. Harrison St., Chicago, Ill.	404-405
Knowles Mushroom Ventilator Co., 202-204 Franklin St., New York City.	241
Langenberg Mfg. Co., 4519 N. Euclid Ave., St. Louis, Mo.	328
Marsh, Jas. P., & Co., 118 S. Clinton St., Chicago, Ill.	406-407
Mason Regulator Co., 1190 Adams St., Boston, Mass.	408
McAlear Mfg. Co., 1901 S. Western Ave., Chicago, Ill.	401
Midwest Air Filters, Inc., 100 East 45th St., New York City.	243
Molby Boiler Co., Inc., 41 East 42nd St., New York City.	276
Monarch Metal Products Co., 5020 Penrose St., St. Louis, Mo.	358-359
Monash-Yunker Co., Inc., 553 W. Monroe St., Chicago, Ill.	409
Moncrief Furnace Co., 62 Hemphill Ave., Atlanta, Ga.	329
Mouat Vapor Heating Co., 1246 West 4th St., Cleveland, Ohio.	345
Mueller Co., Decatur, Ill.	351
Nash Engineering Co., South Norwalk, Conn.	369
National Radiator Co., Johnstown, Pa.	278-279
New York Blower Co., 2248 S. Halsted St., Chicago, Ill.	322
Norristown Magnesia & Asbestos Co., Norristown, Pa.	356
O-E Specialty Mfg. Co., 8-12 Keefe Ave., Milwaukee, Wis.	410
Oil City Boiler Works, Oil City, Pa.	280-281
Page, Wm. H., Boiler Co., 58 West 40th St., New York City.	277
Patterson-Kelly Co., 101 Park Ave., New York City.	342
Pennsylvania Engineering Co., 1119-21 N. Howard St., Philadelphia, Pa.	381
Pierce, Butler & Pierce Mfg. Corp., 41 East 42nd St., New York City.	282-440
Powers Regulator Co., 2719 Greenview Ave., Chicago, Ill.	427-429
Prox, Frank, Co., Terra Haute, Ind.	286-287
Reading Heater & Supply Co., Woodward and Church Sts., Reading, Pa.	352
Reed Air Filter Co., Inc., 616-28 Barret Ave., Louisville, Ky.	242
Reliance Electric & Engineering Co., 1088 Ivanhoe Rd., Cleveland, Ohio.	360
Richardson & Boynton Co., 260 Fifth Ave., New York City.	296
Richmond Radiator Co., 1480 Broadway, New York City.	288-289
Ric-wil Co., Guardian Bldg., Cleveland, Ohio.	357
Riley, Sanford, Stoker Co., 9 Neponset St., Worcester, Mass.	419
Sarco Co., Inc., 233 Broadway, New York City.	411
Skidmore Corporation, 1535 Dayton St., Chicago, Ill.	370
Skinner Bros. Mfg. Co., 1400-1490 S. Vandeventer Ave., St. Louis, Mo.	336-337
Smith, H. B., Co., Westfield, Mass.	290-293
Standard Heater Co., Williamsport, Pa.	294-295
Sterling Engineering Co., 1636-44 Holton St., Milwaukee, Wis.	412-413
Stickle Steam Specialties Co., 502 S. Pennsylvania St., Indianapolis, Ind.	416
Sturtevant, B. F., Hyde Park, Boston, Mass.	323

INDEX TO ADVERTISERS

	Page
Taylor Instrument Companies, Rochester, N. Y.....	354
Taylor Machine Works, Battle Creek, Mich.....	371
Thermal Appliance Co., 342 Madison Ave., New York City.....	343
Titusville Iron Works Co., Titusville, Pa.....	297
Trane Co., La Crosse, Wis.....	372-375, 414-415
XXth Century Heating & Ventilating Co., Edison and Ira Ave., Akron, Ohio.....	330
U. S. Radiator Corp., 133 E. Grand River Ave., Detroit, Mich.....	301-305
Utica Heater Co., Utica, N. Y.....	298-299
Webster, Warren, & Co., Camden, N. J.....	417
Weil-McLain Co., 641 W. Lake St., Chicago, Ill.....	300
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.....	361
Winslow Boiler & Engineering Co., 208 S. La Salle St., Chicago, Ill.....	308-309
Wing, L. J., Mfg. Co., 352 West 13th St., New York City.....	324-325
"X" Laboratories, 25 West 45th St., New York City.....	244
York Heating & Ventilating Corp., 1502 Locust St., Philadelphia, Pa.....	338-339

Roll of Membership

AMERICAN SOCIETY of
HEATING and VENTILATING ENGINEERS

1924-1925

Contains Lists of Members
Arranged Alphabetically and
Geographically also Lists of
Officers and Committees, Past
Officers and Local Chapter
Officers

Corrected to June 1, 1924

Published at the Headquarters of the Society
29 West 39th Street, New York, N. Y.

Officers and Council

AMERICAN SOCIETY of HEATING and VENTILATING ENGINEERS

1924

President.....HOMER ADDAMS, New York, N. Y.
First Vice-President.....S. E. DIBBLE, Pittsburgh, Pa.
Second Vice-President.....WILLIAM H. DRISCOLL, New York, N. Y.
Treasurer.....PERRY WEST, Newark, N. J.
Secretary.....F. C. HOUGHTEN, New York, N. Y.

Council

HOMER ADDAMS, *Chairman*

S. E. DIBBLE, <i>Vice-Chairman</i>	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, <i>Secretary</i>

Advisory Council

H. P. Gant, *Chairman*; R. P. Bolton, John Gormly, John F. Hale, H. M. Hart, E. Vernon Hill, J. D. Hoffman, S. A. Jellett, D. D. Kimball, J. H. Kinealy, S. R. Lewis, J. I. Lyle, J. R. McColl, D. M. Quay, C. L. Riley, C. B. J. Snyder, F. R. Still, W. S. Timmis.

Committees of the Council

Executive: S. E. Dibble, *Chairman*; W. H. Carrier, William H. Driscoll.
Finance: Thornton Lewis, *Chairman*; J. A. Cutler, Perry West.
Membership: Alfred Kellogg, *Chairman*; W. H. Carrier, W. E. Gillham.
Publication: L. A. Harding, *Chairman*; F. Paul Anderson, H. P. Gant.

Research Department

Committee on Research: William H. Driscoll, *Chairman*; O. P. Hood, *Member-ex-officio*; F. Paul Anderson, *Director of Research Laboratory*; Homer Addams, E. Vernon Hill, Alfred Kellogg, J. R. McColl, F. R. Still (3 years); S. E. Dibble, C. F. Eveleth, F. B. Howell, Thornton Lewis, E. E. McNair (2 years); William H. Driscoll, C. V. Haynes, J. D. Hoffman, J. I. Lyle, Perry West (1 year).

Committees—1924

Nominating Committee: J. R. McColl, *Chairman*; J. D. Cassell, Roswell Farnham, H. M. Hart, J. C. Hobbs.

Guide Publication Committee: F. D. Mensing, *Chairman*; J. Esten Bolling, C. V. Haynes, Perry West.

Committee on Chapters: Geo. B. Nichols, *Chairman*; E. P. Bradley, W. L. Fleisher.

Committee on Code of Ethics: Chas. L. Reeder, *Chairman*; H. M. Hart, Alfred Kellogg, Henry C. Meyer, Jr., S. A. Jellett.

Committee on Code for Testing Low Pressure Heating Boilers: John Blizzard, *Chairman*; F. Paul Anderson, C. E. Bronson, H. W. Brooks, William H. Driscoll, F. B. Howell, J. F. McIntire, C. W. Obert.

Committee on Legislation: W. G. R. Braemer, *Chairman*; F. F. Bahnson, C. R. Bradbury, S. A. Challman, Ralph T. Coe, F. I. Cooper, H. C. Eicher, H. H. Fielding, L. M. Frederick, W. B. Johnston, S. R. Lewis, J. J. Mason, Wm. Mallis, H. M. Miller, J. G. Pease.

Committee on Increase of Membership: C. V. Haynes, *Chairman*; C. W. Farrar, F. J. Friedman, F. H. Gaylord, E. F. Glone, C. P. Hackett, H. A. Hanson, H. E. Pursell, E. A. Stark, E. S. Storm, H. F. Thomas, J. F. Tuttle.

Committee of Revision of Constitution: J. R. McColl, *Chairman*; R. P. Bolton, H. P. Gant, John Gormly, John F. Hale, H. M. Hart, E. V. Hill, J. D. Hoffman, S. A. Jellett, D. D. Kimball, J. H. Kinealy, S. R. Lewis, J. I. Lyle, D. M. Quay, C. L. Riley, C. B. J. Snyder, F. R. Still, W. S. Timmis.

Committee on School House Standards: F. I. Cooper, *Chairman*; J. D. Cassell, H. P. Dempsey, H. C. Eicher, E. S. Hallett, John Howatt, S. R. Lewis.

Committee on Steam and Return Main Sizes: W. L. Durand, *Chairman*.

University Professors: J. E. Emswiler, F. E. Giesecke.

Contracting Engineers: William H. Driscoll, W. L. Fleisher, H. M. Hart.

Consulting Engineers: R. V. Frost, W. R. Jones, W. S. Timmis.

Manufacturers: J. A. Donnelly, C. E. Eveleth.

Central Station Heating: J. C. Hobbs, J. H. Walker.

Committee to Confer with American Institute of Architects: S. A. Jellett, *Chairman*; D. D. Kimball, S. R. Lewis, J. R. McColl, C. L. Riley.

Committee on Code of Heating & Ventilating: L. A. Harding, *General Chairman*.

Sub-Com. I.	Definition of Terms.....	F. Paul Anderson, <i>Chm.</i>
Sub-Com. II.	Ventilation Requirements for Public Buildings.....	E. Vernon Hill, <i>Chm.</i>
Sub-Com. III.	Requirements for Heating Buildings.....	A. C. Willard, <i>Chm.</i>
Sub-Com. IV.	Direct Steam or Hot-Water Radiation.....	R. V. Frost, <i>Chm.</i>
Sub-Com. V.	Indirect Steam or Hot-Water Radiation.....	L. C. Soule, <i>Chm.</i>
Sub-Com. VI.	Heating Boiler Capacity.....	J. F. McIntire, <i>Chm.</i>
Sub-Com. VII.	Warm Air Furnace Heating.....	J. D. Hoffman, <i>Chm.</i>
Sub-Com. VIII.	Design of Chimneys and Flues.....	J. R. McColl, <i>Chm.</i>
Sub-Com. IX.	Pipe Sizes for Steam Heating.....	J. A. Donnelly, <i>Chm.</i>
Sub-Com. X.	Pipe Sizes for Hot-Water Heating.....	W. S. Timmis, <i>Chm.</i>
Sub-Com. XI.	Air Ducts for Ventilation.....	C. A. Booth, <i>Chm.</i>
Sub-Com. XII.	Air Washers and Humidifiers.....	W. H. Carrier, <i>Chm.</i>
Sub-Com. XIII.	Pumps for Heating Systems.....	Perry West, <i>Chm.</i>
Sub-Com. XIV.	Standard Symbols for Drawings.....	J. H. Walker, <i>Chm.</i>

Committee on Standards of Ventilation: W. H. Carrier, *Chairman*; F. R. Still, *Vice-Chairman*; E. P. Bradley, Philip Drinker, F. R. Ellis, E. S. Hallett, Thomas Chester, E. Vernon Hill, F. C. Houghten, John Howatt, J. R. McColl, W. H. Sears, R. W. Smith, Perry West, A. C. Willard.

Committee to Confer with A. S. M. E. Boiler Code Committee: W. S. Timmis, *Chairman*; Homer Addams, F. Paul Anderson, L. P. Breckenridge, James Doherty, H. M. Hart, F. B. Howell, J. F. McIntire.

Officers of Local Chapters

1924-25

Cleveland

Headquarters, Cleveland
Meets: Second Thursday in Month
President, ERNEST SZEKLEY
820 W. Superior Ave.
Secretary, E. L. ANDERSON
526 Sweetland Bldg.

Colorado

Headquarters, Denver
Meets: Second Monday in Month
President, GEO. L. BRADBURY
1219 Stout St.
Secretary, OSCAR G. WARD
517 Boston Bldg.

Illinois

Headquarters, Chicago
Meets: Second Monday in Month
President, CHARLES D. ALLAN
1923 Calumet Ave.
Secretary, H. G. THOMAS
549 W. Washington Blvd.

Kansas City

Headquarters, Kansas City, Mo.
Meets: First Monday in Month
President, W. N. MCINTYRE
1927 Montgall St.
Secretary, P. M. HAVES
1307 West 10th St.

Massachusetts

Headquarters, Boston
President, W. T. JONES
11 Rossmere St., Newtonville, Mass.
Secretary, E. A. DUSOSSOIT
202 Harrison Ave.

Michigan

Headquarters, Detroit
Meets: First Monday after the 10th of the Month
President, J. B. DILL
8771 Dexter Blvd.
Secretary, N. B. HUBBARD
1504 Broadway, Room 614

Minnesota

Headquarters, Minneapolis
Meets: Second Monday in Month
President, A. L. SANFORD
245 Ninth Ave., N.
Secretary, R. W. OTTO
2529 University Ave., S.E.

New York

Headquarters, New York
Meets: Third Monday in Month
President, W. L. DURAND
101 Park Avenue
Secretary, E. B. JOHNSON
134 Wardwell Ave., W. New Brighton, S. I.

Western New York

Headquarters, Buffalo
Meets: Second Monday in Month
President, HUGO HUTZEL
1807 Elmwood Ave.
Secretary, ROSWELL FARNHAM
490 Broadway

Ontario

Headquarters, Toronto, Can.
Meets: Third Friday in Month
President, A. S. LEITCH
1002 Kent Bldg.
Secretary, W. R. BLACKHALL
332 Waverly Rd.

Philadelphia

Headquarters, Philadelphia
Meets: Second Thursday in Month
President, R. C. BOLSINGER
521 Bulletin Bldg.
Secretary, R. V. FROST
828 Marshall St., Norristown, Pa.

Pittsburgh

Headquarters, Pittsburgh
Meets: Third Tuesday in Month
President, J. C. HOBBS
504 Chamber of Commerce Bldg.
Secretary, C. C. SCHRADER
A. S. H. & V. E. Research Laboratory, U. S.
Bureau of Mines

St. Louis

Headquarters, St. Louis
Meets: Third Thursday in Month
President, W. A. KLEIN
Arcade Bldg.
Secretary, THOMAS J. C. GALE
4023 Shaw Ave.

Wisconsin

Headquarters, Milwaukee
Meets: First Tuesday in Month
President, CHARLES W. MILLER
209 Grand Ave.
Secretary, EDWARD J. LOMASNEY
456 Broadway

Roll of Membership

AMERICAN SOCIETY of HEATING and VENTILATING ENGINEERS

HONORARY MEMBERS

BALDWIN, WM. J. (1915), New York, N. Y. (Deceased May 7, 1924.)
BILLINGS, DR. J. S. (1896), New York, N. Y. (Deceased March 10, 1913.)
GORMLY, JOHN (Charter Member), Norristown, Pa.
NEWTON, C. W. (Charter Member), Baltimore, Md. (Deceased August 6, 1920.)

LIST OF MEMBERS

Arranged Alphabetically—All Grades

(Asterisk indicates authorship of papers)

A

ABBOUD, Alfred (Junior 1924) J. Gallivan Co., 153 N. Washington St., and (for mail) 21 Milford St., Boston, Mass.
ABRAMS, Abraham (Junior 1924), Secy. and Treas. (for mail) Berman-Rathe Corp., 4 St. Clair Pl. and 210 West 114th St., New York, N.Y.
ACHESON, Albert R. (1919), Prof. of Mech. Engr., Syracuse University, and (for mail) 601 Eckel Theatre Bldg., Syracuse, N. Y.
ADAMS, Benjamin (1919), Dist. Mgr. (for mail) American Blower Co., 612 Otis Bldg., Philadelphia, and 3006 W. Coulter St., Germantown, Pa.
ADAMS, Charles W. (1920), 1425 16th St., Denver, Colo.
ADAMS, Dan (1919), Lockwood, Greene & Co. (for mail) 24 Federal St., Boston, and 91 Allerton Rd., Newton Highlands, Mass.
ADAMS, Henry (Charter Member), (Board of Managers 1894; Council 1895; 1898; 2nd Vice-Pres. 1897; Pres. 1899); Consulting Engr. (for mail) 1263-69 Calvert Bldg., and 2038 Park Ave., Baltimore, Md.
ADAMS, Nell D. (Junior 1922), Ellerhee & Co., 692 Endicott Bldg., St. Paul, Minn.
ADDAMS, Homer (Charter Member), (Treas. 1915-1922; 1st Vice-Pres. 1923; Pres. 1924); Vice-Pres. Kewanee Boiler Co., Inc., 47 West 42nd St., New York, N. Y.
ADDY, Edward (1923), Sup. Engr., Bd. of Education, 155 College St., and 128 Victor Ave., Toronto, Ont.
ADDY, Robert (1919), Plbg. and Heat. Contr., 7012 Fort St., W., Detroit, Mich.
ADLER, Alphonse A.* (1921), Consulting Engr. (for mail) 9 Murray St., New York, N. Y., and 35 Stewart Ave., Arlington, N. J.
ADRIANSE, Paul R. (1923), Sales Engr., Buffalo Forge Co., 368 Kirby Bldg., Cleveland, O.
AHERN, Thos. L. (Junior 1923), Vice-Pres. (for mail) J. F. Ahern Co., 70 S. Portland St., and 157 Sixth St., Fitchburg, Mass.
AHLFF, Albert A. (Associate 1918; 1923), Mgr. (for mail) U. S. Radiator Corp., 303 Crosby Bldg., and 163 Hughes Ave., Buffalo, N. Y.
ALEXANDER, Alfred D. (1915), Consulting Engr., 168 Marion St., Oak Park, Ill.
ALEXANDER, Clifford M. (1920), Ch. Draftsman, Mouat Vapor Heat Co., 1246 W. Fourth St., Cleveland, and (for mail) Box 266, Rocky River, O.
ALGER, Richard W. (1911), Vice-Pres. and Gen. Mgr. (for mail) Marye, Alger & Alger, Archt., 201-4 Walton Bldg., and 378 N. Blvd., Atlanta, Ga.
ALLAN, Charles D. (1920), (Pres. Illinois Chapter) Consulting Engr. (for mail) 127 N. Dearborn St., and 4526 Dover St., Chicago, Ill.
ALLEN, DeWitt M. (Junior 1922), Sales Repr. (for mail) R. B. Carter Co., 152 Chambers St., New York, N. Y.
ALLEN, Harry D. (1917), Heat. Engr. (for mail) H. D. Allen, 2940 W. Lake St., and 5915 W. Erie St., Chicago, Ill.
ALLEN, LeRoy E. (1921), Dept. Ch. Engr. (for mail) Grinnell Co., Inc., Dana and Paige Aves., and 209 Howland Ave., Warren, O.
ALLEN, W. Harwell (Junior 1910; 1911), Pres. (for mail) State Heat. & Power Co., 272 Walnut St., and 607 S. Cleveland Ave., Memphis, Tenn.
ALLING, Harold W. (Junior 1917), Accountant and Engr. (for mail) Chirnside, Roberts & Langston, 170 Broadway, New York, N. Y., and 529 River St., Hoboken, N. J.
ALLINSON, Orrle H. (1915), Johnstown, N. J.
ALMIRALL, Juan A. (1897), Pres., Almirall & Co., Inc., 66 W. Broadway, New York, N. Y.
ALT, Harold L.* (1913), P. O. Box 1188, Shanghai, China.
AMIRAL, J. H. (Junior 1923), Estimator (for mail) Austin Eng. Co., 121 West 42nd St., New York., and 2713 Voorhees Ave., Brooklyn, N. Y.
AMMERMAN, Charles R. (1916), Consulting Engr. (for mail) 529 Occidental Bldg., and 3908 Guilford Ave., Indianapolis, Ind.
AMSTEIN, Albert W. (1924), Autovent Fan & Blower Co., 736 W. Monroe St., Chicago, Ill.
ANDEL, Frank J. (1922), 5062 Pensacole Ave., Chicago, Ill.
ANDEREGG, R. H. (1920), Ch. Engr. and Mgr. of Pump Dept., Trane Co., and (for mail) 625 S. Eighth St., La Crosse, Wis.

ANDERSON, Carroll S. (1920), Branch Mgr., American Blower Co., 405 Detwiler Bldg., Los Angeles, and 5738 Franklin Ave., Hollywood, Calif.
 ANDERSON, Claude A. (1916), Dist. Mgr. (for mail) Iig Electric Vent. Co., 325 Commercial Trust Bldg., Philadelphia, and 5025 Pulaski Ave., Germantown, Pa.
 ANDERSON, Edward L. (1921), (Secy. Cleveland Chapter), Asst. Dist. Mgr. (for mail) American Blower Co., 526 Sweetland Bldg., Cleveland, and Aurora St., Hudson, O.
 ANDERSON, F. Paul* (1921), (Council 1924), Director, Research Laboratory, A. S. H. & V. E., U. S. Bureau of Mines, Pittsburgh, Pa.
 ANDERSON, Hjalmer J. (1919), Sales Engr., Whitlock Coil Pipe Co., 149 Broadway, New York, N. Y., and (for mail) 212 Ampere Parkway, Bloomfield, N. J.
 ANDERSON, S. A., Jr. (1909), Anderson Bros., 303 Fir St., La Grande, Ore.
 ANDREWS, Bernard R. (1919), (for mail) Andrews & Goodrich, Inc., 88 Broad St., Boston, and 49 Oak St., Braintree, Mass.
 ANGELL, Winfield T. (1922), Asst. Heat. Engr. (for mail) Lord & Burnham Co., Irvington-on-Hudson, and 409 E. Fifth St., Mt. Vernon, N. Y.
 ANGUS, Harry H. (1918), Consulting Engr., 2 Bloor St., W., and (for mail) 32 Sidney St., Toronto, Ont.
 ANGUS, Robert A. (1920), Service Equipmt. Engr. (for mail) Dwight P. Robinson & Co., Inc., 125 East 40th St., New York, and 19 Rich Ave., Mt. Vernon, N. Y.
 APPELL, Albert O. (1919), Engr. and Estimator, Brohl & Appell, 319 E. Madison St., Sandusky, O.
 ARENBERG, Milton K. (Associate 1920), (for mail) Iig Electric Vent. Co., Rm. 1816 Mallers Bldg., 5 S. Wabash Ave., and 5236 Ingleside Ave., Chicago, Ill.
 ARKLEY, N. M. (1922), Prof. Mech. Engr. (for mail) Queen's University, and 22 Kensington Ave., Kingston, Ont.
 ARMAGNAC, Arthur S. (Associate 1907; 1914), Editor, Heat. and Vent. Magazine, 1123 Broadway, New York, N. Y., and 375 Upper Mountain Ave., Upper Montclair, N. J.
 ARMSPACH, Otto W. (1919), Mech. Engr. (for mail) E. Vernon Hill Co., 64 W. Randolph St., and Villa Park, Chicago, Ill.
 ARNOLD, Robert S. (Junior 1922), Sales Engr. (for mail) York Heating & Ventilating Corp., 1502 Locust St., and 1219 South 52nd St., Philadelphia, Pa.
 ARONWITS, Wilfred (1924), Leon Stern, Archt., 1017 Commerce Bldg., and (for mail) 1171 Park Ave., Rochester, N. Y.
 ARTHUR, Harry W. (Associate 1920), Mgr. Arthur Service Co., Pibg. & Heat. Engrs., 409 Empire Bldg., Pittsburgh, Pa.
 ARTHUR, John M., Jr. (1923), Industrial Engr., Kansas City Power & Light Co., Kansas City Mo.
 ASHLEY, Edward E., Jr. (1912), Starrett & Van Vleck, 8 West 40th St., New York, N. Y., and (for mail) P. O. Box 188, Norton Heights, Conn.
 ASTON, James (1919), Metallurgical Engr. (for mail) A. M. Byers Co., 235 Water St., Pittsburgh, and 50 Forest Ave., Ben Avon, Pa.
 ATHERTON, G. R. (1918), Sales Engr., Hart & Crouse Co., 144 E. Canal St., Chicago, and (for mail) Franklin St., Geneva, Ill.
 ATKINSON, Harry G. (Junior 1921), New York Telephone Co., 104 Broad St., New York, N. Y., and (for mail) P. O. Box 462, Closter, N. J.
 ATKINSON, R. E. (Junior 1923), Engr. (for mail) C. A. Dunham Co., 230 E. Ohio St., and 4245 N. LaSalle Ave., Chicago, Ill.
 ATKINSON, Robert E. (1897), (Board of Governors 1907), 6 Trafalgar Rd., Birkdale, Southport, England.
 ATWATER, Lyman W. (1923), W. H. Curtin Mfg. Co., 331 Adams St., and (for mail) 552 East 14th St., Brooklyn, N. Y.
 AUBINGER, E. W. (1921), Secy., Wolff Mfg. Corp., 300 N. Robey St., Chicago, Ill.

AUSTIN, Frank L. (1914), Archt., 240 College St., Burlington, Vt.
 AUSTIN, William E. (1909), Br. Mgr. (for mail) National Radiator Co., P. O. Box 1708, and 210 W. Graham Rd., Richmond, Va.
 AYERS, A. E. (1921), Rautman Pibg. & Heat. Co. (for mail) 109 Jackson St., and 3437 Belvidere Ave., Seattle, Wash.

B

BABBITT, Edward C. (1923), Engr. (for mail) Snyder, Babbitt & Mathews, 16 E. Broad St., and 1157 E. Mount St., Columbus, O.
 BACHLER, Harry C. (Junior 1921), Heat. Engr. (for mail) C. F. Bachler & Son, 139 N. Fourth St., and 836 Kenmore Rd., Philadelphia, Pa.
 BACHLER, Leonard J. (1918), Engr. (for mail) Rm. 1800, 41 East 42nd St., and 35 West 47th St., New York, N. Y.
 BACKUS, Theodore H. L. (1916), (for mail) Schumacker & Backus, 308 S. Main St., and 1018 Vaughn St., Ann Arbor, Mich.
 BACON, John H. (1909), Branch Mgr., Richmond Radiator Co., 900 Keith Bldg., and (for mail) 1832 East 79th St., Cleveland, O.
 BAEZ, Z. Wiener (1919), (for mail) Skinner Bros. Mfg. Co., Inc., 1424 S. Vandewater St., and 5854 Etzel Ave., St. Louis, Mo.
 BAHNSON, Frederic F. (1917), Ch. Engr., The Bahnsen Co., and (for mail) Drawer G., Salem Sta., Winston-Salem, N. C.
 BAILEY, Edmund G. (Associate 1924), (for mail) H. B. Smith Co., 17th and Arch Sts., and 2528 N. Gydentom St., Philadelphia, Pa.
 BAILEY, Jos. H. (Junior 1923), Carrier Eng. Corp., 750 Frelinghuysen Ave., Newark, N. J.
 BAILEY, Winfield, C. (1913), Sales Engr. (for mail) Warren Webster & Co., 15 West 34th St., New York, and P. O. Box 91, Milton-on-Hudson, N. Y.
 BAIN, James G. (1920), Pres. Ideal Specialty Co., Box 493, Helena, Mont.
 BAKER, E. E. (1910), Pres., Kewanee Boiler Co., Kewanee, Ill.
 BAKER, Edward V. (1923), J. H. Olson, 4012 S. State St., and (for mail) 3654 Westworth Ave., Chicago, Ill.
 BAKER, Harry W. H. (1918), Sanitary & Heat. Engr. c/o J. Twyford & Co., 20 British Bund, Tientsin, China.
 BAKER, Howard C. (1921), Pres. (for mail) The Howard C. Baker Co., 213 Michigan St., and 15 Columbia St., Toledo, O.
 BAKER, Irving C. (1921), Dist. Engr., American Blower Co., 614 Bona Allen Bldg., Atlanta, Ga.
 BALDWIN, William H. (1921), Sales Engr. (for mail) C. A. Dunham Co., Ltd., 229 College St., and 600 Windermere Ave., Toronto, Ont.
 BAMPION, C. Morton (1919), Secy. and Mgr. Ideal Heat. Co., 915 Gates Ave., Brooklyn, and (for mail) 8806 191st St., Hollis, L. I., N. Y.
 BARKER, Arthur H. (1906), Consulting Engr. (for mail) 100 Victoria St., Westminster, London, S.W.1. and Oakhill House, Beckenham, Kent, England.
 BARNES, Arthur F. (1921), (for mail) Texas Engineering Co., 905 San Jacinto St., and 703 Webster Ave., Houston, Tex.
 BARNES, Arthur R. (1924), W. E. Hulse & Co., and 24 E. Sixth St., Hutchinson, Kan.
 BARR, George W. (1905), Asst. Gen. Sales Mgr., Hoffman Specialty Co., 25 West 45th St., New York, N. Y., and (for mail) Box 95, Bala-Cynwyd, Pa.
 BARRETT, Leonard L. (1922), 620 Livingston Hall, Columbia University, New York, N. Y.
 BARROWS, C. E. (Associate 1921), Mgr. City Sales (for mail) Crane Co., 156 N. Jefferson St., Chicago, and 114 Kedzie St., Evanston, Ill.
 BARRY, Patrick I. (1920), Heat. Engr., M. Barry & Co., 4 Marlboro St., and Grand View Terrace, Victoria Rd., Cork, Ireland.
 BARTH, Herbert E. (1920), Dist. Mgr. (for mail) American Blower Co., 526 Sweetland Bldg., and 334 Hotel Winton, Cleveland, O.

BARTLETT, Amos C. (1919), Sales Mgr. (for mail) B. F. Sturtevant Co., 555 Mass. Trust Bldg., Boston, and 10 Dunbarton Rd., Wallaston, 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.
 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.
 BASLER, Edwin M. (1923) (for mail) c/o D. J. Murray Mfg. Co., Wausau, and 518 Lake Dr., Milwaukee, Wis.
 BASTEDO, Albert E. (1919), Treas. (for mail) Burnham Boiler Corp., Irvington-on-Hudson, and 12 Riverview Pl., Hudson Heights, Hastings-on-Hudson, N. Y.
 BATHMAN, David M., 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), Engr. and Sales Rep. B. Baxter & Utica Heating 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) Carrier Eng. Corp., 750 Frelinghuysen Ave., Newark, N. J., and 1274 New York Ave., Brooklyn, N. Y.
 BEAURIENNE, Auguste* (1912), Contr. and Consulting Engr., 25 Rue des Marguettes, Paris, 12th Arr., France.
 BECKER, Albert L. (Associate 1919), Pres. (for mail) J. A. Wecker Co., 621 Union Bldg., Cleveland, and 1142 Webb Rd., Lakewood, O.
 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) W. Gordon Corp., 601 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.
 BENKENDORF, Richard (1923), Secy. and Supt., R. J. Graeff, Inc., 1048 Beaubien St., Detroit, Mich.
 BENNETT, Prescott D. (Associate 1924), Division Sales Mgr., The Trane Co., 844 Rush St., Chicago, Ill.
 BENNETT, 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, N. J.
 BERG, A. Herman (1919), Pres. (for mail) Berg Heat. & Vent. Co., 752 Laura Ave., and 140 N. Stafford, Nunnington Park, Calif.
 BERGER, Clyde D. (1922), Sup. Engr., Heat & Power Corp., 30 Light St., and (for mail) 2604 Overland Ave., Baltimore, Md.
 BERGGREEN, Paul H. (1921), 22 Horsholmsgade, Copenhagen, Denmark.

BERGNER, William G. (Associate 1923), Heat. Contr., Bergner Pibg., Heat. & Supply Co., 1925 State St., and 2435 C St., Granite City, Ill.
 BRAMAN, Louis K. (1908), Secy., Raiser Heat. Co., 129 Amsterdam Ave., New York, N. Y.
 BEST, John H. (1921), Heat. & Sanitary Engr., Martin C. Schawb, 116 S. Michigan Ave., and (for mail) 5227 Connell Ave., Chicago, Ill.
 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. & Pibg. Co., 5604 Cedar Ave., and (for mail) 1317 East 112th St., Cleveland, O.
 BIGGIN, Frank (1918), Mgr. (for mail) Heat. & Vent. Dept., Wicker Iron Works, Sheffield, and 19 Rupert Rd., Sheffield, England.
 BINDER, Charles C. (1920), Mgr. Heat. Dept., Warren Webster & Co., 115 Oak Terrace, Camden, and (for mail) 510 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.
 BISHOP, Charles R. (1901), (Council 1916), Consulting Engr., 27 East 40th St., New York, and (for mail) 413 Locust St., Lockport, N. Y.
 BISHOP, Frederick R. (1921), Mgr., Furnace Dept., Michigan Stove Co., 3306 E. Jefferson Ave., and (for mail) 3247 Carter Ave., Detroit, Mich.
 BLACK, Edgar Newbold (1922), Ch. Engr., Whitney MacDonald Co., 2320 E. Tioga St., and (for mail) 1533 Locust St., Philadelphia, Pa.
 BLACK, Fred C. (1919), Mgr., M. H. Crane Estate (for mail) 28 N. Des Moines 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 6052 Catherine St., Philadelphia, Pa.
 BLACK, John (1919), John Black & Son, 134 Prospect St., Trenton, N. J.
 BLACK, John J. A. (Junior 1922), John Black & Son, 135 Prospect St., Trenton, N. J.
 BLACKHALL, Wilmot R. (1922), (Secy. Ontario Chapter), Sales Engr. (for mail) McKellar & Blackhall, 228 St. Helens Ave., and 332 Waverly Rd., Toronto, Ont.
 BLACKMAN, Alfred O. (1911), Supt. Power and Plant, Yale & Towne Mfg. Co. (for mail) 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; J. L. Mott Iron Works, 118 Fifth Ave., 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., 177 N. Dearborn 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., Blest & Emery Co., Inc., 784 Coney Island Ave., and (for mail) 226 Argyle Rd., Brooklyn, N. Y.

ROLL OF MEMBERSHIP

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. (1923), U. S. Radiator Corp., 1412 West 12th St., and (for mail) 5529 Tillman Ave., Kansas City, Mo.

BLOMFELDT, Allen A. (1914), Vice-Pres. (for mail) Blomfeldt & Rapp Co., 108 N. Jefferson St., and 5523 Greenwood Ave., Chicago, Ill.

BLOOM, Samuel C. (1915), Vice-Pres. and Research Engr., Atmospheric Conditioning Corp., 841 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), Salesman, Hoffman Specialty Co., Carleton Plaza Hotel, John R. and Walton Sts., 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.

BODTKE, Max (Associate 1921), Box 24, R. F. D. No. 1, Berrien Springs, Mich.

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 Publicity Engr., Office and Residence, 1531 Hood Ave., Chicago, Ill.

BOLSINGER, Raymond C. (1916), (Pres. Philadelphia Chapter), Secy. (for mail) Fowler & Wolf Mfg. Co., 521 Bulletin Bldg., Philadelphia, Pa., and 238 E. Madison Ave., Collingswood, N. J.

BOLTON, Reginald Pelham* (1897), (Board of Governors 1901; 2nd Vice-Pres. 1903; 1st Vice-Pres. 1905-10; Pres. 1911; Board of Governors 1912, 1913) Pres. (for mail) R. P. Bolton Co., 116 East 19th St., and 638 West 158th St., New York, N. Y.

BOON, George (1915), Engr. (for mail) Boon & Sample, 3008 Ludlow St., and 3527 Hamilton St., 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, N. Y.

BORDEN, John M. (1920), Const. Engr., Johns-Manville, Inc., 210 N. Broad St., and (for mail) 48 E. Washington Lane, Philadelphia, Pa.

BORNEMAN, Walter A. (Junior 1923; 1924), Engr. (for mail) Carrier Engr. Corp., 1402 Land Title Bldg., and 194 Thelma St., Philadelphia, Pa.

BOSTAIN, James C. (1923), Sales and Service Engr. (for mail) Williamson Heater Co., 337 W. Fifth St., and 326 Elland Circle, Avondale, Cincinnati, O.

BOSTWICK, Clinton G. (1924), Brame, Dow & Co., 239 Causeway St., Boston, Mass.

BOSWIM, George A. (1917), Secy. (for mail) R. B. Hayward Co., 1714 Sheffield Ave., and 902 Diversey Parkway, Chicago, Ill.

BOUCHER, M. F. (1924), H. B. Smith Co., 17th and Arch Sts., Philadelphia, Pa.

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), Industrial Heat. & Eng. Co., 143 Oneida St., 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. Engr., Turner Supply Co., 8 W. Sixth St., and 702 East 17th 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), (Secy., Colorado Chapter) Co-partner and Mgr. (for mail) Bradbury Bros. Heat Co., 1219 Stout St., and 1254 Race St., Denver, Colo.

BRADLEY, Eugene P.* (1906), Hester, Bradley Co., 4200 Forest Park Blvd., St. Louis, and 4 Yale 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 Gen. Mgr., Kelsey Heat. Co., The Alhambra Bldg., Syracuse, N. Y.

BRAEMER, William G. R. (1915), Consulting Engr., Grinnell Co., Inc., 290 W. Exchange St., Providence, and 181 Norwood Ave., Cranston, R.I.

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.

BREDSON, Clarence R. (Junior 1921), 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), Designer and Estimator, Haynes-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.

BRENNAN, Thomas P. (1914), Pres. (for mail) Brennan, Moran, McGowan, Inc., 157 Columbus Ave., and 502 West 141st St., New York, N. Y.

BRESNAHAN, James J. (1919), Pres. and Treas., James J. Bresnahan, Inc., 37-41 Pearl St., and 135 Fordham Dr., Buffalo, N. Y.

BRICEY, Joel P., 665 S. Pearl St., Denver, Colo.

BRIDGES, Frank C. (1919), Heat. Engr., Powers Regulator Co., 1863 Reburn Rd., Cleveland, O.

BRINTON, J. W. (1920), Mgr., American Blower Co., 10 High St., Boston, Mass.

BRODERICK, Jos. F. (Junior 1914; 1918), Engr., S. H. Sweeney, 238 East 45th St., New York, N. Y., and (for mail) P. O. Box 388, Springdale, Conn.

BROGAN, James J. (Associate 1917), (for mail) Brogan & Co., 810 Race St., Philadelphia, and 6142 Lebanon Ave., Overbrook, Pa.

BROGAN, William J. (Junior 1922), (for mail) Brogan & Co., 810 Race St., Philadelphia, and 6142 Lebanon Ave., Overbrook, Pa.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS GUIDE, 1924-25

BRONSON, Carlos E. (1919), Mech. Engr., Kewanee Boiler Co., Kewanee, Ill.

BROOKS, Henry W. (1924), Fuel Engr. (for mail) U. S. Bureau of Mines, 4800 Forbes St., Pittsburgh, Pa., and 1300 McPherson Blvd., Tremont, O.

BROOKS, T. C. (1923), Pres. and Treas., T. C. Brooks Co., 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, Edwin H. (1920), Hewitt & Brown, Architects and Engrs. (for mail) 1200 Second Ave. S., Minneapolis, and Point Lookout, Wayzata, Minn.

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 Engr. 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 3068 Huntington Rd., 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 45th 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, John W. (1918), The Bryce Heat. & Vent. Co., 415-18 Spitzer Bldg., Toledo, O.

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.

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), Mech. Sales Engr. (for mail) Carrier Eng. Corp., 39 Cortlandt St., and 61 West 10th St., New York, N. Y.

BULKLEY, Claude A. (1923), E. T. DuPont de Nemours & Co., Rm. 12063 DuPont Bldg., 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., P. O. Box 602, North Worth, Tex.

BURNS, Edward J. (1923), Heat. Engr. (for mail) H. Kelly & Co., 925 Plymouth Blvd., Minneapolis, Minn.

BURNS, James J. (1919), (for mail) Burns, Fleming & Co., 620 Second Ave., and 6646 Ridgeway St., Pittsburgh, Pa.

BURNS, Richard D. (1915), 19th and Brown Sts., Philadelphia, Pa.

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., 308 Third Ave., S., Minneapolis, Minn.

BURT, John E. (1924), J. E. Burt & Son, 2442 South 16th St., Philadelphia, Pa.

BURTON, Clarence A. (1919), Mgr., Kewanee Boiler Co., 2020 W. Washington 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.

BUSHNELL, Clifford D. (1921), Supt. of Physical Plant (for mail) Purdue University, West Lafayette, Ind.

BUSHNELL, Thomas H., Jr. (1920), Engr., National Lamp Works, Nela Park, and (for mail) 1781 Rosedale Ave., E., Cleveland, O.

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. (1924), Heat. & Vent. Engr. (for mail) M. J. Daly & Sons, and 42 Edson Ave., Waterbury, Conn.

BYSSOM, 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.

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., 1330 Grand Ave., Kansas City, Mo.

CALLAHAN, Michael J. (1914), Pres. and Treas., Peerless Unit Ventilation Co., Skillman Ave. and Huist St., Long Island City, N. Y.

CALVERT, Norman W.* (1921), Engr. (for mail) The Detroit Edison Co., 2000 Second Ave., and 5244 Allendale Ave., Detroit, Mich.

CAMPBELL, Everett K.* (1920), Pres. and Treas., E. K. Campbell Heat. Co., 2445 Charlotte St., and 4133 Oak St., Kansas City, Mo.

CANTWELL, William T. (1920), Plbg. and Heat. Contr. (for mail) 306 Bleeker St., and 1302 Brinkerhoff 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.

ROLL OF MEMBERSHIP

CARPENTER, R. H. (1921). Mgr. (for mail) Nash Eng. Co., 350 Madison Ave., New York, and 10 First St., White Plains, N. Y.

CARRIER, Willis H. (1913). (Council 1923-1924). Pres., Carrier Eng. Corp., 750 Frelinghuysen Ave., Newark, and (for mail) Rensselaer Rd., Essex Falls, N. J.

CARRUTHERS, Keith L. (Junior 1923). 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). H. B. Smith Co., 17th and Arch Sts., and (for mail) 512 W. Cornwell St., Philadelphia, Pa.

CARTLAND, Silas (Junior 1923). Ch. Engr., Juno Heater Co., 647 Oakdale Ave., Chicago, Ill., and (for mail) Box 84, Penwater, Mich.

CARTY, Thomas (1924). 20 Audubon Ave., 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. Case & Son Mfg. Co., 31 Main St., Buffalo, N. Y.

CASEY, Byron L. (1921). Sales Engr. (for mail) Ilg Electric Vent. Co., 5 S. Wabash Ave., Chicago, and 501 Clifton Ave., Park Ridge, Ill.

CASSEL, Hiram H. (1920). Mech. Engr. (for mail) Smith, Hinchman & Grylls, 800 Marquette Bldg., and 9835 Chenlot Ave., Detroit, Mich.

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., 90 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.

CHAMBERS, Wm. E. (Associate 1923). 1025 Franklin St., Williamsport, Pa.

CHAPMAN, D. Witt (1914). Pres., D. W. Chapman Eng. & Supply Co., 1413 Lakeland Ave., 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., 262 Doyle Ave., Providence, R. I.

CHASE, John M. (Associate 1916). Vice-Pres. and Eastern Repr. (for mail) W. H. Case & Son Mfg. Co., 50 East 42nd St., and 468 Riverside Dr., New York, N. Y.

CHATTERDO, B. W. (Associate 1921). Salesman (for mail) 528 S. Grove Ave., Oak Park, Ill., and 1445 Congress St., Cleveland, O.

CHENOWETH, William H., Jr. (1911). Dist. Mgr. (for mail) Warren Webster & Co., 649 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. and Vent. Engr., Holland Furnace Co., and 326 Maple Ave., Holland, Mich.

CHESTER, Thomas* (1917). Consulting Engr. (for mail) 2970 W. Grand Blvd., and c/o Lexington Hotel, Detroit, Mich.

CHEW, Irving (Associate 1921). Salesman, Pierce, Butler & Pierce Mfg. Corp., 31st and Oxford Sts., Philadelphia, Pa., and (for mail) 5 Cedar Ave., Haddonfield, N. J.

CHEYNEY, Charles C. (Junior 1913). Mgr. (for mail) Buffalo Forge Co., 562 W. Washington Blvd., Chicago, and Glencoe, Ill.

CHILD, Earnest T. (1915). Pres. (for mail) Child & Scott Co., 112 Wooster St., New York, N. Y., and 70 Mt. Pleasant Ave., W. Orange, N. J.

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, 135 Brevard Ct., and Myers Park, Charlotte, N. C.

CHUBB, John E. (Associate 1917). Sales Engr., Whitlock Coil Pipe Co., 343 S. Dearborn St., 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). Sales Mgr. (for mail) American Blower Co., 1450 David Whitney Bldg., and 475 Peterboro, Detroit, Mich.

CLARK, Fred C. (1923). Pres., F. C. Clark Heat. Co., 1015 Homewood Ave., Pittsburgh, Pa.

CLARK, Homer J. (1919). Dist. Mgr. (for mail) B. F. Sturtevant Co., 438 Guardian Bldg., Cleveland, O.

CLARK, Robert L. (Associate 1918). Gen. Mgr. (for mail) Clark Asbestos Co., 1893 East 55th St., Cleveland, and 931 Caledonia, Cleveland Heights, O.

CLARK, William C. (1918). Secy. (for mail) Becker-Seidel Co., 2341 East 22nd St., Cleveland, and 298 Gilchrist Dr., Wickliff, O.

CLARK, W. Chas. M. (1915). Consulting Engr., 825-827 Engineers Bldg., 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). Anchor Sanitary Co., 123 Third 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.

CLGCG, Carl (1922). Mgr. (for mail) American Blower Co., 210 Mutual Bldg., and 2433 Holmes St., Kansas City, Mo.

CLIFTON, William A. (1919). Heat. Engr., State Dept. of Architecture, Albany, and (for mail) Round Lake, N. Y.

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.

CLISE, Floyd W. (Associate 1920). 325 Jefferson Ave., Detroit, Mich.

CLOUGH, Leslie (1922). Engr. (for mail) H. P. & E. S. Stubbs, 9 Ash St., Boston, and 63A Mt. Auburn St., Watertown, Mass.

COCHRAN, Moncrieff M. (1908). Pres., Cochran-Sargent Co., Fifth and Sibley Sts., and 400 Holly Ave., St. Paul, Minn.

AMERICAN SOCIETY of HEATING and VENTILATING ENGINEERS GUIDE, 1924-25

COCKBURN, Leslie S. (1920). Asst. Works Engr. (for mail) Fisher Body Corp., General Motors Bldg., Detroit, and Trenton, Mich.

COE, Ivan B. (1918). Mgr., 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 Chill Ave., Rochester, N. Y.

COHAGEN, Chandler C. (1919). Archt. (for mail) Box 1305, 508 Elec. 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.

COLLINS, Howard F. (1919). Mgr., Reading Heat. & Vent. Co., 331 Calls Ct., and 1503 North 14th St., Reading, Pa.

CONES, Benjamin (1911). (for mail) Secy. and Treas., National Eng. Co., 1119 Peoples Bank Bldg., 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). Heat. Engr., U. S. Radiator Corp., Broadway and Grand River Ave., and (for mail) 4659 Pacific Ave., Detroit, Mich.

CONNOR, Michael (Associate 1922). Mgr. (for mail) Connor Bros. Plbg. & Heat. Co., 827 Second Ave., S., and 1134 Vincent Ave., Minneapolis, Minn.

COOGAN, Jesse (1915). (for mail) Jesse Coogan Eng. Co., 1108 Boston Bldg., and Commercial Club, Salt Lake City, Utah.

COOK, Benjamin F. (1920). Consulting Engr., Gillham, Cook & White, 409 Interstate Bldg., Kansas City, and (for mail) Route 6, Box 452, Independence, Mo.

COOK, Chester D. (1921). Contr. (for mail) 2340 Pine St., and 4923 Magnolia Ave., St. Louis, Mo.

COOK, Harris R. (Associate 1924). Mgr., American Foundry & Furnace Co., 805 36th St., Milwaukee, and Okauchee, 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-DeViss Co., 1772 W. Lafayette Blvd., and (for mail) 828 Edison Ave., Detroit, Mich.

COOPER, Frank I. (1911). (Council 1914-1916). Pres., Frank Irving Cooper Corp., Archts. and Engrs., 172 Tremont St., Boston, and Concord Rd., Wayland, Mass.

COOPER, John W. (Junior 1921). Repr. (for mail) Buffalo Forge Co., 515 Chemical Bldg., and 4305 Lindell Blvd., St. Louis, Mo.

COOPER, Michael A. (1920). Mgr. Heat. Dept. (for mail) Plbg. & Mill Supply Co., Inc., 840 Baronne St., and 2225 Peniston St., New Orleans, La.

COOPER, Thos. R. (1923). Shanghai Waterworks Co., Shanghai, China.

COOPER, Thomas W. (Associate 1922). Mgr. (for mail) Utica Heater Co., 1712 Ludlow St., and 5117 N. Mervine St., Philadelphia, Pa.

CORBETT, Melvin C. (1922). Eng. Dept., Standard Heater Co., and (for mail) P. O. Box 280, Williamsport, 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.

COWAN, Robert A. (1921). Heat. & Vent. Engr. (for mail) New Amsterdam Hotel, 22nd St. and Euclid Ave., Cleveland, O.

COWARD, Herbert (1921). Mgr. Wash. Office (for mail) Buffalo Forge Co., 501 Washington Loan & Trust Bldg., Washington, D. C., and East Falls Church, Va.

COWELL, Robert J. (1922). Gordon & Co., Ltd., 110 Szechuen Rd., Shanghai, China, and Elitzroy St., Minneapolis, Minn.

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). Crane Co., 1328 West 12th St., Kansas City, Mo.

COX, William W. (1923). Consulting Engr. (for mail) Godfrey Jones Co., 2021 L. C. Smith Bldg., 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.

CRAIGHEAD, Edward W. (Associate 1920). Heat. Engr. (for mail) C. W. Sales Co., 2038 East 105th St., and 1197 Brockley Ave., Cleveland, O.

CRANNELL, Chas. A. (1922). Secy.-Treas., Crannell-Beaton Co., 210 Hammond Bldg., 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.

CROCKER, Robt. B. (1921). Heat. and Vent. Engr. and Heat. Mgr., Mfrs. Nat'l Bank Bldg., Lynn, and (for mail) 104 Sycamore St., Waverly, Mass.

CROFT, Terrell (1924). Directing Engr. (for mail) T. Croft Eng. Co., 6600 Delmar Blvd., and 6925 Amberst Ave., University City, St. Louis, Mo.

CRONE, Chas. E. (1922). Sales Engr. (for mail) Mehring & Hanson Co., 162-166 W. Clinton St., and 5432 Woodlawn Ave., Chicago, Ill.

CRONE, Thomas E. (1920). Dist. Mgr., Minneapolis Heat Regulator Co., 34 Park Place, Rm. 11, Newark, and (for mail) 11 Prospect St., E. Orange, N. J.

CRUTCHLEY, Edward, Jr. (1920). Heat Contr. (for mail) E. Crutchley, 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.

CUMMINGS, George H. (1919). Sales Engr. (for mail) Morgan-Gerrish Co., 800-806 La Salle Ave., and 2300 Girard Ave., S. Apt. 8, Minneapolis, Minn.

CUMMINGS, Gerald J. (1923). 405 Oakland Ave., Oakland, Calif.

CURRIER, Charles H. (1919). Vice-Pres. (for mail) Drying Systems, Inc., 11 S. Desplains St., and 400 Deming Pl., Mariborough Asps., Chicago, Ill.

CUSTER, Allen E. (1921). Heat. Engr., C. W. Richards Co., 5-9 W. Commerce St., Bridgeton, N. J.

ROLL OF MEMBERSHIP

CUTLER, Joseph A. (1916), (Council 1917-1924) Mgr. (for mail) Johnson Service Co., 1355 W. Washington Blvd., and Drake Hotel, Chicago, Ill.
 CUTLER, Edward H. (Associate 1923), Special Distributor, Hoffman Steam Specialties (for mail) 179 W. Washington St., Chicago, and Elgin, Ill.
 CUYLER, David H. (1917), Engr., Wolf Mfg. Corp., 300 N. Robey St., Chicago, Ill., and (for mail) 910 S. Carson St., Charlotte, N. C.

D

DAILEY, James A. (Associate 1920), Heat. Contr., 24 Elmwood Ave., Bogota, N. J.
 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.
 DAME, Clement T. (1920), (for mail) M. A. Dame & Son Co., 27 Haymarket Sq., Boston, and 175 Ocean St., Lynn, 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., 513 Congress Bldg., 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 Warning & Vent. Co., 317-319 Pennsylvania Ave., Elmira, N. Y.
 DAVIDSON, H. MacD. (Junior 1922), Local Sales Officer Mgr., C. A. Dunham Co., 302 Main St., and 1710 Madison St., La Crosse, Wis.
 DAVIDSON, Philip L. (Junior 1921), Sales Engr., Carrier Eng. 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 Warning & Vent. Co., 317 Pennsylvania Ave., and 603 W. Church St., Elmira, N. Y.
 DAVIS, Frank R. (1920), Heat. & Vent. Engr., Rm. 1000, 12th St. Station, Illinois Central Railroad, and 6125 S. Ellis Ave., Chicago, Ill.
 DAVIS, Holyoke (1919), (for mail) Holyoke, Jemne & Davis, Archts., 649 Endicott Bldg., and 591 Lincoln Ave., St. Paul, Minn.
 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-Billing Corp., 82-20 150th St., and (for mail) 142-15 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.
 DEALY, Victor F. (Junior 1924), H. B. Smith Co., 17th and Arch Sts., Philadelphia, Pa.
 DECKER, Edward M. (Associate 1917), (for mail) American Radiator Co., 400 Barlum Bldg., and 197 Rhode Island Ave., Detroit, Mich.
 DECKMAN, Elmer M. (1921), Pres., Deckman Power Heat. Co., 2215 Woodlynn Ave., Woodlynn, N. J.
 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), (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.
 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), Standard Heater Co., 20 Walnut St., Williamsport, Pa.
 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), (for mail) 19 East 11th St., and 2305 St. Elmo Dr., Columbus, Ga.
 DERANLEAU, Raymond L. (Junior 1922) 914-18 Central Savings Bank Bldg., Denver, Colo.
 DEVENDORF, W. F. (1919), W. F. Devendorf & Co., 112 Clinton Ave., S., and (for mail) 33 Audubon St., Rochester, N. Y.
 DEVEREUX, Leslie W. (Associate 1922), 5620 Grand Central Terminal, New York, N. Y.
 DEVORE, Milton J. (1920), Heat. Engr., 54 Adelina Pl., N. Bergen, N. J.
 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), (Council 1921-1924, 2nd Vice-Pres. 1922, 1st Vice-Pres. 1924), Consulting Engr. and Prof. Heat and Vent., Depts. Carnegie Institute of Technology, and 3307 Parkview Ave., Pittsburgh, Pa.
 DICKEY, Arthur J. (1921), Vice-Pres. and Gen. Mgr. (for mail) C. A. Dunham Co., Ltd., 1523-41 Davenport Rd., and 93 Indian Rd., Toronto, Ont.
 DICKINSON, Dr. Hobart G. (1919), Ch. Heat. and Power Div., Bureau of Standards, Connecticut Ave. and Pierce Mill Rd., and 4629 30th St., N.W., Washington, D. C.
 DICKSON, George P. (1919), Pres. (for mail) Kansas City Vent. Co., 1817 Grove St., and 3830 Park Ave., Kansas City, Mo.
 DICKSON, Robert B. (1919), Sales Mgr., Kewanee Boiler Co., 409 E. Prospect St., Kewanee, Ill.
 DIEBOLD, Chas. M. L. (1923), San. Insp., Dept. of Health, 704 City Hall, and (for mail) 3454 Beach Ave., Chicago, Ill.
 DIEBOLT, Norman J. (Associate 1922), Secy., Diebolt & Sons, 11313 Woodward Ave., Detroit, Mich.
 DIGBY, Homer Evans (Junior 1922), Salesman (for mail) C. A. Dunham Co., 910 May Bldg., and 220 Meridian 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.
 DILL, Jay B. (1921), (Pres. Michigan Chapter) Sales Mgr. (for mail) American Blower Co., 1450 David Whitney Bldg., and 8771 Dexter Bldg., Detroit, Mich.
 DILLMAN, Earnest J. (1921), Engr. (for mail) Research Dept., American Radiator Co., 1807 Elmwood Ave., and 1349 Hertel Ave., Buffalo, N. Y.
 DILLON, Henry R. (Associate 1923), Sales Mgr., Utica Heater Co., 5620 Grand Central Terminal, New York, N. Y.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS GUIDE, 1924-25

DISTEL, Frank Jr. (1918), (for mail) Distel Heat. Equip. Co., 515 Oakland Bldg., and 1011 Genesee St., W. Lansing, Mich.
 DOBBS, C. 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.
 DODD, Samuel M. (1921), Consulting Engr. (for mail) Hoffman Specialty Co., Rm. 203 Fuller Bldg., 10 South 18th St., Philadelphia, and Swarthmore, Pa.
 DODDS, Forrest F. (1920), Asst. to Mgr. (for mail) American Radiator Co., 906 Davidson Bldg., and 310 Central St., 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., 218 W. Kinzie St., and 2600 Lake View Ave., Chicago, Ill.
 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 45 Harmon 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), Economic Heat. Engr., 34 Trumbull St., 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., 24 Park Ave., Port Chester, N. Y.
 DORNHEIM, G. A. (Junior 1906; 1912), Thompson-Starrett Co., 245 Hunters Point Ave., Long Island City, and (for mail) 715 West 172nd St., New York, N. Y.
 DORSEY, Francis C. (1920), Heat. Pibg. and Elect. Contr., Francis C. Dorsey, 110 Prospect Ave., Roland Park, Baltimore, Md.
 DOUD, Malcolm P. (Associate 1921), Estimator and Salesman, Norristown Magnesia & Asbestos Co., and (for mail) 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 28 Avenue d'Eylau, 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., 613 Clybourn St., and (for mail) 1188 Prospect Ave., Milwaukee, Wis.
 DOWNS, Edwin L. (1916), United States Radiator Corp., 135 E. Grand River Ave., and (for mail) 10334 Second Blvd., Detroit, Mich.
 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., 5558 Marburg Ave., Oakley, and (for mail) 5856 Yonontse Ave., Kennedy Heights, Station M., R. R. 10, Box 210, 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 18 Kilsyth Rd., Brookline, Mass.
 DRINKWATER, Edgar L. (1919), Mech. Engr., Hanley & Co., 3438 Giles Ave., and (for mail) 147 N. Long Ave., Chicago, Ill.
 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) 770 Montreal St., Kingston, Ont.
 DUBRY, Ernest (1924), Asst. Supt. of Central Heat. (for mail) Detroit Edison Co., 2000 Second Ave., and 5040 Ivanhoe Ave., Detroit, Mich.
 DUDFIELD, Alvin (1920), Pres., Dudfield Mfg. Co., 118 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 M. (1922), Purdy, Mansell, Ltd., 63 Albert St., Toronto, Ont.
 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., C. A. Dunham Co., 230 E. Ohio St., and (for mail) Box 94, Union League Club, Chicago, Ill.
 DUNLAP, Ralph L. (1917), Ch. Engr. and Gen. Supt. (for mail) J. H. Kitchen & Co., 1012 A. & R. 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.
 DUQUEST, Asa M. (1923), Heat. and Vent. Engr. (for mail) Ross-Chase Co., 263 Summer St., and 38 Gould St., Boston 32, Mass.
 DURAND, William L. (1921), Engr. (for mail) Clark, McMullen & Riley, 101 Park Ave., New York, and 242 Lafayette Ave., Brooklyn, N. Y.
 DUSOSSIT, Edmond A. (1920), (Secy., Massachusetts Chapter) Treas. (for mail) Lynch & Woodward, Inc., 202 Harrison Ave., Boston, and 957 South St., Roslindale, Mass.
 DWYER, Frank A. (1902), Consulting Engr., 447 Guy Park Ave., Amsterdam, N. Y.
 DWYER, Jas. P., Jr. (Junior 1915; 1919), Consulting Engr., Little Bldg., 80 Boylston St., Boston, Mass.
 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), (for mail) Bd. of Education, Concord St., and Flatbush Ave., Brooklyn, and 2693 Morris Ave., New York, N. Y.
 DYER, Orville K. (1919), Sales Engr., Buffalo Forge Co., 490 Broadway, Buffalo, N. Y.

ROLL OF MEMBERSHIP

E

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, Robert F. (1922). Engr. (for mail) Eagar, Coombs & Co., Ltd., P. O. Box 904, Halifax, 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). Ch. Engr., Winslow Boiler & Eng. Co., 208 S. LaSalle St., Chicago, (and for mail) 433 S. Grove Ave., Oak Park, 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). Research Engr., Research Laboratory, U. S. Bureau of Mines, and 751 Bryn Mawr Rd., Pittsburgh, Pa.

ECKARDT, Chas. A. T. (Associate 1924). Sales Engr., The Whitlock Pipe Co., 728 Commercial Trust Bldg., and 5822 Girard Ave., Philadelphia, Pa.

ECKART, Claude H. (1915). Secy.-Treas. (for mail) Eckart Pibg. & Heat. Co., 320 Westlake Ave., 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. (Charter Member). (Council 1920). (for mail) Edgar Heat. Co., 1802 Chestnut St., Philadelphia, and Newton Sq., Delaware County, Pa.

EDWARDS, C. H. (Associate 1924). R. M. Edwards & Son, Canonsburg, Pa.

EDWARDS, Daniel F. (1920). (for mail) D. F. Edwards Heat. Co., 2340-42 Pine St., and 3000 Victor St., St. Louis, Mo.

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.

EHRLEICH, W. 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). Heat. Contr. (for mail) Eichler Heating Co., 2011 Railway Exchange Bldg., and 5449 Enright Ave., St. Louis, Mo.

EISERT, Hermann* (1920). Consulting Engr. (for mail) 11 E. Lexington St., and 4007 Bateman Ave., Baltimore, Md.

ELLIOTT, A. Douglass (1918). Elec. and Heat. Engr. (for mail) Charles L. Pillsbury Co., 1200 Second Ave., S., Minneapolis, and 1710 Capitol Ave., St. Paul, Minn.

ELLIS, Earnest E. (1922). Mgr. (for mail) Fred A. Ellis & Son, 840 Center St., and 998 Chatfield St., Winnetka, Ill.

ELLIS, Frederick E. (1923). Taylor Forbes Co., Ltd., 1088 King St., Toronto, Ont.

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., H. L. Stevens & Co., 30 N. Michigan Ave., Chicago, and (for mail) 105 S. Kensington Ave., La Grange, Ill.

ELLISON, J. Huyler (1919). Secy., 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.

EMERY, 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) Buff. Forge Co., 362 W. Washington Blvd., Chicago, and 1704 Hinman Ave., Evanston, Ill.

EMPKEY, George J. (1919). Secy. (for mail) The Schneider Pibg. Co., 4420 Euclid Ave., and 9812 N. Blvd., Cleveland, O.

EMSWILER, John E.* (1917). Prof. of Mech. Eng., Univ. of Mich., 231 Eng. Bldg., Ann Arbor, Mich.

ENGLER, Alfred (Associate 1923). Salesman, Jenkins Bros., 80 White St., and 72 East 190th St., New York, N. Y.

ENGLE, Harris J. (Associate 1922; 1923). Heat. Engr., 248 East 34th St., New York, N. Y.

ENGLISH, Ralph M. (1917). Pres., R. M. English Co., 1704-64 W. Randolph St., and (for mail) 1062 Ainslie St., Chicago, Ill.

ERICKSON, Harry A. (1917). Mgr. and Engr. (for mail) Fitzpatrick & Hoepfner Co., 63 E. Gay St., and 159 Wilbur Ave., Columbus, O.

ERTMAN, Bernard R. (1920). Heat. Engr. and Mgr., A. F. Ertman, 309 N. Main St., Herkimer, N. Y.

ERWIN, J. P. (Junior 1923). Ch. Engr., Colorado Hospital & Sanitarium, and (for mail), 402 Maxwell Ave., Boulder, Colo.

EVANS, C. A. (1919). 218 Lexington Ave., Buffalo, N. Y.

EVANS, Charles E. (1919). Sales Engr., Gallaher & Speck, 219 W. Congress St., and 3834 Roscoe St., Chicago, Ill.

EVANS, Edwin C. (1919). Mgr. (for mail) American Blower Co., 2136 Oliver Bldg., and 2793 Bergman St., Corless Station, Pittsburgh, Pa.

EVANS, John (1919). Archt. (for mail) 30 Water St., and 15 Ball Ave., Galt, Ont.

EVANS, Raymond S. (Junior 1920). Experimental Engr., 3822 Washington Blvd., Chicago, Ill.

EVANS, William A. (1918). Dealer in Hot Water Equip., 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.

EWING, Ira C. (Associate 1920). Pres. and Gen. Mgr. (for mail) Heat. Supply Co., 34 E. LaCock St., Pittsburgh, and 511 Jeannette St., Wilkinsburg, Pa.

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, George D. (1907). Geo. D. Farnham & Co., 1630 Lakeland Ave., Cleveland, O.

AMERICAN SOCIETY of HEATING and VENTILATING ENGINEERS GUIDE, 1924-25

FARNHAM, Roswell (1920). (Secy. Western New York Chapter) Dist. Sales Engr. (for mail) Buffalo Forge Co., 490 Broadway, and 28 St. James Pl., Buffalo, N. Y.

FARNSWORTH, F. C. (1919). Pres. (for mail) Farnsworth Co., Conshohocken, and Germantown Pike and Centre Sq. Rd., Norristown, Pa.

FARRAR, Cecil W. (Associate 1918; 1920). Vice-Pres. (for mail) Excelco Specialty Works, Inc., 119 Clinton St., and 429 Norwood Ave., Buffalo, N. Y.

FEBREY, Ernest J. (1903). (for mail) E. J. Febre & Co., 616 New York Ave., N.W., and 1610 Riggs Pl., N.W., Washington, D. C.

FEELHAN, J. B. (1923). John B. Feehan, Inc., 471 Union St., Lynn, Mass.

FEHLIG, John B. (1918). Pres. and Treas. (for mail) Excelcor 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, Ya. 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). (for mail) Weinshank & Fenstermaker, 821 Hume-Mansur Bldg., and 3102 Washington Blvd., Indianapolis, Ind.

FERRIS, Donald M. (1921). Engr., Ford Motor Co., Dept. of Power and Construction, and (for mail) 11636 Woodward Ave., Detroit, Mich.

FERRIS, Donald M. (1921). Ford Motor Co., Dept. of Power and Construction, and (for mail) 11636 Woodward Ave., Detroit, Mich.

FEST, Leon T. (1919). Salesman, Pierce, Butler & Pierce Mfg. Corp., 31st and Oxford Sts., and (for mail) 4722 North 15th St., Philadelphia, Pa.

FIELDING, Howard H. (1904). (Council 1918-1919) Heat. and Vent. Engr. (for mail) Warren Webster & Co., 1226-1228 California St., and 515 E. Ninth Ave., Denver, Colo.

FINAN, James J. (Associate 1920). Mfgs. Agent, 3930 Jackson Ave., El Paso, Tex.

FINAN, James J., Sr. (1923). 7149 Euclid Ave., Chicago, Ill.

FIRESTONE, James F. (Junior 1914). Engr., Beckwith Co., Dowagiac, Mich.

FIRSCHING, Frank J. (1921). Heat. Engr. (for mail) Warren Webster & Co., 917 Empire Bldg., Pittsburgh, and 2731 N. Dover St., Philadelphia, Pa.

FISHER, H. J. (Associate 1923). Dist. Sales Mgr., Reliance Elec. and Eng. Co., 9501 Wade Park Ave., Cleveland, O.

FISKE, T. Dumars (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.

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). 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). American Radiator Co., 1807 Elmwood Ave., 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.

FOGCG, Oscar H. (1914). Baltimore Gas Appliance & Mfg. Co., Bayard and Hamburg Sts., Baltimore, Md.

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.

FOOTE, Moses L. (1909). (for mail) 705 Rose Bldg., and 2225 Cummington Rd., Cleveland, O.

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 Selwood Bldg., and 2418 E. Third 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). (for mail) Liggett-Doll-Foster Co., 16508 Woodward Ave., Highland Park, Mich.

FOULHOUX, J. Andre (1915). R. M. Hood & J. A. Foulhoux, 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). Mgr. Steam Dept., W. G. Cornell Co., and (for mail) 3314 N. Smedley St., Philadelphia, Pa.

FRANK, George W. (1919). Pres. and Treas. (for mail) Frank & Miller, 77-79 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). Sales Mgr. (for mail) Alberger Heater Co., 281 Chicago St., 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., 619 White Bldg., and 1515 Amherst St., Buffalo, N. Y.

FREDERICK, Laurence M. (1919). 124 West 93rd St., New York, N. Y.

FRENCH, Bascom P. (Junior 1915). Olney Pibg. & Heat. Co., 106 W. Main St., Olney, Ill.

FRIDAY, Leslie M. (Associate 1923). Utica Heater Co., 707 Union Bldg., Cleveland, O.

FRIEDMAN, Abraham (1922). Heat. Engr. and Contr., 101 W. Hayes Ave., Corona, L. I., N. Y.

FRIEDMAN, Ferdinand J. (1921). Mech. Engr. (for mail) McDougall, Pease & Friedman, 85 Osborne St., and 670 Sherbrooke St., W., Montreal, Que.

FROST, Robinson V.* (1921). (Secy. Philadelphia Chapter) Engr., P. Gormly Co., 155 North 10th St., Philadelphia, and (for mail) 828 W. Marshall St., Norristown, Pa.

FRUTCHY, Asel E. (Junior 1920). Vice-Pres. (for mail) Frutch Barnes Co., Inc., 104 W. Second St., and 414 Walnut St., Elmira, N. Y.

FRY, John D. (Junior 1924), McDougall, Pease & Friedman, 85 Osborne 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), Western 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) 310 Foster Bldg., and 627 Corona St., Denver, Colo.
 FULTON, Walter J. (1924), Sales Mgr. (for mail) Central Steam Heat Div., 54 King St., and Fawcett Ave., Winnipeg, Man.
 FURMAN, Conrad W. (1915), Salesman and Engr., Camiron & Barkley Co., 338 E. Bay St., and Box 871, Route 5 R. F. D., Jacksonville, Fla.
 FURMAN, J. R. (1919), Mech. Engr., 1417 Railway Exchange, and (for mail) 5484 University Ave., Chicago, Ill.

G

GALE, Thomas J. C. (Associate 1920; 1921), (Secy., St. Louis Chapter), 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), Haynes Selling Co., 1711 Sansom St., and (for mail) 1930 South 56th St., Philadelphia, Pa.
 GANNON, James E. (1918), Pres., Gannon & Carey Co., 903 Parade St., Erie, Pa.
 GANT, H. P. (1915), (Council 1918; 2nd Vice Pres., 1921; 1st Vice Pres., 1922; Pres., 1923; Council, 1924), Lewis, Robinson & Gant, Land Title Bldg., Philadelphia, Pa.
 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 S. Ninth 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 Shalcross Ave., Wilmington, Del.
 GAYLOR, William S. (1919), Heat, and Vent. Engr., Starratt & Van Vleck, 8 West 40th St., New York, and (for mail) 42 Mayhew Ave., Larchmont, N. Y.
 GAYLORD, Frank H. (1921), Northwestern Repr., Hoffman Specialty Co., and (for mail) Hastings Hotel, Minneapolis, Minn.
 GEDNEY, Kenneth H. (1923), Archt. and Engr. (for mail) K. H. Gedney Co., Kipp Bldg., and No. 3 Park Court, Hastings, Nebr.
 GEIGER, Irvin H. (1923), Rm. 311, Commonwealth Bldg., 212-14 N. Third St., Harrisburg, Pa.
 GEISER, Harry (1911), Pres. (for mail) Theodore Geiser & Sons, Inc., 248 Plane St., Newark, and 51 Stockton Pl., East Orange, N. J.
 GEISLER, F. E. (1920), Mgr. (for mail) F. E. Geisler & Co., 422 First Ave., and Saybrook Apts., Pittsburgh, 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. Fremont 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), Secy. and Treas. (for mail) The Smith-Gibbs Co., 11 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 Carrollton 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), Prof. of Architectural Eng., Station A, Urbana, Ill.
 GIFFORD, Robert L. (1908), Pres., Illinois Engineering Co., Chicago, Ill., and (for mail) 231 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., and Hotel Pennsylvania, 39th and Chestnut Sts., Philadelphia, Pa.
 GILES, Edward H. (1919), Mgr. (for mail) Pierce, Butler & Pierce Mfg. Corp., 31st and Oxford Sts., and Stoneleigh Court Apts., 46th and Chestnut Sts., Philadelphia, Pa.
 GILLET, Merriman C. (1916), Plant Mgr. (for mail) Standard Heater Co., Walnut St., Williamsport, and 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.
 GLASSEY, J. Wilbur (1922), Mgr. (for mail) Vapor Heating Co., 215 South 17th St., and Wyndmoor, Chestnut Hill, Philadelphia, 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.
 GOINS, Edgar H. (1920), Asst. Dist. Mgr., Warren Webster & Co., East 17th St., and Superior Ave., and 850 East 128th St., Cleveland, O.
 GOLDBERG, Harry M. (Junior 1923), John J. Nesbitt, Inc., 48 East 41st St., New York, N. Y.
 GOLDSTEIN, A. M. (1923), (for mail) Federa Heat Co., 310 13th St., N.W., and 425 Irving St., N.W., Washington, D. C.
 GOLDSCHMIDT, Otto E. (1915), Consulting Engr., 116 West 39th St., New York, N. Y.
 GOMBERS, Harry 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.
 GOMBERSALL, 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., and (for mail) 1621 Lunt Ave., Chicago, Ill.
 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), (Council 1899; Board of Governors 1900-1903; 1st Vice Pres. 1904; Pres. 1906), 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) 25 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, Matthew H. (1921), Estimator and Engr., The Brown Co., 1053 Baltimore Ave., W., and (for mail) 3502 Field Ave., Detroit, Mich.
 GOSSETT, Earl J. (1923), (for mail) Bell & Gossett Co., 117 N. Dearborn St., and 6719 Newgard Ave., Chicago, Ill.
 GOTTFELD, 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), (for mail) W. D. Graham Co., 29 Halsted St., and 421 Melville St., Rochester, N. Y.
 GRASSLER, Edmund (Associate 1919), (for mail) Grassler & Gezelschap, 214 Third St., and 750 Summit Ave., Milwaukee, Wis.
 GRAVES, Ralph E. (Associate 1923), Factory Repr. (for mail) The Fulton Co., 1014 Holland Bldg., St. Louis, and Brentwood, 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 3 Chestnut St., Halifax, N. S.
 GRAY, William E. (1922), Sales Engr. (for mail) Standard Dry Kiln Co., 1550 McCarty St., and 3249 N. Capitol Ave., Indianapolis, Ind.
 GREASON, David R. (Associate 1924), 32 La Salle St., New York, N. Y.
 GREBE, Henry W. (1919), Pres. (for mail) Central Asbestos & Magnesia Co., 214 W. Grand Ave., and 2560 Wilson Ave., Chicago, Ill.
 GREEN, Charles E. (1924), 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 Dennington Dr., Cleveland Heights, 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. & N. Y. 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.
 GRIFFIN, W. H. (1922), Pres. (for mail) Griffin, Lamping & MacLachlan, 5429 N. Madison St., and 5446 Jackson Blvd., Chicago, Ill.
 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.
 GROS CLAUDE, Frederick W. (1911), Dist. Mgr. (for mail) American Warm & Vent. Co., 1899 East 55th St., and 3323 E. Monmouth Rd., Cleveland, O.
 GROSCUP, William F. (1923), (for mail) c/o The Groscup Co., Inc., 2549 St. Paul and 26th St., and 3409 Springdale Ave., Baltimore, Md.
 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) 319 S. Farwell St., 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.
 GRUMBEN, 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.
 GUNNARSON, Charles R. (Junior 1923), Warren & Wetmore, 16 East 47th St., New York, N. Y.
 GUNTON, William (1923), c/o R. J. Schwab & Son Co., 283 Clinton St., and (for mail) 1032 47th St., Milwaukee, Wis.
 GUSTAFSON, T. E. (Junior 1923), U. S. Radiator Corp., 500 N. Dearborn St., Chicago, Ill.

H

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., Oakmont, 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., Silver St., 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 Indian-apolis, Ind.
 HAINES, John J. (1915), Vice-Pres. and Secy., The Haines Co., 1933 W. Lake St., Chicago, Ill.

ROLL OF MEMBERSHIP

HAIRE, Charles S. (1920), Archt. (for mail) Link & Haire, 609 Power Bldg., and 528 Power St., Helena, Mont.

HALE, Frank M. (Associate 1923), Chandler Pump & Supply Co., 931 W. Eighth St., Kansas City, Mo.

HALE, John F.* (1902), (Board of Governors 1908; 1910; 1st Vice-Pres. 1912; Pres. 1913; Council 1914), Pres., Atmospheric Conditioning Corp., 920 Lafayette Bldg., Philadelphia, 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.

HALL, Wilson H. (Junior 1923), Designer and Engr. (for mail) Haynes-Langenberg Mfg. Co., 4519-25 N. Euclid Ave., and 5134 W. Park Ave., St. Louis, Mo.

HAMILTON, Henry, Jr.* (Associate 1922), New York Mgr., Ozon Pure Airifier Co., 1455-57 W. Congress St., Chicago, Ill.

HAMJY, Paul W. (1924), Heat. and Vent. Contr. (for mail) 611 Mohawk St., and 608 Kossuth Ave., Utica, N. Y.

HAMLET, Francis A. (1922), Draftsman and Estimator, W. J. Evans, Heat. Contr., 4 Park Ave., and (for mail) 794 Shuter St., Montreal, Que.

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., 42 Montcalm St., W. Detroit, and 120 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) 807 Farmers & Merchants Bldg., and 337 Carrol Park W., Long Beach, Calif.

HANKIN, Richard (1898) Vice-Pres., John Hankin & Bros., 228 Cherry St., New York, N. Y.

HANLEY, John H., Jr. (1923) c/o Reed Eng. Co., 816 Rugby 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), Mgr. Heat. Dept. (for mail) Haines Jones & Cadbury, 1136 Ridge Ave., Philadelphia, Pa.

HANSON, Leon C. (Associate 1918), Bjorkman Bros., 712 South 10th St., Minneapolis, Minn.

HARBISON, Earl J. (1924), J. E. Harbison, 2114 Union St., Schenectady, N. Y.

HARBICK, John H. (1919), Vice-Pres. and Engr. (for mail) Moncrief Furnace Co., 139 S. Pryor St., and 156 McMillan St., Atlanta, Ga.

HARBULA, Michael G.* (1921), New York Mgr., Atmospheric Conditioning Corp., 149 Broadway, and 15 Cooper St., New York, N. Y.

HARDING, Louis A.* (1911), (Council 1922; 1924), (for mail) Harding & Crea, 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., and 140 Miller St., Edgewood, Wheeling, W. Va.

HARMS, William T.* (1917), Heat. Contr., 515 S. Waterman 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, H. Archibald (Associate 1915; 1916), Archibald Harris & Co., Accts. and Engrs., 140 S. Dearborn St., Chicago, Ill.

HARRIS, Henry W. (Associate 1924), J. R. Brockenan Mfg. Co., 617 N. Second St., St. Louis, Mo.

HARRIS, Jesse B. (1918), (for mail) Rose & Harris, Engr., 417 Northwestern National Life Ins. Bldg., 15th and Oak Grove Sts., and 3820 Colfax Ave., S., Minneapolis, Minn.

HARRISON, Burt S. (1908), Ch. Engr., Drying Systems, Inc., 11 S. Desplaines St., and (for mail) 2200 Warren Ave., 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), (Council 1914; 1st Vice-Pres. 1915; Pres. 1916; Council 1917), Pres., L. H. Prentice Co., 330 S. Sherman St., and 5409 Winthrop Ave., Chicago, Ill.

HARTMAN, Frank E.* (1924), Water Sterilizer & Ozon Co., George and High Sts., Scottsdale, 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.

HASEY, Charles E. (1919), C. E. Hasey Co., 513 Second Ave., S., and 2613 Third Ave., S., Minneapolis, Minn.

HAUSER, Martin (1917), Pres. Engr., General Heat. Supply Co., R. 1, Reliance Bldg., and 1318 East 42nd St., Kansas City, Mo.

HAUST, 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), Lloyd Miller, Inc., 539 Main St., Poughkeepsie, N. Y.

HAYES, James J. (1920), Sales Engr. (for mail) Stannard Power Equipment Co., 928 Monadnock Block, and 1423 East 66th Pl., Chicago, Ill.

HAYES, Patrick M. (Associate 1922), Secy. Kansas City Chapter) Asst. Mgr. (for mail) Dempster Mill Mfg. Co., 1307 West 11th St., 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) 256 South 45th St., 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., 303 Pittsburgh Bldg., and 1646 Iglehart Ave., St. Paul, Minn.

HEAL, Walter E. (1920), Mgr. (for mail) Charles E. Heap & Son, 204 Bay St., Tomkinsville, and 412 Delafield Ave., W. New Brighton, N. Y.

HEATH, Frederick R. (1913), Heat. Engr., Edison Electric Illuminating Co., 39 Boylston 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 6214 Evans Ave., Chicago, Ill.

HECKEL, Edmund P. (1918), Vice-Pres. (for mail) Carrier Eng. Corp., 1429 Burnham Bldg., Chicago, and 314 Cuttriss Pl., Park Ridge, Ill.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS GUIDE, 1924-25

HEDGES, H. B. (1919), Mgr., York Heating & Ventilating Corp., 149 Broadway, New York, N. Y.

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) 382 Highwood St., Bogota, N. J.

HEILES, Frederick C. (Junior 1914; 1920), Engr., 81 N. Maple Ave., E. Orange, N. J.

HEILMAN, Russell H. (1923), Mellon Institute of Ind. 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., Penn Eng. Co., 312 Cherry St., Philadelphia, Pa.

HELPHINGSTEIN, Otto (1919), Engr. and Supt., 1253 W. Jefferson St., Los Angeles, Calif.

HENION, Hudson O. (Associate 1923), Mgr. (for mail) Young Pump Co., 96 Mary St., and 114 Rosslyn Ave., S., Hamilton, Ont.

HENRICH, George A. (1914), Pres. and Treas. (for mail) Geo. A. Henrich Co., 702 N. Wells St., and 1215 Elmdale Ave., Chicago, Ill.

HENSCHEN, Laurence H. (1915), Henschen Co., 101 Van Buren St., Joliet, Ill., and (for mail) Route No. 4 E., Grand Forks, Minn.

HERD, C. C. (Associate 1922), 817 10th St., Wichita Falls, Tex.

HERENDEEN, Frederick W. (1920), Secy., National Boiler & Radiator Mfrs. Assn., 815 S. Main St., and 29 Seneca 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.

HERSHY, John C. (1919), Pres., Jas. Spear Stove & Heat. Co., 1823 Market St., Philadelphia, Pa.

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. 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) 16 Dearborn Rd., Medford 57, Mass.

HIGGINS, Thomas J. (Junior 1923), Ross Eng. Co. of Canada, Ltd., 914 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., King & Co., Ltd., S. Church Side, Hull, and 20 Vermont Crescent, Newland, Hull, E. Yorks, England.

HILL, Dr. E. Vernon* (Associate 1912; 1914), (Council 1915; 1917; 1921; 2nd Vice-Pres. 1918; 1st Vice-Pres. 1919; Pres. 1920), (for mail) E. Vernon Hill Co., 64 W. Randolph St., and 4357 Kenmore Ave., Chicago, Ill.

HILL, Newell J. (1916), Consulting Engr. (for mail) 620 McKerchey Bldg., and 1737 Atkinson Ave., Detroit, Mich.

HILL, William A. (1921), Estimator, Illinois Eng. Co., 301 Epier Block, Seattle, Wash.

HILLMAN, R. Ward (1919), Asst. Gen. Mgr. Sales (for mail) U. S. Radiator Corp., 135 E. Grand River Ave., and 2472 Euclid Ave., W., Detroit, Mich.

HILL, Arthur H. (1924), Heat. Engr., C. A. Dunham Co., 904 New Birks Bldg., and (for mail) 35 Park Ave., Apt. 8, 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., 1104 Continental Bldg., and 4938 Forest Ave., Kansas City, Mo.

HOBBS, J. Clarence (1920), Pres., Pittsburgh Chapter) Mgr., Allegheny County Steam Heat Co., 703 Chamber of Commerce Bldg., and 6349 Douglas St., Pittsburgh, Pa.

HOBEN, Robert J. (1919), (for mail) 258-60 S. Van Pelt St., and 5102 Spruce St., Philadelphia, Pa.

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.

HOFFMAN, George D.* (1906), Hoffman Specialty Co., 512 Fifth Ave., New York, N. Y.

HOFFMAN, James D.* (1903), (1st Vice-Pres. 1908; Pres. 1910; Board of Governors 1911, 1912), Prof. of Practical Mechanics, Head of Dept. (for mail) Purdue University, and 323 University St. W. Lafayette, Ind.

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 1023 Thorndale 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 26 W. Rockland St., Germantown, Pa.

HOLMBERG, John A. (1924), 122 E. Lincoln, Lindsborg, Kan.

HOLMES, Joseph (1921), Pres. and Heat. Engr. (for mail) The Holmes Landwehr Heat. Co., 1508 Adams St., and Cor. Elizabeth and Vance Sts., Toledo, O.

HOLMSKOG, Otto S. (Associate 1923), Mech. Engr., Oppenham & Able, and Y. M. C. A., Wausau, Wis.

HOMANN, Frederick A. (1918), Sales Repr. (for mail) The Herman Nelson Corp., 1233 Marilyn 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.

ROLL OF MEMBERSHIP

HOOPER, Wyllys G. (1921), Mech. Engr. (for mail) Urbauer, Atwood Co., 1450 S. Second St., and 4129 Shaw Ave., St. Louis, Mo.

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.

HOPKINS, Robert D. (1915), Consulting Engr., Establishments Arnoult, Peking, China.

HOPPER, Garnet H. (1923), Taylor-Forbes Co., Ltd., Toronto, Ont.

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) 1652 Haworth St., Philadelphia, Pa.

HORNING, 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.

HOESINGTON, Ned P. (Associate 1923) 102 Summit Ave., Bywood Heights, Upper Darby, P.O. Pa.

HOUGHTEN, Ferry C.* (1921), Heat. and Vent. Engr. and Secy. A. S. H. & V. E., 29 West 39th St., New York, and 5 Bradford Rd., Mt. Vernon, N. Y.

HOUPP, George A. (1916), Engr., S. Faith Co., Inc., 2044 Medary Ave., Philadelphia, 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, Dept. of Research, American Radiator Co., 1807 Elmwood 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.

HOWLEY, J. C., Jr. (Junior 1922), Salesman (for mail) H. B. Smith Co., 17th and Arch Sts., and 6127 Jefferson St., Philadelphia, Pa.

HOYT, William B. (1919), Sales Mgr. and Secy. (for mail) National Bending Co., River and Lloyd Sts., New Haven and 39 Clifford St., Whiteville, 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), 1323 Channing 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), (Secy. Michigan Chapter) Consulting Engr., 1504 Broadway, Rm. 614, and 2985 Blaine Ave., Detroit, Mich.

HUBER, Charles F. (1921), Supt., J. A. McBride Mech. Eng. Co., 1607 Olive St., and (for mail) 5957 Highland Ave., St. Louis, Mo.

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 J. (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.

HUETTER, 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, John T. (Associate 1922), Sales Engr. (for mail) Brogan & Co., 810 Race St., Philadelphia, and 211 Dawson St., Wissahickon, Pa.

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., Oklahoma City, Okla.

HUNT, Richard B. (1912), Mgr., 414 S. Fourth Ave., Mt. Vernon, N. Y.

HUNTER, Charles C. (Associate 1923), Salesman, Building Equipment & Machinery Co., 39 Cortlandt St., New York, N. Y., and (for mail) 55 Hollywood Ave., East Orange, N. J.

HUNTER, Harry O. (1923), American Heat. & Vent. Co., 1505 Race St., and 5600 Baltimore Ave., Philadelphia, Pa.

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.

HUNTLEY, Frank A. (Junior 1918), Salesman, Walworth Mfg. Co. Seattle, and (for mail) Box 1280, Yakima, Wash.

HURLEY, Joseph C. (1915), Pres. (for mail) Petroleum Fuel Eng. Co., 7 South 17th 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.

HUTCHISON, J. Howard (1918), (for mail) 1020 Callowhill St., Philadelphia, and Paper Mill Rd., Enfield, 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) Hutzet & Co., 119 E. Washington St., and 722 W. Washington St., Ann Arbor, Mich.

HUTZEL, Hugo F. (1918), (Pres. Western New York Chapter) Engr. (for mail) American Radiator Co., 1807 Elmwood Ave., and 85 Crestwood Ave., Buffalo, N. Y.

HUTZEL, Max H. (1923), (for mail) Hutzet & Co., Hutzet Bldg., and 731 N. Elm St., Muncie, Ind.

HUTZEL, Victor C. (1923), (for mail) Hutzet & Co., Hutzet Bldg., and 401 E. Main St., Muncie, Ind.

HUZZARD, Edward C. (1924), Flock-Marshall Pibg. & Heat., Hazel and Water Sts., 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), Consulting Engr., Electric Heat. and Control, 36 State St., and 50 S. Mansion Blvd., Albany, N. Y.

I

ICKERINGILL, John (1923), Sales Engr., c/o Standard Heater Co., Otis Bldg., Philadelphia, and 235 Rector St., Roxborough, Pa.

IDDLES, Alfred (1921), Mech. Engr. (for mail) Day & Zimmerman, Inc., 1600 Walnut St., Philadelphia, and 804 Conestoga Rd., Wayne, Pa.

IMPEY, Paul F. (Junior 1921), Heat. Engr., John C. Moninger Co., 900 Blackhawk St., and (for mail) 3951 N. Mozart St., Chicago, Ill.

INGALLS, F. D. B. (1906), Mgr. (for mail) C. A. Dunham Co., 136 Federal St., Boston, Mass., and Reading, Pa.

INGLES, Margaret M.* (Junior 1918; 1923), Research Engr., Research Laboratory, A. S. H. & V. E., Rm. 283, U. S. Bureau of Mines, and 238 N. Dithridge St., Pittsburgh, Pa.

INNIS, Helen R.* (Junior 1918; 1921), Sales Mgr. (for mail) Donnelly Systems Co., 9 Murray St., New York, and 34 McDonough St., Brooklyn, N. Y.

AMERICAN SOCIETY OF HEATING and VENTILATING ENGINEERS GUIDE, 1924-25

IRELAND, Thomas H. (1923), Sales Engr. (for mail) Crane Co., 19-23 West 44th St., New York, and 69 Cedar Ave., Rockville Center, Long Island, N. Y.

IRWIN, Clarence W. (1924), c/o V. G. Ralston, 1004-7 L. & J. Bank, and (for mail) 729 Campbell Ave., Waterloo, Iowa.

ISSETELL, Henry G.* (Associate 1912; 1913), Sales Engr. (for mail) Bldg. Equip. Section, General Electric Co., 120 Broadway and 825 West 180th St., 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.

JALLEN, John J. (1922), Staff Engr. (for mail) Consolidated Gas Co., Dept. of Utilization, 130 East 15th St., and 365 West 118th St., New York, N. Y.

JANES, Arthur (1919), Pres., Arthur Janes Co., Scarsdale, N. Y.

JANET, Harry L. (1920), Engr. (for mail) Carrier Eng. Corp., 750 Frelinghuysen Ave., Newark, N. J., and 688 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. Jellet Co., 1200 Locust St., and 6701 Lincoln Dr., Mount Airy, Philadelphia, Pa.

JENKINS, Harry E. (Associate 1923), (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, Stanley A. (Junior 1924), 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) West Hill, 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), (Secy. New York Chapter) Sales Engr., American Radiator Co., 104 West 42nd St., New York, and (for mail) 154 Wardwood St., New Brighton, N. Y.

JOHNSON, Fred W. (1916), Vice-Pres. (for mail) Johnson, Larsen & Co., 693-703 Monroe Ave., and 273 Chalmers Ave., Detroit, Mich.

JOHNSON, James A. (1919), (for mail) Esenwein & Johnson, 781 Ellicott Sq., and 731 W. Delevan Ave., Buffalo, N. Y.

JOHNSON, Ralph B. (1922), Sales Engr. (for mail) Johnson Service Co., 411 East 10th St., and 5025 S. Troost Ave., Kansas City, Mo.

JOHNSON, Tracy R. (1924), Trane Co., La Crosse, Wis.

JOHNSTON, James A. (1912), Member of Firm, Archt. and Engr. (for mail) Carneal & Johnston, 808 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.

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., Wilkesburg, Pa.

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 Pibg. Heat. & Supply Co., Box 582, Tulsa, Okla.

JONES, Edwin A. (1919), Sales Engr. (for mail) Williams Radiator Co., 1860-08 W. Washington, Los Angeles, and 1007 Seventh St., Santa Monica, Calif.

JONES, Edwin F. (1923), Designing Mech. Engr., Dept. Public Buildings, City of St. Paul, 219 Court House, and (for mail) 701 E. Jessamine St., St. Paul, Minn.

JONES, Ernest F. (1923), Kellogg-Mackay Co. (for mail) 419 West 18th St., 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), I. H. Francis, Otis Bldg., Philadelphia, and (for mail) 344 Taylor Terrace, Chester, Pa.

JONES, Louis T. (1921), Salesman, Richardson & Boynton Co., Edmunds and Highlands Aves., Drexel Hill, Del. County, Pa.

JONES, Raymond E. (1919), Engr. and Salesman (for mail) Haynes Selling Co., 1711 Sansom St., Philadelphia, Pa., and 39 W. End Ave., Haddonfield, N. J.

JONES, Robert L. (1919), Engr., Carrier Eng. Corp., 750 Frelinghuysen Ave., Newark, 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), (Pres. Massachusetts Chapter) 11 Rosemere St., Newtonville, Mass.

JORDAN, Charles F. (1915), Mech. Engr. (for mail) H. L. Bachler 1014 Elm St., and 3636 Herschell Ave., Cincinnati, O.

JOYCE, Harry B. (1922), Executive Repr. (for mail) Ideal Elec. & Mfg. Co., and 75 Stewart Ave., Mansfield, O.

JOYCE, Walter P. (Associate 1924), Treas. McMahon Co., 1316 Oak St., and (for mail) 2049 Hardesty Ave., Kansas City, Mo.

JUNG, John S. (Associate 1923), 554 Layton Blvd., Milwaukee, Wis.

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.

KAEISER, Harry S. (Junior 1924), Hanley & Co., 3444 Giles Ave., and (for mail) 6026 S. Park Ave., Chicago, Ill.

KAMMAN, Arnold R. (Junior 1921), 156 York St., Buffalo, N. Y.

KAMMERER, William Chas. (1923), 764 Ardmore Ave., Akron, O.

KAPLAN, Joseph N. (Associate 1923), Heat., Vent. and Pibg. Contr., 524 Emerson Ave., Detroit, Mich.

KAPPEL, George W. A. (1921), Secy. and Treas. (for mail) Camden Heat. Co., 8 Market St., Camden, N. J., and 5844 Springfield Ave., Philadelphia, Pa.

ROLL OF MEMBERSHIP

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.

KAISTELLO, August (1923), Mgr. (for mail) C. A. Dunham Co., Ltd., 904 New Birks Bldg., and 112 Portland Ave., Montreal, Que.

KAUFFMAN, Rufus (1921), Heat. Engr. and Contr., 326 W. Seymour St., Germantown, Philadelphia, Pa.

KAUFFMANN, Frederick F. (1922), 36 S. Seventh St., Philadelphia, Pa.

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.

KEATING, Daniel J. (1921), (for mail) 2042 Rittenhouse St., 44th and Pine Sts., Philadelphia, Pa.

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), Editor, Domestic Engineering, 1900 Prairie Ave., 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.

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. Sec., 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), Moncrief Furnace Co., P. O. Box 1073, Atlanta, Ga.

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), (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., 187 Academy St., Astoria, I. I., N. Y.

KIEWITZ, Conway (1907), Engr., N. Y. Bd. of 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), D. S. Reynolds Consulting Engr., 900 Hill St. Bldg., and 7125 Overland Ave., Palms, Los Angeles, Calif.

KIMBALL, Charles W. (1915), Richard D. Kimball Co., 6 Beacon St., Boston, Mass.

KIMBALL, Dwight D.* (1908), (Board of Governors 1912, 1913; 2nd Vice-Pres. 1914; Pres. 1915; Council 1916), Richard D. Kimball Co., 15 West 38th St., New York, 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), (1st Vice-Pres. 1898; Pres. 1901; Board of Governors 1902), Consulting Engr., 503 Granite Bldg., St. Louis, Mo.

KING, Charles T. (1920), (for mail) Charles T. King & Co., 323 N. Charles St., and 2802 Garrison Ave., Baltimore, Md.

KING, Thompson (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. F. (1924), Bryant Heater & Mfg. Co., 952 East 72nd St., and 1453 East 116th St., Cleveland, Ohio.

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., Consulting Engr. (for mail) Grinnell Co., Inc., 276 Marietta St., Atlanta and 306 Ponce de Leon Pl., Decatur, Ga.

KIRK, Charles D. (1909), Chas. D. Kirk Co., 502 Tribune Bldg., and 774 McMillan 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), Walworth-English-Flett Co. (for mail) 100 Pearl St., Boston, and 29 Oakland St., Melrose, Mass.

KISSICK, J. J. (1918), Supt. of Bldgs., Board of Education, Sixth and Rockwell Ave., and 1768 Wayville Rd., Cleveland, O.

KITaura, Shigeyuki (1918), Mech. Engr., Monopoly Bureau, Dept. of Finance, Tokyo, Japan.

KITCHEN, Francis A. (Junior 1923), John H. Kitchen Co., 1012 A. & R. Bldg., 1016 Baltimore Ave., and 4909 Main St., Kansas City, Mo.

KITCHEN, John H. (1906), Heat. and Vent. Engr. (for mail) John H. Kitchen & Co., A. & R. Bldg., 1016 Baltimore Ave., and 3259 Washington St., 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), Mech. Engr., Dwight P. Robinson Co., Inc., 125 East 46th St., New York, and (for mail) Farmingdale, L. I., N. Y.

KLEIN, Dr. Albert R. (1920), Panoramastrasse 23, Stuttgart, Germany.

KLEIN, Edward W. (1917), S.E. Dist. Mgr., Warren Webster & Co., 1318 Atlantic Trust Co. Bldg., and 227 Myrtle St., Atlanta, Ga.

KLEIN, Walter A. (1919), (Pres. St. Louis Chapter) Pres. (for mail) Klein Heating Co., Arcade Bldg., and 3703 Washington Ave., St. Louis, Mo.

KLIE, Walter (1915), Pres. (for mail) Smith & Oby Co., 6107 Carnegie Ave., and 1849 Cadwell Ave., 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. Cassidy Co., 133 Austin St., Cambridge, and "The Breakers," Shore Dr., Lynn, Mass.

KNAPP, A. F. (1923), (for mail) 260 Ridge St., Newark, N. J., and American Radiator Co., 104 West 42nd St., New York, N. Y.

KNIGHT, Alvin B. (Associate 1916), Warren Webster & Co., 2123 D. Bank Bldg., and 8818 Deer Blvd., Detroit, Mich.

KNOWLES, Arthur F. (Associate 1914), Knowles Mushroom Ventilator Co., 202 Franklin St., New York, N. Y., and 135 Hadden Pl., Upper Montclair, N. J.

AMERICAN SOCIETY of HEATING and VENTILATING ENGINEERS GUIDE, 1924-25

KNOWLTON, Donald W. (Junior 1922), Salesman, H. B. Smith Co., 17th and Arch Sts., Philadelphia, Pa., and 215 Garfield Ave., Palmyra, N. Y.

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) Kohlbray-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), Supt. and Engr., Hersh Bros. Co., 645 Mill St., and (for mail) 1022 S. Eighth St., Allentown, Pa.

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., 522 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), Richmond Radiator Co., 213 E. Illinois St., 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.

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 Tarpinning-La Follette Co., Engrs., and Sheet Metal Contrs., 1030 Canal St., and 230 East 47th St., Indianapolis, Ind.

LAGODZINSKI, Harry J. (Junior 1920), Draftsman, Ig Elec. Vent. Co., 2850 N. Crawford Ave., and (for mail) 3828 N. Tripp Ave., 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.

LANCE, Joseph (1923), Harrigan & Reid, 1705 First St., Detroit, Mich.

LANDERS, John J. (Junior 1924), American Radiator Co., 1807 Elmwood Ave., Buffalo, N. Y.

LANDON, Archer A. (1920), Vice-Pres., American Radiator Co., 816 S. Michigan Ave., Chicago, Ill., and 1807 Elmwood Ave., 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 A. (1916), Pres. and Mgr. (for mail) Lane-Bowen Co., 201 Seventh St., and 333 Fourth St., Lorain, O.

LANGDON, Joseph D. (1920), Secy. and Treas. (for mail) Jos. A. Langdon & Sons Co., 2030 Fifth Ave., and 340 S. Fairmount Ave., Pittsburgh, Pa.

LANGENBERG, Everett B. (1914), Vice-Pres. (for mail) Henes-Langenberg Mfg. Co., 4525 N. Euclid Ave., and 7214 Pershing Ave., St. Louis, Mo.

LAPERLE, Lorenzo G. (1923), Asst. Supt., George H. Drake, Inc., 218 Lexington Ave., Buffalo, N. Y.

LARIMER, George B. (1915), Partner (for mail) Larimer & Leuer, 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, Gustav 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.

LAURIE, Robert J. (1917), Sales Engr. (for mail) Kellogg-Mackay Co., 2030 Walnut St., and 3225 S. Benton St., Kansas City, Mo.

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) Asst. Engr. (for mail) W. H. Taylor & Co., 256 Hamilton St., and 143 N. Seventh St., Allentown, Pa.

LECOMPTE, William G. (Associate 1914), Sales Engr. (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), Estimator, William Lees, 548 W. Washington Blvd., Chicago, Ill.

LEGIER, Edward W. (1924), American Blower Co., 1221 Boatmen's Bank Bldg., 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. (1903), (Pres. Ontario Chapter) Mgr. Toronto Office (for mail) Sheldons, Ltd., 1002 Kent Bldg., and 421 Russell Hill Rd., Toronto, Ont.

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, George C. (1919), Sales Engr. (for mail) American Heat. & Vent. Co., 1505 Race St., Philadelphia, Pa.

LEWIS, J. Clifford (1913), Lewis & Warren, 1001 Realty Bldg., and 2505 Oak St., 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), (Board of Governors 1909; 2nd Vice-Pres. 1910; Board of Governors 1912; Pres. 1914; Council 1915), Lewis & Capron Co., 910 S. Michigan 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 629 New Britain Ave., Hartford, Conn.

LICHTY, A. J. (Junior 1923), (for mail) C. A. Dunham Co., 1631-33 Second Ave., and 1011 Tuscaloosa Ave., Birmingham, Ala.

LICHTY, Chas. P. (1920), Br. Mgr. (for mail) C. A. Dunham Co., 1631-1633 Second Ave., and 1011 Tuscaloosa Ave., Birmingham, Ala.

LIND, Clarence C. (Junior 1921), Heat. Engr., and 1853 Mt. Ephraim Ave., Camden, N. J.

LINDEMAN, Henry (Junior 1923), Engr., Carrier Engr. Corp., 750 Frelinghuysen Ave., Newark, N. J.

LINDEMAN, Reinhold F. (1916), Mgr. Vent. Dept., Robt. Gordon, Inc., 1355 W. Washington Blvd., and (for mail) 2042 Eastwood Ave., Chicago, Ill.

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.

ROLL OF MEMBERSHIP

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). Industrial Engr., American Radiator Co., 816 S. Michigan Ave., Chicago, and (for mail) 321 S. Ashland Ave., La Grange, Ill.

LIPPE, Ernest V. (1922). Consulting Heat. and Vent. Engr. (for mail) 4521 N. Rockwell St., Chicago, Ill.

LIPPMAN, Orville S. (Associate 1920). Sales Mgr., The Kellogg-Mackay Co., 419 West 18th St., 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 East-lawn Ave., Detroit, Mich.

LITTLE, Edwin R. (1916). Consulting Engr., E. R. Little Co., Inc. 1918-1920 Ford Bldg., and 1403 Lawrence Ave., Detroit, Mich.

LOCKE, Hiram W. (1920). Heat. Engr. and Sheet Metal Contr., 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.

LOCKHART, George L. (1919). Archt. (for mail) G. L. Lockhart, Inc., 814 Kimball Hall, 25 E. Jackson Blvd., Chicago, Ill., and 1736 Wellesly Ave., St. Paul, Minn.

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.

LOHMANN, William J. (Associate 1922). Ozone Pure Airifier Co., 1455 W. Congress St., Chicago, Ill., and (for mail) 3849 Cleveland Ave., St. Louis, Mo.

LOMASNEY, Edward J. (1916). (Secy. Wisconsin Chapter) Consulting Heat. Engr., 456 Broadway, and 663 Cass St., Milwaukee, Wis.

LONG, John (1916). 2600 South 61st St., Philadelphia, Pa.

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). Mfr. 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.

LOWNSBERRY, Benjamin F. (1920). Heat. Engr. (for mail) B. 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) 3833 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). (for mail) E. R. Lumsden Co., 728 Philadelphia St., and 737 Water St., Indiana, Pa.

LUNN, W. R. (1921). Ch. Engr. (for mail) W. P. Mackenzie Co., 1234-36 Callowhill St., Philadelphia, and 170 E. Tulpehocken St., Germantown, Pa.

LUTTS, Conrad West (1922). Heat. and Vent. Engr., Hersh Bros. Co., 645 Mill St., and (for mail) 1023 S. Seventh St., Allentown, 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., Carrier Eng. Corp., 750 Freling-huysen 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.

Mc

McCAFFREY, H. Grattan (1922). Ch. Engr., Sheldons, Ltd., W. Main St., S. Galt, Ont.

McCANN, Frank G. (1903). Ch. of Heat. and Vent. Div. (for mail) Dept. of Education, Rm. 614, 131 Livingston St., Brooklyn, and 292 West 92nd St., New York, N. Y.

McCARTHY, Charles J. (1919). Contr. (for mail) 1718 Sansom St., and 533 South 55th St., Philadelphia, Pa.

McCARTHY, Thos. (1921). Heat. Contr. (for mail) McCarthy & Crandall Pbg. & Heat. Co., 529 E. Cascade Ave., and 444 W. Yampa St., Colorado Springs, Colo.

McCAULEY, James H., Jr. (1921). Estimator, W. J. Gemeny Co., 1050 W. Randolph St., and (for mail) 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). (2nd Vice-Pres. 1920; 1st Vice-Pres. 1921; Pres. 1922; Council 1923) Dean of Eng., University of Detroit, Consulting Engr. (for mail) McColl, Snyder & McLean, 2348 Penobscot Bldg., and 825 Chicago Blvd., Detroit, Mich.

McCONNER, Charles R. (Junior 1922). (for mail) Clarage Fan Co., 111 W. Washington St., and 536 Bromton Ave., Chicago, Ill.

McCORMICK, Edward T. (Associate 1923). Br. Mgr., Pierce, Butler & Pierce Mfg. Corp., 600 Second Ave., Pittsburgh, and (for mail) 2210 S. Hobson St., Philadelphia, Pa.

McCREA, Lester W. (1920). (for mail) Jas. McCrea & Son, 19 N. Carrollton Ave., and 564 University Apt., University Parkway, Baltimore, Md.

McCREERY, Hugh Joseph (1922). Dist. Mgr. (for mail) Combustion Eng. Corp., Ltd., Credit Foncier 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 Cumming St., Omaha, Neb.

McCUNE, Lawrence V. (Associate 1920). Salesman (for mail) Jenkins Bros., 207 Fulton Bldg., and 7 Riverview Ave., Pittsburgh, Pa.

McDONALD, John C. (1920). Br. Mgr. (for mail) U. S. Radiator Corp., 1412 West 12th St., Kansas City, Mo.

McDONNELL, Everett N. (1923). McAlear Mfg. Co., 1901 S. Western Ave., Chicago, Ill.

McDONNELL, Geo. P. (1923). St. Louis Public Library, 13th and Olive Sts., St. Louis, Mo.

McELWEE, Hugh J., Jr. (1920). 2029 E. Hunt-ington St., Philadelphia, Pa.

McEVOY, William J. (1917). Western Mgr. (for mail) Buckeye Blower Co., 923 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) Guinness Co., 527 First Ave., and 142 Belle-field Ave., Pittsburgh, Pa.

McGLENN, G. Raymond (1915). American Warming & Vent. Co., 175 Falck St., and (for mail) 218 Lorinore 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., 815 S. Claremont Ave., Chicago, and 902 S. Crescent Ave., Park Ridge, Ill.

McGUIGAN, L. A. (Associate 1919). Salesman, National Engr. 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., 2504 Century Bldg., and 204 Stratford Ave., Pittsburgh, Pa.

McINTYRE, Wm. N. (1917). (Pres. Kansas City Chapter) 1927 Montgall, Kansas City, Mo.

McKEIGHAN, Edward E. (1920). Engr. and Mgr. (for mail) Eng. Sales Co., 1314 McGee St., and 3130 Olive 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.

McKINNON, Duncan (1923). Heat. Contr., Box 759, Elmhurst, Ill.

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.

McLELLAND, H. Burton (Associate 1912). American Blower Co., 140 S. Dearborn St., Chicago, Ill.

McMAHON, W. W. (Associate 1923). National Regulator Co., 166 Lexington Ave., New York, N. Y.

McMILLAN, Luther B.* (1918). Consulting Engr. (for mail) Johns-Manville, Inc., Madison Ave. and 41st St., New York, 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.

McMURREY, Louis M. (Junior 1924). Office 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.

McNEAL, William R. (1921). Supt., Bldgs. and Grounds, Seattle School District, 810 Dexter Ave., and (for mail) 4110 Densmore Ave., Seattle, Wash.

McPHEARSON, Charles J. (1903). Pres. (for mail) W. G. McPhearsen Co., 19th and Wilson Sts., and 1031 Quimby St., Portland, Ore.

McQUESTON, Fred. (1923). Hammond High School, Hammond, Ind.

McVEHIL, Earl W. (1923). Mgr., McVehil Pbg. 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.

MACKIE, James (1917). Pres. and Mgr. (for mail) James Mackie Co., Ltd., 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, Peiden Court, Pelham, N. Y.

MALLIS, William (1914). Archt. and Engr., 409 Lyon Bldg., Seattle, Wash.

MANDEVILLE, Edgar W. (1914). Treas., E. W. Mandeville, Inc., 623 Parkside Ave., and (for mail) 1171 East 37th St., Brooklyn, N. Y.

MANSSELL, P. C. (1921). (for mail) Purdy-Manssell, Ltd., 68 Albert St., and 20 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.

MARINE, John Deputy (Junior 1920). Heat. Engr., Bourse Bldg., and 1937 Church Lane, Philadelphia, Pa.

MARKE, 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 Orin 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. Y.

MARTIN, J. Howard (Junior 1923). Estimator, Austin Eng. Co., 121 West 42nd St., New York, and (for mail) 59 Fletcher Ave., Mt. Vernon, N. Y.

MARTY, Edgar O. (1916). Mech. and Elec. Engr., Bacteriological Laboratories of G. H. Sherman, M.D., 14600 E. Jefferson Ave., and (for mail) 517 Ashland Ave., Detroit, Mich.

MASON, James J. (1918). Dist. Sales Mgr., Utica Heater Co., 707 Union Bldg., Euclid Ave., and (for mail) 936 Whitby Rd., Cleveland, O.

MASON, Orton Augustus (Associate 1922). Branch Mgr. (for mail) Pierce, Butler & Pierce Mfg. Corp., 312 Congress St., Boston, and 30 Vista Ave., Auburndale, Mass.

MATCHETT, James C. (1923). Illinois Eng. Co., Racine Ave. at 21st St., Chicago, Ill.

ROLL OF MEMBERSHIP

MATHEY, Nicholas J. (1915). Heat. and Vent. Engr., Mathey Pblg. 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.
 MATTHEWS, Charles Russell (1924). (for mail) Warren Webster & Co., 220 Devonshire St., Boston, and 38 Dana St., Cambridge, Mass.
 MATTHEWS, John K. (1923). Morgan Heat. & Pblg. Co., Box 843, Charleston, W. Va.
 MATTHIESSEN, H. C. F. (1923). Hoffman Specialty Co., 512 Fifth Ave., New York, N. Y.
 MATZEN, Harry B. (1919). Sales Engr., Carrier Eng. Corp., 1429 Burnham Bldg., La Salle and Randolph Sts., and 1625 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.
 MAYOR, Robert J. (1915). Rm. 204 Erie Bldg., Cleveland, O.
 MAYER, Robert S. (1911). Br. Sales Mgr. (for mail) Chicago Pump 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) 263 Lexington Ave., Dayton, O.
 MEADOWS, Frank H. (1923). The Meadows Heating Co., 94 Second St., Milwaukee, Wis.
 MEAGHER, John F. (Associate 1921). Mgr. (for mail) General Boilers Co., 840 Planters Bldg., and 5916 Washington Ave., St. Louis, Mo.
 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., Mehrling & Hanson Co., 162-66 N. Clinton St., Chicago, Ill.
 MEIER, Konrad* (1916). Consulting Engr., Rythenbergstrasse 57, Winterthur, Switzerland.
 MELLON, James T. J. (1911). (Council 1915). Mellon Co., 4415-21 Ludlow St., and 431 North 63rd St., Philadelphia, Pa.
 MENEFEE, Jesse I. (1924). Clinton & Russell, Ebel Bldg., and 2823 Hanes Ave., Richmond, Va.
 MENK, Rudolph W. (1919). Mgr., Furnace Dept., Excelsior Steel Furnace Co., 118 S. Clinton 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.
 MERRILL, Carl J. (1919). Treas. and Mgr. (for mail) C. J. Merrill, Inc., 85 Kennebec St., and 79 Clinton St., Portland, 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, Emil A. (Associate 1923). Archt. (for mail) Rm. 7, 2703 Lisbon Ave., Milwaukee, and c/o G. Wolff, Hales Corners, Wis.
 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 5849 Cass Ave., Detroit, Mich.
 MEYERING, Archer S. (1922). Heat. and Vent. Engr. (for mail) Br. Mgr., C. A. Dunham Co., 6004 Citizens National Bank Bldg., and 317 33rd St., Cheyenne, Wyo.
 MICHAEL, J. Paul (1920). Ch. Engr. (for mail) Stanton Heater Co., Sheets St., and 410 N. Seventh St., Martins Ferry, O.
 MICHAEL, L. A. (1921). Heat. and Vent. Engr. (for mail) 507 Bank Block, and 2264 Holly St., 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). (Pres., Wis. Chapter) (for mail) Rado Co., 194 Reed St., Milwaukee, and R. I. Box 62, Menomonee Falls, Wis.
 MILLER, Floyd A. (1911). Inspector of Mech. and Elec. Eng., 477 Federal Bldg., Chicago, Ill.
 MILLER, Harry M. (1920). Heat. and Vent. Engr., 628 Merchants & Mfgs. Bank Bldg., and (for mail) 1290 Stowell Ave., Milwaukee, Wis.
 MILLER, Harvey N. (1921). Sales Engr., Egyptian Supply Co., Inc., Box 667, Christopher, Ill.
 MILLER, James E. (1914). Vice-Pres. (for mail) 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, Lloyd (Associate 1913; 1918). L. Miller 539 Main St., Poughkeepsie, N. Y.
 MILLER, M. E. (1921). Ch. Mech. Engr. (for mail) Construction Service Co., M. C. Rm. 1315, Munitions Bldg., 20th and B Sts., and 5514 Eighth St., N.W., Washington, D. C.
 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., Miller & Brady, Inc., 210 East 38th St., New York, and 903 Manor Ave., Woodhaven, L. I., N. Y.
 MILLER, Tolbert G. (Junior 1921). Piping Engr., Pennsylvania R. R. and (for mail) 429 Kelker St., Harrisburg, Pa.
 MILLER, William C. (1918). Freed Heater Co., Collegeville, Pa.
 MILLIKEN, J. H. (1923). Reed Engineering Co., 140 S. Dearborn St., Chicago, 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, Mass.
 MOFFETT, William S. (1907). Consulting and Constructing Engr., Staunton, Va.
 MOLBY, Edgar C.* (1915). Vice-Pres. and Sales Mgr., Molby Boiler Co., Inc., 41 East 42nd St., Rm. 1800, New York, and (for mail) 5 Devon Pl., Forest Hills, L. I., N. Y.
 MOLTER, 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., 1353 W. Washington Blvd., 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). 2013 Colonial 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). c/o Flexlume Sales Co., 811 American Bldg., Baltimore, Md.
 MOORE, Josiah C. (1921). Aero Alarm Co., 725 Central Bldg., Seattle, Wash.
 MOORE, H. Lee (1919). Buffalo Forge Co., 917 Union Arcade, Pittsburgh, Pa.
 MORAN, Frank E. (1922). Pres. (for mail) Ben Rigby, Inc., 604 W. Lake St., and 1101 S. Mason Ave., Chicago, 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). J. F. Morgan & Son, Inc., 67 Blake 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, Richard H. (1918). Heat. Engr. (for mail) The Chappel-Warren Co., 1830 St. Clair Ave., and 523 East 124th St., Cleveland, O.
 MORGAN, Robert C. (1915). Ch. Engr. (for mail) Stewart A. Jellott Co., 1200 Locust St., and 314 W. Seymour St., Philadelphia, Pa.
 MORGAN, Sherman H. (1918). Heat. Contr. and Engr., Morgan Bldg., Wayne St. at Larned, Detroit, Mich.
 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 E. (Associate 1919). Mgr. (for mail) National Radiator Co., 215 Wood St., Pittsburgh, and Wampum, Pa.
 MORSE, C. T. (1921). Sales Mgr., American Blower Co., 6004 Russell St., Detroit, Mich.
 MORSE, Henry C. (Associate 1923). Johns-Manville, Inc., 2004 Grand Ave., Kansas City, Mo.
 MOSER, Philip F. (1921). Engr. (for mail) Grinnell Co., Inc., and 24 Homewood Ave., Warren, O.
 MOSHER, Clarence H. (Associate 1919). Dist. Repr., The Schaeffer & Budenberg Mfg. Co., and American Steam Gauge & Valve Mfg. Co., Div. (for mail) 423 Ashland Ave., Buffalo, N. Y.
 MOSS, Edward (1920). Supervisor Pblg. and Heat. (for mail) New York Consolidated R. R. Co., 1130 Atlantic Ave., and 231 94th St., Brooklyn, N. Y.
 MOTEJIL, J. A. (1917). Secy. (for mail) Bd. of Education, 705 First Ave., and 220 16th Ave., Cedar Rapids, Ia.
 MOTT, Abram C., Sr. (1897). Pres. Abram Cox Stove Co., American and Dauphin Sts., Philadelphia, and The Woods, Lansdale, Pa.
 MOTT, Abram C., Jr. (1921). 1st Vice-Pres., Abram Cox Stove Co., American and Dauphin Sts., Philadelphia, and (for mail) "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.
 MUELLER, Ben. H. (Junior 1923). Mfgs. Agt. (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.
 MUNIER, Leon L. (Junior 1915; 1919). Secy. and Treas. (for mail) Wolfe & Munier, Inc., Engrs. and Contr., 405 Lexington Ave., New York, and 610 Lafayette Ave., Mt. Vernon, N. Y.
 MUNRO, Edward A. (1920). Secy., Hutchinson Regulator Co., 506-507 Metropolitan Bank Bldg., and 1717 K St., N.W., Washington, D. C.
 MUNROE, Edward K. (1904). Mech. Engr., U. S. Veterans Bureau, Munitions Bldg., Washington, D. C., and 5924 Bellona Ave., Baltimore, Md.
 MURCH, Greenwood E. (1923). Richardson & Boynton Co., 3839 S. Ashland Ave., and (for mail) Chicago Ath. Assoc., Box 120, Chicago, Ill.
 MURPHY, Edward T.* (1915). Vice-Pres., and Phila. Mgr., Carrier Eng. Corp., 1402 Land Title Bldg., Philadelphia, Pa.
 MURPHY, Howard C. (1923). Wm. Reed Eng. Co., 620 S. Third St., Louisville, Ky.
 MURPHY, William R. (1911). Pres. American Heat. & Vent. Co., 804 Times-Dispatch Bldg., Richmond, Va., and 1505 Race St., and (for mail) Powelton Apt., 35th and Powelton Ave., 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 1245 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 6552 N. Campbell 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). New England Air Conditioning Co., 53 Devonshire St., and 1521 Washington St., Boston, Mass.
 N
 NACEY, Harry M. (1908). Pres. and Gen. Mgr. (for mail) F. Nacey Co., 927 S. State St., and 229 Lake Shore Dr., Chicago, Ill.
 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.
 NASH, Albert W. (1924). Schley & Nash Co., 709 Columbia Bank Bldg., Pittsburgh, Pa.
 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., Standard Asbestos Mfg. & Insulation Co., Kansas City, Mo.

ROLL OF MEMBERSHIP

NEILER, Samuel G. (1898), Consulting Engr., Neiler, Rich & Co., 431 S. Dearborn St., Chicago, and 737 N. Oak Park Ave., Oak Park, Ill.
 NEISEL, Carl Wm. (1921), Ch. Mech. Supt., Bd. of Education, Cleveland, and (for mail) 3240 Washington Blvd., Cleveland Heights, O.
 NELSON, Benjamin (1914), Sales Mgr. (for mail) Continental Machinery Co., 1611 Harris Trust Bldg., Chicago, and 936 Hinman Ave., Evanston, Ill.
 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 The Le Claire, Moline, Ill.
 NELSON, Ralph L. (1917), Engr. and Sales Repr., Ralph L. Nelson, 506 Empire State Bldg., and 218 W. Buckeye, Spokane, Wash.
 NESBITT, David M.* (1895), (Board of Governors 1900), Ashwell Lodge, Barkby Lane, Leicester, England.
 NESBITT, A. J. (1921), (for mail) 213 N. Vermont Ave., and 212 Victoria Ave., Atlantic City, N. J.
 NESBITT, John J. (1923), Ch. J. Nesbitt Co., 213 N. Vermont Ave., Atlantic City, N. J.
 NESDAHL, Elert (1915), Ch. Engr. (for mail) Atmospheric Conditioning Corp., 920 Lafayette Bldg., Philadelphia, Pa., and 811 York St., Camden, N. J.
 NEVINS, J. R. (1921), Archt. and Engr., 1708 Hoge Bldg., Seattle, Wash.
 NEWPORT, Charles F.* (1906), Vice-Pres. Newport Boiler Co., 105 S. Dearborn St., 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) 294 Madison Ave., New York, N. Y., and 5 Erie Ave., Rutherford, N. J.
 NICOL, N. C. (1923), National Tube Co., 71 Broadway, New York, N. Y.
 NIESTRATII, W. H. (1921), Jas. P. Marsh & Co., 3324 S. Jefferson Ave., St. Louis, Mo.
 NILSON, Andrew (1917), Pres. (for mail) Eureka Smokeless Furnace Co., 3222 N. Halsted St., and 5407 Wayne Ave., Chicago, Ill.
 NOBBS, Walter W. (1919), 50 Fairhazel Gardens, London, N.W., 6, England.
 NOBIS, Harry M. (1914), Heat. Engr. (for mail) 2036 East 105th St., Cleveland, and 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 A. (1915), Pres. (for mail) Virginia Eng. Co., Inc., 322-330 28th St., and 319 54th St., Newport News, Va.
 NOLAND, Ralph W. (1914), Consulting Engr., and Non-resident Lecturer on Heat. and Vent., Purdue University (for mail) 824 Lafayette Life Bldg., Lafayette, and 223 Waldron St., W., Lafayette, Ind.
 NOLL, Wm. Frederick (1924), P. E. Mueller Co., 320 Park St., Milwaukee, Wis.
 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, 537 W. Broadway, New York, and 126 Park Ave., Port Richmond, S. I., N. Y.
 NORTON, Thos. (1921), Pres. (for mail) Norton Heat. Co., Inc., 511 40th St., and 515 48th St., Brooklyn, 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), Heat. Dept., Hanley & Co., 3444 Giles Ave., and 931 Ainslie, Chicago, Ill.
 NUNAN, John F. (Junior 1921), Foreman (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. Y.
 OBERT, Casin W. (1916), (Secy. 1916-1923) Secy., A. S. M. E. Boiler Code Committee, 29 West 39th St., New York, and (for mail) 155 Archer Ave., Mt. Vernon, N. Y.
 O'BRIEN, J. H. (1923), American Blower Co., 120 S. Dearborn St., Chicago, Ill.
 O'CONNELL, Presly M. (1916), Mech. Engr. (for mail) J. Graham, Archt., 1351 Dexter Horton Bldg., and 718 East 60th St., Seattle, Wash.
 O'CONNOR, Jos. M. (1923), C. A. Dunham Co., 302 Orpheum Bldg., Wichita, Kan.
 O'DONNELL, Thomas J. (1920), Heat. and Vent. Engr. (for mail) Wm. H. McKiever, 247 West 134th St., and 140 Vermilyea Ave., 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., 182 Broadway, New York, N. Y.
 OGELSEY, 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. (1924), c/o C. J. Olsen, 109-111 Center St., Winona, Minn.
 OLSEN, Carlton F. (Junior 1920), 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, Peter (1920), Treas. and Mgr., Bartley-O'Neill Co., 224 Third Ave., Pittsburgh, Pa.
 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., and 926 Tupper St., Apt. 12, Montreal, Que.
 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 735 Bartlett Ave., Milwaukee, Wis.
 OSWALD, Walter L. (1919), Sales Engr., Crane Co., 23 West 44th St., New York, and (for mail) 611 S. Columbus Ave., Mt. Vernon, N. Y.
 OTIS, Gerald Earle (1923), Ch. Engr., Herman Nelson Corp., Moline, Ill.
 OTTO, Robert W. (1912), (Secy. Minnesota Chapter) 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.

AMERICAN SOCIETY of HEATING and VENTILATING ENGINEERS GUIDE, 1924-25

P

PADGINTON, George (1919), Engr., Power Efficiency Corp., 602 White Bldg., and (for mail) 73 Huntington Ave., Buffalo, 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), Gen. Mgr., B. F. Sturtevant Co., Western Div., Sturtevant, Wis.
 PAGE, Sidney H. (1923), 512 Sellwood Bldg., Duluth, Minn.
 PAINE, Leonard G. (1920), Mgr. (for mail) C. A. Dunham Co., 605 Bldg., 112 South 16th St., and 5915 Carpenter St., Philadelphia, Pa.
 PAINTER, David H. (Associate 1924), Hoffman Specialty Co., 2007 Independence Ave., Kansas City, Mo.
 PALMER, Geo. J. (1923), 12 W. Market 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 (1921), 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.
 PARILAN, James W. (1916), (for mail) 1255 Park Pl., and 478 Algonquin Ave., Detroit, Mich.
 PASK, Raymond J. (Junior 1924), Wolf Coal Saver Co., 1330 Congress St., and (for mail) 5 N. 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, H. B. (Junior 1920; 1921), Asst., H. H. Angus, Consulting Engr., 2 Bloor St. W., and (for mail) 71 Falcon St., Toronto, Ont.
 PATORNO, S. A. S. (1923), Heat. and Vent., Meyer, Strong & Jones, Inc., 101 Park Ave., New York, N. Y.
 PATTERSON, D. Finley (Junior 1923), (for mail) V. N. Welamb Co., 135 North 22nd St., and 6428 N. Woodstock St., Philadelphia, Pa.
 PATTISON, George B. (1920), Sales Engr., 404 Empire Bldg., and (for mail) 2138 Hudson Ave., Detroit, Mich.
 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 498 Manor Lane, Pelham Manor, N. Y.
 PEARCE, C. E. (1911), Ch. Engr., Guilbert & Betelle, Archts., Chamber of Commerce Bldg., Branford Pl., Newark, and (for mail) 1256 Clinton Pl., Elizabeth, N. J.
 PEARSON, Harry D. (1917), Pres. and Treas., Michigan Warm. and Vent. Co., 313 Kelsey Bldg., Grand Rapids, Mich.
 PEASE, Harrison H. (Associate 1922), Commercial Trust Bldg., and (for mail) 8409 Shawnee St., Chestnut Bldg., Philadelphia, Pa.
 PEASE, John G. (1917), Harlan & Harlan Machine Supply 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), Peebles & Ferguson, 729 Bldg., Norfolk, Va.
 PERHAM, Stanley H. (1920), Associate Engr. (for mail) Charles R. Ammerman, 529 Occidental Bldg., and 4507 Carrollton Ave., Indianapolis, Ind.

PERKINS, Fred C. (Associate 1923), Perkins-LeNoin Co., 963 Drexel Bldg., Philadelphia, Pa.
 PETERKIN, Stuart MacC. (1922), Engr., C. A. Dunham Co., 229 College St., and (for mail) 71 Deloaine Ave., Toronto, Ont.
 PETERMAN, Robert M. (1917), Engr., School Dist. of Philadelphia, 19th St., above Chestnut, Philadelphia, and (for mail) 205 Lauriston St., Wessahickon, Pa.
 PETERSEN, Gustave (Associate 1916), Secy. and Treas. (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., 356 Beaver Hall Sq., and 122 Kenaston Rd., Town of Mount Royal, Montreal, Que.
 PETERSON, H. K. (1920), Heat. Engr. (for mail) Nelson Co., 2604 Fourth Ave., and 4834 Fernwood Ave., Detroit, Mich.
 PETHERICK, David H. (Associate 1916), Spec. Repr., U. S. Radiator Corp., 517 Dime Bank Bldg., Detroit, and 17 Kernberton Ave., Pleasant Ridge, Mich.
 PFEIFFER, Jos. F. (1921), (for mail) Jos. F. Pfeiffer Steam & Hot Water Heat. Co., 1140 California St., and 668 Cook St., Denver, Colo.
 PFUEHLER, John L. (Junior 1923), 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, Frederick W., Jr. (1921), Engr. (for mail) E. W. Manderville, Inc., 623 Parkside Ave., and 825 East 38th St., Brooklyn, N. Y.
 PHILLIPS, Lee (1920), 610 Ferguson Bldg., Pittsburgh, and Terrace Ave., Carnegie, Pa.
 PICKETT, Clinton A. (Associate 1923), Herman Nelson Corp., 710 Rialto Bldg., St. Louis, Mo.
 PICKUP, Harry (1920), Owner, H. Pickup, 2-14 Staple St., London, and Glenessly, Udney Park, Teddington, England.
 PIERCE, Edward R. (1919), 41 Stratmore Rd., Brookline, Mass.
 PIERCE, Frank J. (1921), Mgr. Heat. Dept. (for mail) W. M. Pattison Supply Co., 777 Rockwell Ave., Cleveland, and 1612 Lincoln Ave., Lakewood, O.
 PIERON, Anton (1921), Heat. and Vent. Engr., Warren & Wetmore, 10 East 47th St., New York, and (for mail) 113 Schley St., Glendale, L. I., 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. Y.
 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., Piner 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.
 PISEL, Jos. W. (Junior 1921), Engr., I. H. Francis, 1306 Otis Bldg., and (for mail) 29 Brookline Blvd., Upper Darby P. O., Brookline, Pa.
 FITCHER, Lester J. (Junior 1924), Illinois Eng. Co., 1168 West 21st St., and (for mail) 6415 Harper Ave., Chicago, Ill.
 PITTEKOW, Arthur G. (1907), Pres. (for mail) Pittelkow Heat. & Eng. Co., 312 W. Larned St., and 355 Chalmers Ave., Detroit, Mich.
 PITTSFORD, William A. (1919), Mech. Engr., Kewanee Boiler Co., Kewanee, and (for mail) 106 S. Menard, Chicago, Ill.
 PLAYFAIR, G. A. (Associate 1924), Br. Mgr. (for mail) Johnson Temperature Reg. Co., 145 Wellington St., W., Toronto, and 288 Milvorton Blvd., Toronto, Ont.
 PLEWES, Stanley E. (1917), Br. Mgr. (for mail) Johnson Service Co., 258 S. Van Pelt St., Philadelphia, and Evergreen Rd., Jenkintown, Pa.

ROLL OF MEMBERSHIP

AMERICAN SOCIETY of HEATING and VENTILATING ENGINEERS GUIDE, 1924-25

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 315 William St., 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), Secy.-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.
 PRESTON, Bruce B. (1919), Vice-Pres., Ideal Heat Equipment Co., 1250 W. Fourth St., and 1839 East 9th St., Cleveland, O.
 PRICE, Frank E. (Associate 1922), Mgr. Heat Dept. Hedges Atkins Supply Co., 1730 Blake St., Denver, Colo.
 PROBST, Alfred H. (1919), Sales Engr. (for mail) Morgan-Gerrish Co., 800-6 LaSalle Ave., and 2902 James Ave., St. 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) Koithan & Pryor, 39 Cortlandt St., New York, N. Y., and 199 Roseville Ave., Newark, N. J.
 PUGH, Earl C. (1921), Heat and Vent. Engr. (for mail) Fulton, Taylor & Cahill, Archts., 8120 Euclid Ave., Cleveland, and 1311 Lakeland Ave., Lakewood, O.
 PURCELL, Arthur J. (1914), Heat., Plbg. and Steam Spec. Rep., 631 New Britain 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.
 PURTINTON, Dexter J. (Associate 1923), Head of Mech. De. (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.
 PYLES, Julius W. (1924), C. L. Reeder, 196 N. Charles St., Baltimore, Md.

Q

QUAY, D. M.* (Charter Member), (2nd Vice-Pres. 1895; 1st Vice-Pres. 1896, 1899; Pres. 1909) Mgr., W. C. Cornell Co., 322 Leader 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., Howard & Morse, 45 Fulton St., New York, and 8570 113th St., Richmond Hill, L. I., N. Y.

R

RAE, Thos. W. (1924), Salesman (for mail) American Radiator Co., P. O. Box 535, and 3006 E. Douglas, Wichita, Kan.
 RAINE, John J. (1912), G. S. Blodgett Co., Burlington, Vt.
 RAINGER, Wallace F. (Junior 1924), Jaros & Baum, 116 West 39th St., and (for mail) 3 West 124th St., New York, N. Y.
 RAISLER, Samuel (1921), Pres., Raisler Heat & Sprinkler Co., 129 Amsterdam Ave., and (for mail) 202 Riverside Dr., New York, N. Y.
 RANDLE, Joe E. (1923), (for mail) W. G. Cornell Co., 2010 Railway Exchange Bldg., and 4119 Westminster Pl., St. Louis, Mo.
 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.
 REIDER, Benedict S. (1922), (for mail) B. S. Reider & Co., 513 Arrott Bldg., and 1515 Rockland Ave., Pittsburg, Pa.
 REED, John F. (Associate 1923), Wm. Reed Eng. Co., 50 Church St., New York, N. Y.
 REED, William Dick (1919), W. D. Reed Co., 622 Benton Blvd., Kansas City, Mo.
 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), Factory Repr., The Fulton Co., and (for mail) 204 Oklahoma Ave., Knoxville, Tenn.
 REESE, Henry L. (1923), Elmh Bros. Co., Allentown, and (for mail) 521 Elm St., Emaus, Pa.
 REEVES, Charles G. (1916), 257 W. Clapier St., Germantown, Pa.
 REICHWALD, Charles W. (1923), Tallman & Co., and (for mail) 327 Palisade Ave., West Hoboken, 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), Asst. Engr., N. Y. Central R. R. Lines, Rm. 2416, Grand Central Terminal, New York, and (for mail) 1 Pinecrest Dr., Hastings-on-Hudson, 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 2493 Valentine Ave., New York, N. Y.
 RICE, C. J. (Associate 1923), Sterling Eng. Co., 413 Third St., Milwaukee, 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., Walters, Purks & Mellon, 419 Ludlow St., and (for mail) 1437 N. Redfield St., Philadelphia, Pa.
 RICHARDS, Frank A. (1920), Sales Engr. (for mail) Herman Nelson Corp., 219 New First National Bank Bldg., and 2612 Glen Echo Dr., Columbus, O.
 RICHARDS, Samuel F. (1915), Mgr., Heat Dept., Anchor Sanitary Co., 123 Third Ave., and (for mail) 335 W. Riverview Ave., Bellevue Branch, 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.
 RICHARDSON, Frank J. (1921), Heat. and Vent. Insp., Dept. of Education 131 Livingston St., and (for mail) 467 First St., Brooklyn, N. Y.
 RIDLER, Harry C. (1919), Plbg., Heat. and Vent. Engr. and Mgr. (for mail) 310 West 33rd St., and 3248 Massachusetts Ave., Minneapolis, Minn.
 RIELLEY, Edward P. (Junior 1924), Sales Engr., C. A. Dunham Co., 230 E. Ohio St., Chicago, and (for mail) 1325 Henry Ave., Desplaines, Ill.
 REITZ, Elmer W. (1923), Sales Engr. (for mail) Powers Regulator Co., 2720 Greenview Ave., and 446 Oakdale Ave., Chicago, Ill.
 RILEY, Albert H. (1919), Supt. Heat. and Vent. (for mail) Bld. Ave. Education, Ninth and Locust Sts., and 6235 Dowler Ave., St. Louis, Mo.
 RILEY, Champlain L.* (1906), (Council 1918-1919; 1st Vice-Pres. 1920; Pres. 1921) (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), Sales and Heat Engr., Standard Sanitary Mfg. Co., 439 Water St., Pittsburgh, and (for mail) 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., 38 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 698 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, Flatbush Ave., and Concord St., and 1081 East 39th St., Brooklyn, N. Y.
 ROBINSON, Albert G. (1924), (for mail) 4 Thomson Bldg., and 18 Harrison Ave., Glens Falls, N. Y.
 ROBINSON, S. Whitmore (Associate 1902; 1910), Consulting Engr., 10 Kilburn Priory, London, N.W., England.
 ROCK, Adolph C. (1917), Contr. (for mail) C. F. Rock Plbg. and Heat Co., 115 N. Third St., and 1501 Frances St., St. Joseph, Mo.
 ROCKART, Edward B. (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 J. (1917), Associate Engr., The R. T. Coe Companies, Cutler Bldg., and Richmond 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) 1912 Hennepin Ave., Minneapolis, Minn.
 RONEY, Thomas G. (1916), T. G. Roney Heat Co., 3461 Fort St., W., and 748 25th St., Detroit, Mich.
 ROONEY, Martin A. (1918), 124 Proctor Blvd., Utica, 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.
 ROSENBAUGH, Rudolph G. (1920), Sales Engr. (for mail) Warren Webster & Co., 549 Washington St., and 1119 N. Avers Ave., Chicago, Ill.
 ROSS, John O. (1920), Pres. and Gen. Mgr. (for mail) J. O. Ross Engr. Corp., 30 East 42nd St., New York, and Colonial Heights, Tuckahoe, 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., 15th and Chestnut Sts., Philadelphia, Pa.
 ROTZ, John M. (1918), Consulting Engr., Snider & Rotz, 703 Merchants Bank Bldg., and 3930 Broadway, Indianapolis, Ind.
 ROW, Oliver M. (1920), Director, Royles, Ltd., Heat Specialists, Irlam, near Manchester, England.
 ROWE, William A. (1921), Ch. Engr., American Blower Co., 6004 Russell St., and 2313 Gladstone 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., St. 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.
 RUDELL, 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), Partner (for mail) Healy-Ruff Co., 502 Plymouth Bldg., Minneapolis, and 2211 St. Clair St., St. Paul, Minn.
 RUPPEL, Richard L. (1911), Consulting Engr., 32 West 40th St., New York, N. Y., and (for mail) Meriden Rd., Waterbury, Conn.
 RUPPERT, E. H. (Associate 1923), Excelso Spec. Works, 85 Eastern Parkway, Brooklyn, N. Y.
 RUSSELL, Hugh C. (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) Imperial Hotel, Peterboro near Woodward, 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 553 Palisade Ave., Yonkers, N. Y.
 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.

ROLL OF MEMBERSHIP

RYAN, Henry B. (1920). Vice-Pres. Barry, Byrne & Ryan Co., 104 S. Michigan Ave., Chicago, and 170 Fuller Lane, Winnetka, Ill.
 RYAN, Thomas F. (1922). Heat and Vent. Engr., M. J. Daly & Sons, 543-555 Bank St., and (for mail) 278 N. Main St., Waterbury, Conn.

S

SABIN, Edward R. (1919). Pres. (for mail) Edward R. Sabin & Co., 4729 Ludlow 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). Gavan, Simanskaja 4, Petrograd, Russia.
 SANBORN, Edward N. (1923). Engr., Mensing & Co. (for mail) 928 Presser Bldg., Philadelphia, Pa., and 119 Haviland Ave., Audubon, N. J.
 SANFORD, Arthur L. (1915). (Pres., Minn. Chapter), Mech. Engr. (for mail) Bd. of Education, 245 Ninth Ave., N., and 301 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) Bourse Bldg., 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.
 SAWADE, Carl A. (Associate 1920). Mgr. Boiler Sales (for mail) Continental Heater Corp., Dunkirk, and 35 Curtis Pl., Fredonia, N. Y.
 SAWDON, William M. (1920). Prof., Exp. Engr., Cornell University, and 1018 E. State St., Ithaca, N. Y.
 SCANLON, John J. (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. Br. Mgr., American Radiator Corp., Barlum Bldg., Grand River and Broadway Aves., and 2206 Pennsylvania Ave., Detroit, 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.
 SCHLOSS, Newton L. (1913). Consulting Engr., 105 West 40th St., and 546 West 146th St., New York, N. Y.
 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) Carrier Eng. Corp., 39 Cortlandt St., and 6063 Broadway, New York, 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.
 SCHOENLIJHN, Robert P. (1919). Consulting Engr. (for mail) Industrial Trust Bldg., 10th and Shipley Sts., and 7 Crawford Circle, Wilmington, Del.

SCHOEFFLIN, 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). 1704 Ludlow St., Philadelphia, Pa.
 SCHRADER, Charles C.* (Junior 1923). (Secy. Pittsburgh Chapter) A. S. H. & V. E. Research Laboratory, U. S. Bureau of Mines, Pittsburgh, Pa.
 SCHROTH, August H. (1911). Sales Mgr., Richmond Radiator Co., 1480 Broadway, New York, N. Y., and (for mail) 40 Carnegie Ave., 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.
 SCPIO, 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, Charles E. (1907). Pres., Vapor Heat Co. (for mail) 597 Fifth Ave., New York, N. Y.
 SCOTT, Edwin A. (1912). Editor, (for mail) E. A. Scott Publishing Co., 43 West 45th St., and 926 Madison Ave., 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., Edgewood, Wheeling, W. Va.
 SEARS, William H. (1919). Archt. and Structural Eng., 1102-3-4 James Bldg., Chattanooga, and 623 Hanover St., N. Chattanooga, Tenn.
 SEKIDO, Kunisuke (1903). Nakano, Tokio Suburb, Japan.
 SELLARS, Fred J. (1917). Pres. (for mail) Sell-Orr Heat Co., 311 N. Penn Ave., and 619 N. Ninth St., Independence, Kan.
 SELLERS, Reuben F. (1922). Owner (for mail) R. F. Sellers Eng. Co., 216 E. Second St., and Terry Apts., Sedalia, Mo.
 SELLMAN, Nils T. (1922). Asst. Secy. Mgr. (for mail) American Gas Assn., 342 Madison Ave., and 2463 Grand Ave., New York, N. Y.
 SELTZER, A. P. (1921). Br. Mgr. (for mail) American Radiator Co., 401 Pennway Bldg., and Spink-Arms Hotel, Indianapolis, Ind.
 SETZER, Walter C. (Junior 1922). Sales Engr., 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., 480 Broadway, New York, and (for mail) 369 Washington Ave., Brooklyn, N. Y.
 SEWELL, John M. (1919). Consulting Engr., P. O. Box 318, Warren Ave., Berwyn, Pa.
 SHANKLIN, John R. (1899). Pres. and Gen. Mgr. (for mail) West Virginia Heat & Pbg. 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). Lynch & Woodward, Inc., 202 Harrison Ave., Boston, Mass.
 SHAW, Raymond E. (1921). Mgr., New England Sales (for mail) B. F. Sturtevant Co., 555 Massachusetts Trust Bldg., 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., 1523-4 Davenport Rd., and (for mail) 53 Sylvan Ave., Toronto, Ont.
 SHEPHERD, Edward B. (1921). Asst. Engr. (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 C. (1922). Heat. and Vent. Engr. (for mail) Sheppard & Abbott, 119 Harbord St., and 479 Dovercourt Rd., Toronto, Ont.
 SHERIFFS, Walter A. (1918). Mehning & Hanson Co., 162 N. Clinton St., Chicago, Ill.
 SHIPP, C. G. (1923). C. C. Shipp & Co., Rm. 210, 230 E. Ohio St., Indianapolis, Ind.
 SHODRON, John (1921). Research Engr., James Mig. 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., 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.
 SHUELL, Frank W. (Associate 1921). Pres. and Gen. Mgr. (for mail) Everhot Heater Co., 214 W. Woodbridge St., and 5120 E. Jefferson Ave., Apt. C-2, Detroit, Mich.
 SHULTZ, Earle (Associate 1919). Vice-Pres. (for mail) Illinois Maintenance Co., Rm. 1136, Edison Bldg., and 5818 Magnolia Ave., Chicago, Ill.
 SIEGEL, John F. (Associate 1915). (for mail) Newport Boiler Co., 101 Park Ave., New York, and Mt. Vernon, N. Y.
 SIEGEL, Leo (1924). Mech. Engr. (for mail) Bd. of Education, Heat and Vent. Div., Flatbush and Concord Sts., and 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). Sales Engr. (for mail) American Blower Co., and 1610 Burlingame, Detroit, Mich.
 SKELLY, John F. (1921). Heat. and Vent. Engr., M. J. Daly & Sons, 543 Bank St., and (for mail) 148 Chipman St., Waterbury, Conn.
 SKINNER, Harry W. (1920). Mech. Engr., Heat. and Pbg. Dept., Atlas Supply Co., and (for mail) 612 Jefferson St., Muskogee, Okla.
 SKRILOFF, Elias (1924). N. Y. Edison Co., Inwood Ave. and 170th St., New York, N. Y.
 SMALL, John D. (1910). Consulting Engr. (for mail) 127 N. Dearborn St., Chicago, and 411 Maple Ave., Wilmette, Ill.
 SMALLMAN, Edwin W. (1920). Heat. and Vent. Engr., 173 Bellevue Ave., Melrose, Mass.
 SMALLMAN, William T. (1911). Treas., Isaac Coffin Co., 52 Sudbury St., Boston, Mass.
 SMITH, Edward C. (1918). Super. Engr. (for mail) Bd. of Education 340 N. Water St., and 358 N. Lorraine Ave., Wichita, Kan.
 SMITH, George P. (1922). Sales Repr. (for mail) Herman Nelson Corp., 122 Michigan Ave., Rm. 437, Chicago, and 500 Western Ave., Joliet, Ill.
 SMITH, Layton F. (1923). Dist. Mgr. (for mail) Midwest Air Filters, Inc., Bourse Bldg., 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 Eng. 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). C. A. Dunham Co., 1631-33 Second Ave., N., Birmingham, Ala.
 SMITH, Wilbur F. (1920). Mech. Engr. (for mail) 600 Schuylkill Ave., and 3318 N. Park Ave., Philadelphia, Pa.
 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.
 SODEMANN, Paul (Junior 1920). Sales Engr., Fischer Heat Co., 367-369 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, Mo.
 SODERBERG, Charles H. (1919). Consulting Engr., 1011 Charlevoix Bldg., Detroit, and 600 Pierce St., Birmingham, Mich.
 SOLING, William (1923). Estimator and Engr., Reis & O'Donovan, Inc., 93 Tompkins Ave., Brooklyn, N. Y.
 SOMMERS, Louis J., Jr. (1922). Pbg. and Heat. Contr. (for mail) Sommer & Son, 2438 Brown St., and 6021 Clifford Terrace, 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., 849 W. Washington Blvd., and 7214 Prairie Ave., Chicago, Ill.
 SOULE, Lawrence C. (1908). c/o Aerofin Corp., 750 Frelinghuysen Ave., Newark, and 33 Ely Pl., E. Orange, 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. of Installation (for mail) Jas. Spear Stove & Heat Co., 1823 Market St., and 5904 Chestnut St., Philadelphia, Pa.
 SPARLING, Clifford M. (1922). Pres. and Mgr. (for mail) Mechanical Trades Co., Ltd., 54 University Ave., and 33 Jackman Ave., Toronto, Ont.
 SPECKMAN, Charles H. (1918). (for mail) 572 The Bourse, and 1217 S. Fourth St., Philadelphia, Pa.
 SPELLER, Frank N.* (1908). Metallurgical Engr., National Tube Co., 1802 Frick Bldg., and 6411 Darlington Rd., Pittsburgh, Pa.
 SPERZEL, Henry J. (1919). Kewanee Boiler Co., 708 Builders' Exchange, 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, N. Y.
 SPOONER, Harold R. (1921). Engr. and Estimator, Jarcho Bros., Inc., 358 West 31st St., New York, and (for mail) 33 Woodhall Ave., Hollis, L. I., N. Y.
 SPRAGUE, Frank H. (1923). Skidmore Corp., 1535 Dayton St., Chicago, Ill.
 SPRIGGS, Walter J. (Junior 1920). (for mail) F. J. Spriggs, 43 W. Fourth St., and 56 Otis Ave., St. Paul, Minn.
 SPROULL, Howard E. (1920). Dist. Mgr., American Blower Co., 1151 Consolidated Bldg., Indianapolis, and Bedford, Ind.
 SPURGEON, Joseph H. (1924). 2403 First National Bank Bldg., Detroit, Mich.

ROLL OF MEMBERSHIP

STACEY, Alfred E., Jr. (1914), Research Engr., Carrier Eng. Corp., 750 Frelinghuysen Ave., Newark, and (for mail) Wootton Rd., Essex Fells, N. J.

STACKHOUSE, Raymond M. (1919), Mgr. (for mail) American Radiator Corp., 906 Davidson Bldg., and Rockhill Manor, Kansas City, Mo.

STAINS, W. A. (1923), c/o R. F. Taylor, Western Indemnity Bldg., Dallas, Tex.

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., Forbes-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 1905-1908; 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., 1220 Monadnock Block, Chicago, Ill.

STANWOOD, J. B. (1924), Consulting Engr., Houston, Stanwood & Gamble Co., and (for mail) 2415 Maplewood Ave., Cincinnati, O.

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), Sales Engr., C. A. Dunham Co., Vick Apts., Greensboro, N. C.

STARKS, Verne E. (1921), Dist. Mgr., Ilg Electric Vent. Co., 1314 Schofield Bldg., and 1331 East 143rd St., Cleveland, O.

STEDMAN, C. N. (1921), Dist. Sales Mgr. (for mail) Fulton Co., 610 Wrigley Bldg., and 2309 East 69th St., Apt. 2, Chicago, Ill.

STEIM, Charles J., Jr. (1923), Samuel Sloan & Co., 67 Exchange St., and 436 Rosewood Terrace, Rochester, N. Y.

STEINER, John G. (Associate 1922), Utica Heater Co., 1708 Broadway, and 1368 Elizabeth St., Denver, Colo.

STEINHORST, Theodore F. (1919), Engr. and Estimator, Emil Steinhorst & Sons, 1158 Mohawk St., and West Shore R. R., and 1642 Brinkerhoff Ave., Utica, N. Y.

STEINKE, G. B. (1924), Pres. (for mail), 103 Park Ave., and 2730 Decatur Ave., Brooklyn, N. Y.

STEPHANY, Erwin J. (Junior 1920), Supt. of Sales Dept., Equitable Gas Co., 435 Sixth Ave., Pittsburgh, Pa.

STEPHEN, Alexander M. (1922), Pres., Heat. and Vent. Engr. (for mail) Stephen and Boyle, Ltd., 1325 Standard Bank Bldg., and 784 Thurlow St., Vancouver, B. C.

STEPHENSON, Lewis A. (1917), Mgr. (for mail) Powers Regulator Co., 407 East 13th St., and 801 West 57th St., 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 Bradford Ave., Roslindale, Mass.

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 W. Eighth St., and (for mail) 1823 Houston St., Kansas City, Mo.

STILL, Fred R. (1904), (Council 1916; 2nd Vice-Pres. 1917; Pres. 1918; Council 1919), Vice-Pres. and Secy. (for mail) American Blower Co., 50 Church St., New York, N. Y.

STITT, Eugene W. (1917), Mgr. (for mail) U. S. Radiator Corp., 607 Arrott Bldg., and 1535 Fair-lawn Ave., Dormont, Pittsburgh, Pa.

STITT, Howard B. (Associate 1922), Heat. Engr. (for mail) 506 West 29th St., Indianapolis, Ind.

STOCK, Edward L. (Associate 1918), Pres., Republic Boiler & Radiator Co., 1220 New York Ave., Washington, D. C., and Bradley Hills, Bethesda, Md.

STOCKENBERG, Ruben (1922), Sales Engr. (for mail) Johnson Service Co., 1355 W. Washington Blvd., and 1314 Columbia Ave., Chicago, Ill.

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), M. J. Dougherty Co., 25th and Washington Ave., and (for mail) 4520 N. Carlisle St., Philadelphia, Pa.

STORM, Edwin S. (1916), Vice-Pres., Hoffman Specialty Co., 130 N. Wells St., Chicago, Ill.

STRADER, Budd K. (Associate 1913), Repr., Elevator Supplies Co., 1515 Willow Ave., Hoboken, N. J., and 233 Rose St., Freeport, L. I., N. Y.

STRANDWITZ, William J. (1919), Secy. and Treas. (for mail) Strandwitz & Scott, Inc., 537-49 S. Second 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 140 S. Maryland Ave., Atlantic City, N. J.

SUITS, George A. (1920), Mgr., Hoffman Specialty Co., 26 Stanley Ave., Medford, Mass.

SULLIVAN, Daniel A. (1923), c/o Miller & Brady, Inc., 210 East 38th St., and (for mail) 2755 Creston Ave., 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 E. Second 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., Somerville, Mass.

SWARTWOUT, Jay D. (1917), Contr. Engr., 349 S. Wendock Ave., Saginaw, Mich.

SWEENEY, Sylvester H. (1915), Engr. and Contr., 213-215 East 44th St., New York, N. Y.

SZEKELY, Ernest (1920), (Pres., Cleveland Chapter) 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 W. First St., Mansfield, O.

TALIAFERRO, Robert R. (1919), (for mail) Carrier Eng. Corp., 1402 Land Title Bldg., and Beechwood Park, Philadelphia, Pa.

TALLMAN, D. Stephen (1920), (for mail) D. S. Tallman & Co., 3637 Boulevard, Jersey City, and 11 E. Gouverneur Ave., Rutherford, N. J.

TANGEMAN, Bruno W. (Associate 1919), Mgr. (for mail) A. V. McDonald Mfg. Co., 221 Third St., N., and 2716 Aldrich Ave., S., Minneapolis, Minn.

TAPLIN, Neal W. (1921), Pres., Taplin Furnace Co., 1701 Clyde Park Ave., S.W., and (for mail) 143 Cherry St., S.E., Grand Rapids, Mich.

AMERICAN SOCIETY of HEATING and VENTILATING ENGINEERS GUIDE, 1924-25

TAVERNA, Frederick F. (1924), Raiser Heat. Co., 120 Amsterdam Ave., New York, N. Y.

TAYLOR, Fred K. (1919), (for mail) Sales Dept., Taylor Instrument Co., 95 Ames St., and 111 Trafalgar St., Rochester, N. Y.

TAYLOR, Reginald F. (1915), Consulting Engr., R. F. Taylor, 1020 Western Indemnity Bldg., and 5742 Richmond Ave., Dallas, Tex.

TAYLOR, Thomas Smith (1921), (for mail) Westinghouse Elec. & Mfg. Co., Westinghouse Research Bldg., E. Pittsburgh, and Forest Hills Rd., Forest Hills, Wilkesburg, Pa.

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.

TEMLIN, Charles L. (1921), Engr., 204 Allen Bldg., and Scales and Graham Sts., 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 Co., 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.

THATCHER, George S. (1919), Pres. (for mail) Thatcher Heat. Co., 455 E. Exchange St., and 140 Morningstar Dr., Akron, O.

THEISEN, Edwin F. (1922), Pres. and Heat. Engr., Industrial Pblg. 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), (for mail) J. Hokom Co., Inc., Heat. Dept., 4312 Moneta Ave., and 4614 Fifth Ave., Los Angeles, Calif.

THOMAS, Glegge (1923), Br. Mgr. (for mail) B. F. Sturtevant Co., 900 St. N.W., Washington, D. C., and Box 71, Route 1, Roslyn, Va.

THOMAS, Herbert G. (1917), (Secy. Illinois Chapter) 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 80 India Rd., 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, Arthur W. (Associate 1920), 88 Analomink St., E. Stroudsburg, Pa.

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.

THRELFALL, William R. (Associate 1920), Pres., W. R. Threlfall Eng. Co., 315 N. Main St., and (for mail) 146 S. Fountain St., Wichita, Kan.

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), 12-14 Oak St., Weekawken, N. J.

TIBBETS, John C. (1920), Heat. and Vent. Engr., B. & O. R. Co., 1303 B. & O. Central Bldg., Baltimore, and (for mail) Elliott 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), Works Eng. Dept., Westinghouse Elec. & Mfg. Co., E. Pittsburgh, and (for mail) 859 E. Hutchinson Ave., Swissvale, Pa.

TIMMIS, Pierce (1920), Mech. Engr. (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), (Council 1916, 1917, 1920; 1st Vice-Pres. 1918; Pres. 1919) Consulting Engr. (for mail) 315 Fifth Ave., New York, and Hillside and Homer Lee Aves., 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) Bd. of Education, Concord St. and Flatbush Ave., Brooklyn, and 640 Academy St., Astoria, N. Y.

TITZELL, J. Edgar (1923), Mgr., Eastern Dist. Sales Office, Boilers Co., 101 Park Ave., and (for mail) 132 West 88th St., New York, N. Y.

TJERSLAND, Alf. (Junior 1906; 1916), E. Sundé & 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), (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.

TOOBER, 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), Auto-force Vent. System, and 580 St. Nicholas Ave., 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), 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.

TUCKER, Edw. J. (1923), (for mail) McDougall, Pease & Friedman, 85 Osborn St., and 23 Sussex Ave., Montreal, Que.

TUFFREE, Geo. E. (1924), Jas. P. Marsh & Co., 118 S. Clinton 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.

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, Willard (1918), Sales Engr. (for mail) Uhl Co., 132 South 10th St., and 4716 Lyndale Ave., S., Minneapolis, Minn.

ROLL OF MEMBERSHIP

UHLHORN, W. J. (1920). Sales Engr., Drying Systems, Inc., 11 S. Desplains 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., Claring 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 ALLEN, Walter T. (1924). Sales Eng. Heat Dept., Standard Sanitary Mfg. Co., 439 Water St., Pittsburgh, and (for mail) 3 T St., New Brighton, Pa.
VANCE, Louis G. (1919). Dist. Mgr. (for mail) Warren Webster & Co., Gunther Bldg., and 3601 Garrison Ave., Baltimore, Md.
VAN INWAGEN, Frank (1916). (for mail) Bond Dept., Corn Exchange National Bank, Chicago, Ill.
VAN NORDEN, Ernest M. (1923). N. Y. Edison Co., 130 East 15th St., New York, N. Y.
VAN SICKLE, William (1915). Pres. (for mail) W. B. Van Sickle Co., 707 Frankfort Ave., Cleveland, and 1530 Grace Ave., Lakewood, O.
VAN TINE, C. H. (1921). The DeVore Co., 908 Nicholas Bldg., Toledo, O.
VAN ZANDT, John H. (1914). Mfrs. Agt. (for mail) J. H. Van Zandt Co., 809 Southwestern Life Bldg., and 4416 Bryan St., Dallas, Tex.
VAUX, Frederick J. (1919). Vice-Pres. and Gen. Mgr., Monitor Bi-Loop Radiator Co., 538 Woolworth Bldg., and (for mail) 202 E. King St., Lancaster, Pa.
VAUX, Noble (Associate 1923). Heat. Engr., R. T. Vaux & Son, 12 Fawcett St., and (for mail) 11 Holemeads Park St., Sunderland, England.
VERNER, William F. (1913). (for mail) Mech. Eng., Verner, Wilhelm & Molby, 751 Book Bldg., Detroit, and 908 Lincoln Ave., Ann Arbor, Mich.
VIVARTTAS, Eugene A. (1910). Consulting Engr. (for mail) 61 S. Portland Ave., Brooklyn, N. Y.
VOGELBACH, Oscar (1923). Warren & Wetmore Co., 17 East 47th St., New York, N. Y., and 195 Devon St., Kearney, N. J.
VOIGT, Charles O. (1921). Sales Engr., The Stearns, Roger Mfg. Co., 1720 California St., and 788 Clayton St., Denver, Colo.
VOLK, Joseph H. (1923). Thos. E. Hoyer 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). Engr., Cuyler & Mohler, 611 William St., Baltimore, Md.
WADDINGTON, Bertram C. (1922). Dist. Mgr. (for mail) Natkin Eng. Co., 706 W. Herald Bldg., and 105 Turner St., Omaha, Neb.
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) Excelsior Specialty Works, Inc., 119 Clinton St., and 1165 Delaware Ave., Buffalo, N. Y.
WAGNER, A. M. (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.
WALKER, James B. (1919). Secy. and Treas. (for mail) Pittsburgh Heat Co., 8 Wood St., 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, William K. (Junior 1924). McKenzie, Voorhoos & Gelmin, 342 Madison Ave., New York, N. Y.
WALLACE, Albert (1921). Mfrs. Repr., A. Wallace & Co., 401 Jacobson Bldg., and (for mail) 2971 Irving St., Denver, Colo.
WALLACE, George J. (1923). 206 East 57th St., New York, N. Y.
WALLACE, John F. (1921). Secy. and Treas., Wallace Pkg. Co., 1238 California St., and 1320 S. Josephine, Denver, Colo.
WALLICH, A. C. (1919). (for mail) Brunswick-Kroeschell Co., 1832 Gratiot Ave., and 1211 E. Grand Blvd., Detroit, Mich.
WALMSLEY, Chas. (Associate 1921). Sales Engr., D. & T. Mfg. Co., 3001 La Salle St., and (for mail) 6714 Virginia Ave., St. Louis, Mo.
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., 720 A. & R. Bldg., and 4406 Main St., Kansas City, Mo.
WALSH, Malcolm (1924). Secy. (for mail) Walsh & Wertheim, 55 W. Houston St., New York, and 332 St. Marks Pl., S. I., N. Y.
WALTERS, Arthur Lee (Junior 1924). Buck's Stove & Range Co., 3500 N. Second St., St. Louis, Mo.
WALTERS, Victor (Junior 1924). Draftsman, I. C. R. Bldg. Dept., Dowie Bldg., and (for mail) 9036 Cottage Grove Ave., Chicago, Ill.
WALTERS, William T. (1917). Engr., Illinois Eng. Co., West 21st St. and Racine Ave., and (for mail) 9036 Cottage Grove Ave., Chicago, Ill.
WALTHER, Harry J. (1919). Mgr. Heat Dept. (for mail) Henry B. Pancoast Co., 946-62 N. Front St., and 1125 Lindley Ave., Philadelphia, Pa.
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.
WALTON, Hiram L. (1916). Mech. Engr., Smith, Hinchman & Grylls, 800 Marquette Bldg., Detroit, and 218 Monterey Ave., Highland Park, Mich.
WARD, Oscar G. (1919). (Secy. Colorado Chapter) Dist. Mgr. (for mail) Johnson Service Co., 1228 California St., and 1515 E. Ninth Ave., Denver, Colo.
WARNKE, Fred E. (Associate 1921). Sales Mgr. (for mail) Rm. 219, 5005 Euclid Ave., Cleveland, 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). Asst. Ch. Engr., American Blower Co., 6004 Russell St., and 9121 Third Ave., Detroit, Mich.
WATTERS, Peter J. (1921). Mgr., John Watters, 67 Richmond Ave., 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., Portland, Me.
WEBER, Erwin L. (1921). Consulting Engr. (for mail) 723 Seaboard Bldg., and 3046 18th Ave., S., Seattle, Wash.
WEBER, G. A. (1922). Heat. Engr. (for mail) McGinness, Smith Co., 435 Water St., Pittsburgh, and 188 Kendall Ave., Bellevue, Pa.

AMERICAN SOCIETY of HEATING and VENTILATING ENGINEERS GUIDE, 1924-25

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., and 626 Cooper St., Camden, N. J.
WEGMANN, Albert (1918). Blower and Vent. Engr., A. & W. Wegmann, 2207 North 27th 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., 834-5 Merchants & Mfrs. Bank Bldg., 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.
WELAMB, Victor N. (1918). Contr., V. N. Welamb Co., 135 North 22nd St., and (for mail) 1741 North 33rd St., Philadelphia, Pa.
WELSH, Arthur E. (1918). Price & Welker, 707 Walnut Rd., Cleveland, and 1299 Hall Ave., Lakewood, O.
WELSH, Harry S.* (1906). Pres. and Mgr., Boiler & Radiator Corp., Davis Bldg., 154 East Ave., and 4 Lake View Terrace, Rochester, N. Y.
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 633 Lafayette Ave., Buffalo, N. Y.
WESCHLER, Geo. A. (1923). Prof. of Mech. Engr. (for mail) 820 Transportation Bldg., and 1243 Monroe St., N. W. Washington, D. C.
WEST, Peter (1911). (Council 1920-1923; Treas. 1924) 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., 910 May Bldg., Pittsburgh, and Allison Park, Pa.
WHEELER, Kenneth E. (1922). (for mail) St. Stephen's House, Westminster, London, S.W. 1., and 38 Hanover House, St. John's Wood, London, N.W. 8, England.
WHEELER, Otto J. (1923). Mgr. and Secy., Samuel A. Eswein Heat & Pkg. Co., 96 W. Broad St., and (for mail) 504 Linwood Ave., Columbus, O.
WHELOCK, Harry C. (1919). 118 College St., Burlington, Vt.
WHELAN, William J. (1923). Harrigan & Reid, 1705 First St., Detroit, Mich.
WHEELER, 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.
WHITBY, Stephen S. (Associate 1922). Treas., Culbert-Whitley Co., 1503 Sansom St., Philadelphia, Pa., and (for mail) 280 Yale Rd., Audubon, N. J.
WHITE, Everett A. (1921). Mgr. Heat Dept. (for mail) Crane Co., 30 South 16th St., and 4253 Juniata St., St. Louis, Mo.
WHITE, Elwood S. (1921). Pres. and Treas. (for mail) Thermal Appliance Co., Inc., 342 Madison Ave., New York, and 18 North Lane, Glen Cove, L. I., 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.
WHITEMAN, W. R. (Associate 1921). Salesman, Ozon Pure Airifier Co., 1401 W. Jackson Blvd., Chicago, Ill.

WHITTEMORE, Edward H. (1920). Heat. and Vent. Engr. (for mail) Lord Construction Co., 112 Water St., Boston, and 12 Edgemont St., Roslindale, Mass.
WHITTEN, Herbert W.* (Associate 1908; 1909). Br. Mgr. (for mail) Chamberlain Metal Weather Strip Co., 619 East 13th Ave., and 1031 Harrison St., Denver, Colo.
WHITTLESEY, Grant (1919). Power Plant Specialties (for mail) 844 Elliott Sq., and 458 Parkside Ave., Buffalo, N. Y.
WHY, H. Berkeley (1919). Construction Engr. (for mail) 312 Earham 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.
WIGGINS, C. H. (Associate 1924). R. F. Taylor, 106 Indemnity Bldg., Dallas, Tex.
WIGGS, Gordon L. (Junior 1924). Mechanics Supply Co., Ltd., Quebec, Que.
WILBUR, Edwin R. (1921). Salesman (for mail) Morgan-Gerrish Co., 501 Sixth St., S., and 2902 James Ave., S., Minneapolis, Minn.
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., 514 Atlantic Ave., Boston, and 7 Biltmore St., Jamaica Plain, Mass.
WILD, Walter H. (Associate 1921). Mgr. Agt. (for mail) General Boilers Co., 1325 Land Title Bldg., Philadelphia, and 122 Cynwyd Rd., Cynwyd, 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, J. Walter (1915). Pres. and Treas., Forest City Pkg. 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 W. Fourth St., and (for mail) 360 East 105th St., Cleveland, O.
WILLIS, F. H. (1921). Ch. Engr., Heat. and Vent. Div., Wm. N. Bowman Co., R. 914, Central Savings Bank Bldg., 1111 Jackson St., Denver, Colo.
WILLIS, Ralph P. (1923). Herman Nelson Corp., 511 Duffy Powers Bldg., Rochester, N. Y.
WILMOT, Charles S. (1919). Research Engr. and Works, Mgr., Monitor Bi-Loop Radiator Co., Harrisburg Ave., Lancaster, Pa., and (for mail) 203 Second Ave., Haddon Heights, N. J.
WILSON, Benjamin W. (1922). Heat. and Vent. Engr., Ballinger Co., S.E., Cor. 12th and Chestnut Sts., and (for mail) 816 Perkiomen St., 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.

ROLL OF MEMBERSHIP

WILSON, Eugene K. (1919), (for mail) Wilson & Co., 1017 Duke St., and 12 Lafayette Blvd., Norfolk, Va.
WILSON, Frederick A. (1910), (for mail) 728 Rogers Ave., Brooklyn, N. Y.
WILSON, Harry A. (1903), Moosup, Conn.
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.
WINTER, Frank M. (1921), Sales Repr. (for mail) Pittsburgh Water Heater Co., 131 E. Sixth St., Los Angeles, and 7353 Jasmine Ave., Palms, Calif.
WINTERBOTTOM, John W. (1915), Vice-Pres. and Engr., Lock Box 2045 Sta. A., Waterloo, Ia.
WINTERBOTTOM R. F. (Associate 1923), Inland Supply Co., 4630 W. Augusta St., Chicago, Ill., and (for mail) P. O. Box 2217, Sta. A., Waterloo, Ia.
WINTERER, Frank C. (1920), Heat. Dept. (for mail) Cochran-Sargent Co., Fifth and Sibley Sts., and 336 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), Engr. (for mail) General Boilers Co., 1627 Main St., and 2800 Independence Ave., Kansas City, Mo.
WISE, Mason W. (1923), Mgr. (for mail) 215 Glenn Bldg., and R. F. D. No. 2, Atlanta, Ga.
WITKOWSKY, Fred A. (1920), Heat. Engr., 13712 Chautauqua Ave., N.E., Cleveland, O.
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 Kunworth Rd., Columbus, O.
WOLFF, Richard A. (Junior 1918; 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.
WOMRATH, George F. (1920), Bus. Supt. Minneapolis Bd. of Education, 305 City Hall, and (for mail) 3215 S. Irving Ave., Minneapolis, Minn.
WOOLLEY, Thomas R. (1916), Sales Engr., Woolley Eng. Sales Co., 661 W. Jefferson Ave., and (for mail) 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.

WORSHAM, Herman (Junior 1918), Sales Engr., (for mail) Carrier Eng. Corp., 1144 Prudential Bldg., and 37 Manchester Pl., Buffalo, N. Y.
WORTHING, E. (1923), Bayley Mfg. Co., 732 Greenbush St., Milwaukee, Wis.
WORTHINGTON, Thomas (1922), Kewanee Boiler Co., 141 Albany Ave., Toronto, Ont.
WRIGHT, Harris H. (1917), Mgr., C. A. Dunham Co., 1027 Main St., and 1214 E. Gillham Rd., Kansas City, Mo.
WRIGHT, K. (1921), Mgr., Johnson Service Co., 319 Gwynne Bldg., Cincinnati, O.
WYLIE, Howard McWilliam (Junior 1917), Vice-Pres. and Sales Mgr. (for mail) Nash Eng. Co., and 51 Elmwood Ave., 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.
YAGLOGLU, Constantin P. (1923), (for mail) A. S. H. & V. E. Research Laboratory, U. S. Bureau of Mines, and 3816 Pier St., Pittsburgh, Pa.
YAMASAKI, Kanjiro (Associate 1923), Takata & Co., Marunouchi, Tokyo, Japan, and (for mail) Takata & Co., 50 Church St., New York, N. Y.
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), Mgr., A. Zeck & Son, 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 Pibg. & Heat. Co., P. O. Box 33, Onarga, Ill.
ZOKELT, C. G. (1921), Partner (for mail) Northwest Engr. Co., 537 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., 236 24th St., Milwaukee, and 579 15th Ave., Wauwatosa, Wis.

Summary of Membership

UNITED STATES

Alabama	4	Nebraska	5
California	17	New Jersey	76
Colorado	25	New York	347
Connecticut	21	North Carolina	6
Delaware	5	North Dakota	1
District of Columbia	14	Ohio	109
Florida	1	Oklahoma	6
Georgia	16	Oregon	2
Illinois	220	Pennsylvania	298
Indiana	32	Rhode Island	7
Iowa	10	Tennessee	6
Kansas	10	Texas	11
Kentucky	3	Utah	1
Louisiana	2	Vermont	4
Maine	3	Virginia	16
Maryland	22	Washington	24
Massachusetts	81	West Virginia	5
Michigan	114	Wisconsin	41
Minnesota	57	Wyoming	1
Missouri	112		
Montana	5		1740

FOREIGN COUNTRIES

Canada	62	Norway	1
China	6	Russia	1
Denmark	2	Sweden	1
England	22	Switzerland	1
France	2	Turkey	1
Germany	1		
Ireland	1		105
Japan	3		
New Zealand	1	Total Membership	1845

SUMMARY OF MEMBERSHIP BY GRADES

Honorary Members	1
Members	1483
Associate Members	233
Junior Members	128
	1845

LIST OF MEMBERS

Arranged Geographically

UNITED STATES

ALABAMA

Birmingham—
Bunnell, E. W.
Lichty, A. J.
Lichty, C. P.
Smith, V. A.

CALIFORNIA

Huntington Park—

Berg, A. H.

Long Beach—

Hanes, J. W. E.

Los Angeles—

Anderson, C. S.
Helpingstein, O.
Hubbard, A. M.
Jones, E. A.
Kilpatrick, W. S.
Larimer, G. B.
Moler, W. H.
Thomas, B. A.
Winter, F. M.

Oakland—

Cummings, G. J.

Pasadena—

Gifford, R. L.

San Francisco—

Duncan, G. W., Jr.
Haley, H. S.
Krueger, J. I.
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.
Fielding, H. H.
Foley, W. J.
Fuller, R. K.
Larimer, W. M.
Michael, L. A.

Pfeffer, 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.

Whitten, H. W.

Willis, F. H.

Colorado Springs—

McCarthy, T.

CONNECTICUT

Hartford—

Libby, L. R.

Purcell, A. J.

Moosup—

Wilson, H. A.

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—

Wylie, H. M. W.

Springdale—

Broderick, J. F.

Stamford—

Blackman, A. O.

Waterbury—

Byrnes, T. F.

Ruppel, R. L.

Ryan, T. F.

Simpson, W. K.

Skelly, J. F.

Winsted—

Griffin, P. C.

Hutton, W.

DELAWARE

Wilmington—

Bulkeley, C. A.

Gawthrop, F. H.

Kershaw, M. G.

Lownsberry, B. F.

Schoenjahn, R. P.

DISTRICT OF COLUMBIA

Washington—

Bradbury, C. R.

Coward, H.

Dickinson, H. C.

Febrey, E. J.

Gardner, S. F.

Goldstein, A. M.

Miller, M. E.

Munro, E. A.

Munroe, E. K.

Stock, E. L.

Thomas, G.

Thompson, N. S.

Tripp, L. H.

Weschler, G. A.

FLORIDA

Jacksonville—

Furman, C. W.

GEORGIA

Atlanta—

Alger, R. W.

Baker, I. C.

Beggs, D. T.

Carder, W. W.

Guest, P. L.

Harbuck, J. H.

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.

Christopher—

Miller, H. N.

Chicago—

Allan, C. D.

Allen, H. D.

Amstein, A. W.

Andel, F. J.

Arefberg, M. K.

Armspach, O. W.

Atkinson, R. E.

Aubinger, E. W.

Baker, E. V.

Barrows, C. E.

Bennett, P. D.

Benoit, W. E.

Best, J. H.

Black, F. C.

Blomfeldt, A. A.

Bloom, S. C.

Boswin, G. A.

Boylston, A. W.

Boylston, J.

Braun, L. T.

Burger, J. C.

Burns, W. A.

Carnahan, G. C.

Casey, B. L.

Casserly, T. D.

Chenoweth, W. H., Jr.

Chesney, C. C.

Clafey, E. J.

Crawford, W. B.

Crone, C. E.

Currier, C. H.

Cutter, E. H.

Davis, F. R.

Davis, J. H.

Deland, C. W.

Dewar, J. G.

Diebold, C. M. L.

Doherty, J.

Douglass, T. C.

Drinkwater, E. L.

Dunham, C. A.

Emmert, L. D.

Ensing, R. M.

Evans, C. E.

Evans, R. S.

Finan, J. J., Sr.

Fleming, J. P.

Furman, J. R.

Gardner, W. Jr.

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.

Griffin, W. H.

Gustafson, T. E.

Haas, S. L.

Haines, J. J.

Hamilton, H., Jr.

Hansen, J.

Harris, H. A.

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. J.

Hubbard, G. W.

Impey, P. F.

Jackson, C. J.

Jensen, 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.

Kohlberg, E. G.

Kroeger, A.

Lagodzinski, H. J.

Lamb, F. W.

Larson, J. M.

Lautenschlager, F.

Lees, H. K.

Leonone, J. M.

Lewis, S. R.

Lindeman, R. F.

Lippe, E. V.

Lippman, O. S.

Lockhart, G. L.

Luce, G. D., Jr.

McCaulley, 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.

Davis, J. W.

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.

Neller, S. G.

Nelson, B.

Newport, C. F.

Nilson, A.

Nulsen, C. A.

O'Brien, J. H.

Olsen, C. F.

Pask, R. J.

Pittcher, L. J.

Pittsford, W. A.

Pope, S. A.

Pope, W. A.

Powers, F. W.

Richardson, A. H.

Rietz, E. P.

Rogers, C. W.

Rollins, F. D.

Rosenbach, R. G.

Ryan, H. B.

Scheidecker, D. B.

Sheriffs, W. A.

ROLL OF MEMBERSHIP

KENTUCKY

Louisville—
Lewis, J. C.
Lissauer, A. W.
Murphy, H. C.

LOUISIANA

New Orleans—
Cooper, M. A.
Todd, J. M.

MAINE

Portland—
Fels, A. B.
Merrill, C. J.
Webb, J. S.

MARYLAND

Baltimore—
Adams, H.
Berger, C. D.
Collier, W. I.
Dorsey, F. C.
Eisert, H.
Fogg, O. H.
Groschup, W. F.
Huetner, C. G. L.
King, C. T.
Kries, H. A.
Leilich, R. L.
McCrea, L. W.
Moore, D. S.
Posey, J. W.
Pytes, J. W.
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.

MASSACHUSETTS

Arlington—
Connell, H. F.

Boston—
Abboud, A.
Adams, D.
Andrews, B. R.
Bartlett, A. C.
Barton, R. E.
Boardman, W. E.
Boyden, C. G.
Brinton, J. W.
Brooks, T. C.
Bryant, Dr. A. G.
Carey, J. J.
Clough, L.
Cooper, F. I.
Dame, C. T.
Davidson, P. L.

Densmore, E. D.
Drinker, P.
Duquest, A. M.
Dusossoit, E. A.
Dwyer, J. P., Jr.
Foulds, P. A. L.
Franklin, R. S.
Gleason, G. H.
Gilmore, F. P.
Goodrich, C. F.
Herrick, D. A.
Hodgdon, H. A.
Hosterman, C. C.
Hubbard, A.
Ingalls, F. D. B.
Kelllogg, A.
Kennally, V. J.
Kimball, C. W.
Kirmes, E. W.
Lyle, E. T.
McKenna, Wm. N.
Mason, O. A.
Matthews, C. R.
Miller, M. P.
Mitchell, C. H.
Myrick, J. W. H.
Preble, J. J.
Shaw, E.
Shaw, R. E.
Smallman, W. T.
Stetson, L. R.
Stone, E. R.
Tilden, E. E.
Tuttle, J. F.
Underhill, W. W.
Whittemore, E. H.
Wiegner, H. B.
Wilcox, Wm.

Brookline—
Pierce, E. R.

Cambridge—
Cox, C. J.
Flint, C. T.
Heath, F. R.
Klonower, A. A.
Norton, Prof. A. E.

Everett—
McMurrer, L. J.

Fitchburg—
Carlson, A. F.

Hyde Park—
Ellis, F. R.
Scheibel, A. H.

Lowell—
Fois, G. A.
Jenkins, H. E.

Lynn—
Feehan, J. B.
Morgan, F. H.
Pool, S. H.
Reardon, J. A.

Medford—
Higgins, J. M.
Suits, G. A.

Melrose—
Smallman, E. W.

Newtonville—
Jones, W. T.

Pittsfield—
Robbins, L. G.
Waverly—
Crocker, R. B.
Wellesley Hill—
Gilling, W. F., Jr.
West Roxbury—
Roberts, W. L.
West Somerville—
Swaney, C. R.
Woburn—
Parker, P.

MICHIGAN

Ann Arbor—
Backus, T. H. L.
Brender, P. E.
Emswiler, Prof. J. E.
Guere, G. H.
Hutzel, A. F.
Zopata, E. L.

Berrien Springs—
Bodtke, M.

Detroit—
Addy, R.
Benkendorf, R.
Bishop, F. R.
Boales, W. G.
Brown, E. R.
Calvert, N. W.
Cassel, H. H.
Chester, T.
Clark, E. H.
Clise, F. W.
Cockburn, L. S.
Collamore, R.
Connell, R. F.
Coon, T. E.
Dauch, E. O.
Davis, L. J.
Decker, E. M.
Degan, J. E.
Diebolt, N. J.
Dill, J. B.
Donahue, E. S.
Downs, E. L.
Dubry, E.
Dwyer, J. V.
Emerick, S. H.
Ferris, D. M.
Fuller, J. L.
Goss, M. H.
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.
Johnston, W. B.
Kaplan, J.
Killian, M. A.
Knight, A. B.
Lance, J.
Linhard, H. V.
Little, C. W.
Little, E. R.

Locker, C. W.
Loveland, J. A.
McColl, J. R.
McIntire, J. F.
McLean, D.
McNair, E. E.
Marty, E. O.
Meyer, J. W., Jr.
Miller, J. F. G.
Morgan, C. S.
Morgan, S. H.
Morse, C. T.
Paetz, H. E.
Parrott, L. G.
Partlan, J. W.
Pattison, G. B.
Peckham, R. R.
Peterson, H. K.
Petherick, D. H.
Pittellkow, A. G.
Purcell, R. E.
Roney, T. G.
Rowe, W. A.
Russell, W. A.
Saulson, S.
Schildmiller, G. H.
Shuell, F. W.
Skagerberg, R.
Smith, L. L.
Snell, E.
Snyder, J. W.
Soderberg, C. H.
Spitzley, R. L.
Spurgeon, J. H.
Vaile, R.
Verner, W. F.
Walker, J. H.
Wallach, A. C.
Walton, H. L.
Watkins, J. A.
Whelan, W. J.
Wilcox, O. H.
Wilde, R. S. M.
Whiteley, J.
Williamson, A. H.
Wooley, T. R.
Ziel, H. E.

Downglac—
Firestone, J. F.
Wagner, J. P.

Grand Rapids—
Pearson, H. D.
Taplin, N. W.

Highland Park—
Foster, W. M.

Holland—
Cherven, V. W.

Kalamazoo—
Blaney, C. A.
Kersjes, W.
Monroe, L. O.

Lansing—
Distel, F., Jr.

Pentwater—
Cartland, S.

Saginaw—
Swartwout, J. D.

Standish—
Burr, R. J.

AMERICAN SOCIETY of HEATING and VENTILATING ENGINEERS GUIDE, 1924-25

MINNESOTA

Duluth—
Page, S. H.
Grand Forks—
Henschen, L. H.
Minneapolis—

Blair, W. B.
Brown, E. H.
Brown, F. C.
Brown, J. H.
Burns, E. J.
Burritt, C. G.
Challman, S. A.
Clarkson, W. B.
Conner, M.
Cowles, B. E.
Cummins, G. H.
Elliott, A. D.
Fitts, C. D.
Forfar, D. M.
Foster, C.
Gausman, C. E.
Gaylord, F. H.
Gerrish, H. E.
Gordon, E. B., Jr.
Hanson, L. C.
Harris, J. B.
Hasey, C. E.
Hildebrandt, H. A.
Huch, A. J.
Jaynes, E. L.
Martens, J. V.
Meyer, H. J.
Morgan, G. C.
Olsen, A. J.
Porter, R. L.
Probst, A. H.
Ridder, H. C.
Rollins, L. M.
Rowley, F. B.
Ruff, D. C.
Sanford, A. L.
Spertzel, H. J.
Tangeman, B. W.
Uhl, W. F.
Wilbur, E. R.
Womrath, G. F.

St. Paul—
Adams, N. D.
Bredeson, C. R.
Buenger, A.
Cochran, M. M.
Davis, H.
Heagler, J. M.
Jones, E. F.
Otto, R. W.
Rockart, E. R.
Stewart, E. A.
Spriggs, W. J.
Wagner, A. M.
Winterer, F. C.
Winterer, R. J.

Kirkwood—
McMorran, F. J.

Liberty—
Dudfield, A.

St. Joseph—
Rock, A. C.

St. Louis—
Baetz, H.
Bayse, H. V.
Bowers, J. S.
Bradley, E. P.
Bradley, J. T.
Breitenbach, W. J.
Cook, C. D.
Cooper, J. W.
Croft, T.
De Nellie, J. L.
Edwards, D. F.
Eichler, A.
Falvey, J. D.
Forgan, D. M.
Foster, J. M.
Gale, T. J. C.
Gallagher, J. E.
Graves, R. E.
Griffin, J. J.
Haller, A. L.
Hallett, E. S.
Halley, W. H.
Hammer, H. M.
Harris, H. W.
Hester, T. J.
Hooper, W. G.
Huber, C. F.
Humphreys, A. E.
Keiser, W.
Kinealy, J. H.
Klein, W. A.
Lane, A. M.
Langenberg, E. B.

Independence—
Cook, B. F.

Kansas City—
Arthur, J. M., Jr.
Blodgett, W. H.
Burton, C. A.
Caleb, D.
Campbell, E. K.
Clegg, Carl
Cline, E. A.
Cox, W. F.
Dickson, G. P.
Dodds, F. F.

Downes, N. W.
Lohman, R. L.
Ellis, J. E.
Fehlig, J. B.
Fiske, T. D.
Gillham, W. E.
Gorton, G. H.
Graham, E. H.
Griffin, F. A., Jr.
Hale, F. M., Jr.
Hauser, M.
Hayes, P. M.
Hitchcock, F. P.
Johnson, R. B.
Joyce, W. P.
Kitchen, F. A.
Kitchen, J. H.
Laurie, R. J.
McDonald, J. C.
McIntyre, W. N.
McKeighan, E. E.
Millis, L. W.
Morse, H. C.
Nadler, J. H.
Niestrath, W. H.
Pickett, C. A.
Quentin, E. H.
Randle, J. E.
Riley, A. H.
Rosebrough, R. M.
Rossman, V. D.
Sachleben, E. H.
Schulze, B. H.
Sodermann, W. C.
Stammer, E. L.
Thomsen, W. T.
Walmesley, C.
Walters, A. L.
White, E. A.

Kirkwood—
McMorran, F. J.

Liberty—
Dudfield, A.

St. Joseph—
Rock, A. C.

St. Louis—
Baetz, H.
Bayse, H. V.
Bowers, J. S.
Bradley, E. P.
Bradley, J. T.
Breitenbach, W. J.
Cook, C. D.
Cooper, J. W.
Croft, T.
De Nellie, J. L.
Edwards, D. F.
Eichler, A.
Falvey, J. D.
Forgan, D. M.
Foster, J. M.
Gale, T. J. C.
Gallagher, J. E.
Graves, R. E.
Griffin, J. J.
Haller, A. L.
Hallett, E. S.
Halley, W. H.
Hammer, H. M.
Harris, H. W.
Hester, T. J.
Hooper, W. G.
Huber, C. F.
Humphreys, A. E.
Keiser, W.
Kinealy, J. H.
Klein, W. A.
Lane, A. M.
Langenberg, E. B.

St. Paul—
Adams, N. D.
Bredeson, C. R.
Buenger, A.
Cochran, M. M.
Davis, H.
Heagler, J. M.
Jones, E. F.
Otto, R. W.
Rockart, E. R.
Stewart, E. A.
Spriggs, W. J.
Wagner, A. M.
Winterer, F. C.
Winterer, R. J.

Kirkwood—
McMorran, F. J.

Liberty—
Dudfield, A.

St. Joseph—
Rock, A. C.

St. Louis—
Baetz, H.
Bayse, H. V.
Bowers, J. S.
Bradley, E. P.
Bradley, J. T.
Breitenbach, W. J.
Cook, C. D.
Cooper, J. W.
Croft, T.
De Nellie, J. L.
Edwards, D. F.
Eichler, A.
Falvey, J. D.
Forgan, D. M.
Foster, J. M.
Gale, T. J. C.
Gallagher, J. E.
Graves, R. E.
Griffin, J. J.
Haller, A. L.
Hallett, E. S.
Halley, W. H.
Hammer, H. M.
Harris, H. W.
Hester, T. J.
Hooper, W. G.
Huber, C. F.
Humphreys, A. E.
Keiser, W.
Kinealy, J. H.
Klein, W. A.
Lane, A. M.
Langenberg, E. B.

Independence—
Cook, B. F.

Kansas City—
Arthur, J. M., Jr.
Blodgett, W. H.
Burton, C. A.
Caleb, D.
Campbell, E. K.
Clegg, Carl
Cline, E. A.
Cox, W. F.
Dickson, G. P.
Dodds, F. F.

Legier, E. W.
Lohman, W. J.
McDonnell, G. P.
Meagher, J. F.
Milward, R. K.
Moon, L. W.
Moritz, C. J.
Mueller, B. H.
Nader, J. H.
Niestrath, W. H.
Pickett, C. A.
Quentin, E. H.
Randle, J. E.
Riley, A. H.
Rosebrough, R. M.
Rossman, V. D.
Sachleben, E. H.
Schulze, B. H.
Sodermann, W. C.
Stammer, E. L.
Thomsen, W. T.
Walmesley, C.
Walters, A. L.
White, E. A.

Sedalla—
Sellers, R. F.
Suter, G.

MONTANA

Billings—
Cohagen, C. C.
Tooker, C. C.

Bozeman—
Powers, F. I.

Helena—
Bain, J. G.
Haile, C. S.

NEBRASKA

Hastings—
Gedney, K. H.

Omaha—
McCulley, D. E.
Merwin, G. E.
Shea, M. B.
Waddington, B. C.

NEW JERSEY

Atlantic City—
Nesbitt, A. J.
Nesbitt, J. J.
Strouse, S. B.

Audubon—
Whitby, S. S.

Bloomfield—
Anderson, H. J.

Bogota—
Dailey, J. A.
Heebner, W. M.

Bridgeton—
Custer, A. E.

Camden—
Eveleth, C. F.
Kappel, G. W. A.
Lind, C. C.
Strandwitz, W. J.
Webster, E. K.
Webster, W.

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.
Bolling, J. E.
Carrier, W. H.
Duncan, J. R.
Geiser, H.
Janet, H. L.
Jones, R. L.
Kiehl, A. A.
Knapp, A. F.
Lewis, L. L.
Lindeman, H.
Lyle, J. I.
Noble, M.
Soule, L. C.
West, P.

Closter—
Atkinson, H. G.

East Orange—
Crone, T. E.
Heiles, F. C.
Hunter, C. C.
Schroth, A. H.
Turno, W. G. W.

Elizabeth—
Cornwall, G. T.
Pearce, C. E.
Wheller, H. S.

Essex Falls—
Stacey, A. E., Jr.

Haddonfield—
Chew, I.
Dobbs, C. E.

Haddon Heights—
Wilmot, C. S.

Hasbrouck Heights—
Goodwin, S. L.

Hoboken—
Strader, B. K.

Jersey City—
Butler, P. D.
Calahan, J. J.
Jones, H. L.
Ritchie, W.
Tallman, D. S.
Walterthum, J. J.

ROLL OF MEMBERSHIP

North Bergen—
De Vore, M. J.

Passaic—
Morris, C. R.

Paterson—
Pryor, F. L.

Plainfield—
MacDougall, B. W.
Tobin, G. J.

Ridgefield—
Davis, A. C.

Riverton—
Brunt, T. B.

Short Hills—
Fouilhoux, J. A.

Trenton—
Black, J.
Black, J. J. A.
Piper, A.
Piper, E. R. W.
Russell, W. E.

Weehawken—
Thuem, A. E.

Wenonah—
Terrell, H. A.

West Hoboken—
Reichwald, C. W.

Woodlynne—
Deckman, E. M.

NEW YORK

Albany—
Hynes, L. P.
Murray, T. F.
Ryan, H. J.
Taggart, R. G.

Amsterdam—
Dwyer, F. A.

Brooklyn—
Atwater, L. W.
Bender, C. P.
Blest, F. S.
Crutchley, E. Jr.
Dwyer, T. F.
Emery, W. D.
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.
Norton, F.
Phillips, F. W. Jr.
Richardson, F. J.
Robertson, G. A.
Ruppert, E. H.
Scollay, U. G.
Seward, P. H.

Buffalo—
Ahlf, A. A.
Booth, C. A.
Bresnahan, J. J.
Case, E. W.
Cherry, L. A.
Ciriqli, A. A.
Danforth, L. 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.
Johnson, J. A.
Kamman, A. R.
Landers, J. J.
Landon, A. A.
Laperle, L. G.
Love, C. H.
Monin, E. H.
Mosher, C. H.
Padginton, G.
Quigley, W. J.
Reinhard, E. L.
Riley, D. H.
Ruckel, J. B.
Scheer, F. W.
Schoepflin, P. H.
Thornton, R. T.
Wadley, C. P.
Wendt, E. F.
Wendt, H. W.
Whittlesey, G.
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.

Hastings-on-Hudson—
Reynolds, T. W.

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.

Morton—
Stangland, B. F.

Mt. Vernon—
Hunt, R. B.
Martin, J. H.
Obert, C. W.

New Rochelle—
Vose, R. H.

New York City—
Abrams, A.
Addams, H.
Adler, A. B.
Allen, D. M.
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.)
Barrett, L. L.
Barwick, T.
Baum, A. L.
Beebe, F. E. W.
Bennett, G. E.
Bernan, L. K.
Binder, I.
Birch, H. A.
Blackmore, J. J.
Blizard, J.
Blum, W.
Bolton, R. P.
Booth, H. N.
Brassington, A. F.
Brennan, T. P.
Browne, A. L.
Brunner, H.
Buensod, A. C.
Callahan, M. J.
(L. I. City)
Carpenter, R. H.
Carty, T.
Cary, A. A.
Chadeayne, G. D.

Chapman, F. T.
Chase, J. M.
Child, E. T.
Clark, W. D.
(Richmond Hill, L. I.)
Cosgrove, W. M.
Cullen, H. J.
(Jamaica, L. I.)
Darts, J. A.
Davis, F. L.
(Jamaica, L. I.)
Devereux, L. W.
Dill, H. O.
Dillon, H. R.
Donnelly, J. A.
Donnelly, R.
Donoghue, J. J.
Dornheim, G. A.
(L. I. City)
Driscoll, W. H.
(L. I. City)
Duff, K.
Durand, W. L.
Eadie, J. G.
Easterbrooks, C. C.
Edelston, S. H.
Emerson, R. R.
Engle, A.
Engle, H. J.
Evans, W. A.
Feldman, A. M.
Fitz, G. L.
Fleisher, W. L.
Fletcher, S. W.
Forge, F. A.
Frederick, L. M.
Friedman, A.
(Corona, L. I.)
Fuller, C. A.
Gore, E. F.
Goldberg, H. M.
Goldschmidt, O. E.
Gombers, H. B.
Goodnow, W. F.
Greason, D. R.
Green, C. E.
Grill, G. E.
Gunnarson, C. R.
Hankin, R.
Harbula, M. G.
Hedges, H. B.
Heatherton, J. M.
Hedges, H. B.
Hoffman, G. D.
Hook, M. G.
Houghten, F. C.
Hunter, W. S.
Hyman, W. M.
Innis, H. R.
Ireland, T. H.
Issertell, H. G.
Jacobus, Dr. D. S.
Jalen, J. J.
Johnson, E. B.
(W. New Brighton, S. I.)
Kahn, H. P.
Kashey, A. P.
Keenan, P. F.
Kellogg, T. M.
Keyes, R. E.
Kiewitz, A. A.
(L. I. City)
Kimball, D. D.
Kirk, L. G.
Klauss, L. J.
(Farmingdale, L. I.)
Knowles, A. P.
Koithan, W. S.
Lawrence, C. E.
LeCompte, W. G.
Lucke, C. E.
McKiever, W. H.
McMahon, W. W.
Macon, W. W.
Maier, G. M.

AMERICAN SOCIETY of HEATING and VENTILATING ENGINEERS GUIDE, 1924-25

Marshall, H. H.
(Garden City, L. I.)
Martin, G. W.
Matthiessen, H. G. F.
Medway, F. J.
Merritt, J. H.
Meyer, H. C. Jr.
Miller, C. A.
Miller, R. B.
Molby, E. C.
(Forest Hills, L. I.)
Munier, L. L.
Musselman, J. F.
Nichols, G. B.
Nicol, N. C.
Norton, F. W.
Oaks, O. O.
O'Donnell, T. J.
Offner, A. J.
Ohmes, A. K.
Olvan, W. J.
Oswald, W. L.
Parkhill, D.
Parter, S. C.
Patorno, S. A. S.
Peabody, E. H.
Peacock, J. K.
Petersen, G.
Pfuhler, J. L.
(W. New Brighton, S. I.)
Pieron, A.
(Glendale, L. I.)
Pinder, P. H.
Pryor, R. W.
Purinton, D. J.
Quirk, C. H.
Rainger, W. F.
Raisler, S.
Reed, J. F.
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.
Schloss, N. L.
Schmidt, G. G.
Schneider, C.
Scott, C. A.
Scott, E. A.
Scott, G. M.
Sellman, N. T.
Siegel, J. F.
Skriloff, E.
Spofford, H. H. R.
Spoonner, H. R.
(Hollis, L. I.)
Steinke, G. B.
Stern, H. R.
Still, F. R.
Sullivan, D. A.
Sweeney, S. H.
Taverna, F. F.
Tazelaar, P.
Terry, F. J.
Timmis, P.
Timmis, W. S.
Titzell, J. E.
Treat, E. J.
Tree, R. T.
Tusch, W.
Van Norden, E. M.
Walker, W. K.
Wallace, G. J.
Walsh, M.
Watters, P. J.
(Port Richmond, S. I.)
White, E. S.
Wolff, R. A.
Wolfsfeld, C. F.
(Bayside, L. I.)
Yamasaki, K.

N. Tonawanda—
Kline, W. J.

Oswego—
Lockett, J. W.

Port Chester—
Donovan, J. E.
Pratt, E. D.

Poughkeepsie—
Doherty, J. J.
Hawley, E. F.
Miller, L.

Rochester—
Aronwits, W.
Beecher, P. M.
Coe, I. B.
Coe, R. T.
Devendorf, W. F.
DeWolf, R. D.
Dobson, G. G.
Graham, W. D.
Hawley, W. Jr.
Stein, C. J., Jr.
Taylor, F. K.
Weider, F. J.
Welsh, H. S.
Wilder, E. L.
Wiley, C. S.
Willis, R. P.

Round Lake—
Clifton, W. A.

Scarsdale—
Janes, A.

Schenectady—
Harbison, E. J.

Syracuse—
Acheson, A. R.
Bradley, R. H.
Driggs, L. L.

Tomkinsville—
Heap, W. E.

Troy—
Brown, S. J.
Wilson, C. H.

Utica—
Baxter, R. A.
Brandelles, H. J.
Cantwell, W. T.
Hamby, P. W.
Hughes, W. C.
Norris, E.
Norris, J. K.
Phlegley, F. G.
Rooney, M. A.
Schneider, P. W.
Steinhorst, T. F.

West Point—
Bryant, P. J.

Yonkers—
Kelly, J. G.

NORTH CAROLINA

Charlotte—
Christian, C. W.
Cuyler, D. H.
Hackney, H.

Greensboro—
Stark, I. S.

Raleigh—
Templin, C. L.

Winston-Salem—
Bahnsen, F. F.

NORTH DAKOTA

Fargo—
Kurke, W. F.

OHIO

Akron—
Humphrey, D. E.
Kammerer, W. C.
Standford, L. E.
Thatcher, G. S.

Cincinnati—
Bostain, J. C.
Doyle, W. J.
Green, W. C.
Grier, W.
Jordan, C. F.
Kiefer, C. J.
Schlemmer, O. H.
Stanwood, J. B.
Wright, K.

Cleveland—
Adrianse, P. R.
Anderson, E. L.
Bacon, J. H.
Barth, H. E.
Becker, A. L.
Beyer, J. E.
Bray, D. S.
Bridges, F. G.
Brueggeman, A. R.
Bushnell, T. H., Jr.
Clark, H. J.
Clark, R. L.
Clark, W. C.
Clark, W. C. M.
Colby, C. W.
Cowan, R. A.
Craighead, E. W.
Daugherty, F. M.
Davis, R. G.
Deex, C. J.
Empkey, G. J.
Farley, J. W.
Farnham, G. D.
Fisher, H. J.
Foote, J. E.
Friday, L. H.
Goins, E. M.
Gottwald, C.
Green, W. C.
Gros Claude, F. W.
Harrison, J. M.
Hautz, E. H.
Kinner, J. W.
Kissick, J. J.
Klie, W.
Leonard, F.
Mason, J. J.
Mayer, R. J.

Cleveland Heights—
Heinle, E. L.
Neitzel, C. W.

Columbus—
Babbitt, E. C.
Brown, A. I.
Erickson, H. A.
Mackensen, W. H.
Richards, F. A.
Wheeler, O. J.
Williams, A. W.
Wolfe, R.

Dayton—
Brusman, H. M.
Gibbons, M. J. Jr.
Haas, W.
Hoerstring, F. J.
Mead, W. R.

Lakewood—
Chapman, D. W.
Maurer, E. D.

Lorain—
Butler, T. F.
Lane, E. K.

Mansfield—
Joyce, H. B.
Tait, G. M.

Martins Ferry—
Michael, J. P.

Ravenna—
Franzheim, G. W.

Rocky River—
Alexander, C. M.

Sandusky—
Appell, A. O.

Toledo—
Baker, H. C.
Boeddner, G.
Bryce, J. W.
Bryce, S. D.
Gibbs, F. C.
Holmes, J.
Mullen, F. J.
Rogers, A. C.
Vantine, C. H.
Zimmer, G. J.

ROLL OF MEMBERSHIP

Warren—
Allen, L. E.
Moser, P. F.
Moulder, A. W.
Youngstown—
Choffin, C. C.

OKLAHOMA

Oklahoma City—
Butler, C.
Dolan, R. G.
Hunt, P. M.
Loeffler, F. X.

Muskogee—
Skinner, H. W.

Tulsa—
Jones, E.
OREGON
La Grande—
Anderson, S. A., Jr.
Portland—
McPhearson, C. J.

PENNSYLVANIA

Alleghany County—
Blackmore, G. C.
Allentown—
Buel, H. G.
Hersh, E. E.
Hersh, G. W.
Korn, C. B.
LeBeau, J. F.
Lutts, C. W.
Bala-Cynwyd—
Barr, G. W.
Berwyn—
Sewell, J. M.
Bridgeport—
Longnecker, H. J.
Brookline—
Pisel, J. W.
Chambersburg—
Mehaffey, W. C.
Chester—
Boyd, W. R.
Jones, I. R.
Cannonsburg—
Edwards, C. H.
Collegeville—
Miller, W. C.
Conshohocken—
Farnsworth, F. C.

Drexel Hill—Del. Co.
Jones, L. T.
Emaus—
Reese, H. L.
East Stroudsburg—
Thompson, A. W.

ERIE

Gannon, J. E.
Germantown—
Huckel, F., Jr.
Reeves, C. G.
Glenside—
Davis, B. H.
Harrisburg—
Eicher, H. C.
Geiger, I. H.
Koehler, G. T.
Kressly, M. E.
Miller, T. G.

INDIANA

Lumsden, E. R.
Johnstown—
Rinkenberger, G.
Kirklyn, Del. Co.—
Long, J. A.
Lancaster—
Grossman, H. M.
Holbrook, F. M.
Huzzard, E. C.
Vaux, F. J.
Lansdale—
Mott, A. C., Jr.
Mott, A. C., Sr.
McKeesport—
Barr, G. W.
Mt. Airy—
Gomersall, W. H.
New Brighton—
Van Allen, W. T.
Norristown—
Frost, R. V.
Gormly, J.
Gormly, P.

OHIO CITY

Heagerty, W. H.
Philadelphia—
Adams, B.
Anderson, C. A.
Arnold, R. S.
Bachler, H. C.
Bailey, E. G.
Bateman, W. H., Jr.
Beahm, R. B., 2nd
Black, E. N.
Black, H. G.
Bogaty, H. S.

Bolsinger, R. C.
Boon, G.
Borden, J. M.
Bornemann, W. A.
Boucher, M. F.
Boyd, D. K.
Breen, J. W.
Brogan, J. J.
Brogan, W. J.
Buck, M. S.
Burns, R. D.
Burt, J. E.
Carstens, E.
Cassell, J. D.
Caviler, J. V.
Clarkson, R. C., Jr.
Cooper, T. W.
Culbert, W. G.
Dambly, A. E.
Dealy, V. F.
Dodd, S. M.
Dome, W. R.
Doyle, C. J.
Dunlap, W. G.
Eagan, C. A.
Eckardt, C. A. T.
Edgar, A. C.
Feige, H. W.
Feltwell, R. H.
Fest, L. T.
Fleming, T. C.
Francis, I. H.
Francis, W. C.
Galligan, A. B.
Galligan, J. H.
Gant, H. P.
Gibson, J. H.
Gilbert, M. F.
Giles, E. H.
Glassey, J. W.
Gretzinger, F.
Grumbein, I. F.
Hackett, C. P.
Hackett, H. B.
Hale, J. F.
Hanson, H. A.
Haynes, C. V.
Hellerman, H. H.
Hering, J. B.
Hershey, J. C.
Hess, H. L.
Hetherington, E. T.
Hibbs, F. C.
Hoben, R. J.
Holloway, R. B.
Homann, F. A.
Hopkin, W. E.
Hopwood, A. M.
Houpt, G. A.
Howley, J. G., Jr.
Hucker, J. H.
Hughes, J. T.
Hunter, H. O.
Hurley, J. C.
Hutchison, J. E.
Hutchison, J. H.
Ickeringill, J.
Iddles, A.
Jellett, S. A.
John, B. F.
Jones, R. E.
Jones, W. R.
Kauffman, R.
Kauffmann, F. F.
Keating, D. J.
Kellogg, H. D.
Kipe, J. M.
Kline, G. W., Jr.
Knowlton, D. W.
Kriebel, A. E.
Levin, J.
Lewin, G. C.
Lewis, T.
Liner, J. J.
Locke, H. W.
Long, J.

Lord, F. R.
Loughery, G. B.
Lunn, W. R.
Lyman, S. E.
McCarthy, C. J.
McClintock, A., Sr.
McClintock, A., Jr.
McClintock, J. L.
McCormick, E. T.
McElwee, H. J., Jr.
McGowan, T. F.
MacDade, A. H.
Mappett, A. S.
Marine, J. D.
Mellon, J. T. J.
Mensing, F. D.
Mervine, T. R.
Minnich, H. S.
Monday, C. E.
Moody, L. E.
Morgan, R. C.
Murphy, E. T.
Murphy, W. R.
Myers, G. W. F.
Nelson, F. Jr.
Nesdahl, E.
Nunon, J. F.
Nusbaum, L.
Officer, H. S.
Ogelsby, W. P.
Paine, L. G.
Patterson, D. F.
Pease, H. H.
Perkins, F. C.
Phillips, F. T.
Plewes, S. E.
Porter, B. A.
Reuss, E. H., Jr.
Rice, E. T.
Rice, W. W.
Roberts, H. L.
Rothrock, J. T.
Sabin, E. R.
Sanbern, E. N.
Sanville, C. P.
Scanlon, J. A.
Schopp, W. J.
Setzer, W. C.
Shaw, C. E.
Sheffer, M.
Smith, L. F.
Sommer, L. J., Jr.
Sparks, F. B.
Speckman, C. H.
Stewart, C. W.
Stone, G. F.
Stroh, W. H.
Strong, R. C.
Sutterley, W. W.
Taliaferro, R. R.
Thompson, J.
Thompson, W. P.
Timm, W. H.
Tinker, W. E.
Walther, O. N.
Wegmann, A.
Welamb, V. N.
Why, H. B.
Wild, W. H.
Wilson, B. W.
Wilson, J. J.
Woolston, A. H.
Woolston, C. E.
Young, R. L.

PITTSBURGH

Anderson, F. P.
Arthur, H. W.
Aston, J.
Brooks, H. W.
Burns, J. J.
Bushnell, C. D.
Clark, F. C.

AMERICAN SOCIETY of HEATING and VENTILATING ENGINEERS GUIDE, 1924-25

Clark, W. H.
Dibble, S. E.
Digby, H. E.
Downes, H. H.
Easter, T. J.
Ebin, L.
Edwards, P. A.
Evans, E. C.
Ewing, I. C.
Firsching, F. J.
Geisler, F. E.
Hanson, E. W.
Heilman, R. H.
Hobbs, J. C.
Hook, C. H.
Ingels, M.
Jones, A. M.
King, T.
Langdon, J. D.
McCune, L. V.
McGuinness, J. E.
McGuigan, L. A.
McIntosh, F. C.
McMurray, J.
Magner, F. A.
Mansfield, F. A.
Moore, H. L.
Morgan, J. S.
Morrow, C. E.
Murray, J. M.
Nash, A. W.
Nichols, P.
O'Neill, P.
Phillips, L.
Rederer, B. S.
Richards, S. F.
Schley, A. A.
Schrader, C. C.
Speller, F. N.
Stanger, R. B.
Stephens, E. J.
Stitt, E. W.
Stokes, R. E.
Taylor, T. S.
Tenkonohy, R. J.
Todd, J.
Walker, J. B.
Weber, G. A.
Wheeler, C. W.
Yagloglou, C. P.

READING

Collins, H. F.
Luck, A. W.

RIDLEY PARK

Bartlett, C. E.

ROXBOROUGH

Blankin, M. F.

RUTLEDGE

Clarke, H. W.
Doud, M. P.

SCOTTSDALE

Hartman, F. E.

SEWICKLEY

Black, G. E.

SHAMOKIN

Gortner, J. W.

SWISSVALE

Timmerman, M. M.

TAMAQUA

Hadesty, A. L., Jr.

UPPER DARBY, P. O.

Hoesington, N. P.

WARREN

Schellhammer, A. L.

WASHINGTON

McVehil, E. W.

WEST CHESTER

Palmer, G. J.

WILKES BARRE

Carpenter, B. H.

WILLIAMSPORT

Chambers, W. E.
Corbett, M. C.
Dennis, C. K.
Gillett, M. C.
McLain, R. D.

WISSAHICKON

Peterman, R. M.

YORK

Lindemuth, N. R.
Sowers, P. E.

RHODE ISLAND

Providence—
Braemer, W. G. R.
Chase, J. D.
Coleman, J. B.
Schley, A. A.
Schrader, C. C.
Speller, F. N.
Stanger, R. B.
Stephens, E. J.
Stitt, E. W.
Stokes, R. E.
Taylor, T. S.
Tenkonohy, R. J.
Todd, J.
Walker, J. B.
Weber, G. A.
Wheeler, C. W.
Yagloglou, C. P.

CHATTANOOGA

Russell, H. C.
Sears, W. H.

KNORVILLE

Reeder, F. C.

MEMPHIS

Allen, W. H.
LaBundy, B. A.
Sodermann, P.

TEXAS

Austin—
Donnelly, J. R.

DALLAS

Stains, W. A.
Taylor, R. F.
Van Zandt, J. H.
Wiggins, C. H.

EL PASO

Finan, J. J.

FORT WORTH

Burnett, E. S.

HOUSTON

Barnes, A. F.

SAN ANGELO

Hogue, C. T.

SAN ANTONIO

Ebert, W. A.

WICHITA FALLS

Herd, C. C.

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.
Johnston, J. A.
Koch, H. O.
Menefee, J. I.
Schulz, H. I.

ROANOKE

Wash, W. P.

STAUNTON

Moffett, W. S.
Moran, F. N.

WASHINGTON

Bremerton—
Bysom, L. L.

SEATTLE

Ayers, A. E.
Carsten, W. H.
Cox, W. W.
Dudley, W. L.
Eastwood, Prof. E. O.
Eckart, C. H.
Godfrey, F. H.
Hill, W. A.
Lavan, P. J.
McNeal, W. R.
Mallis, W.
Moore, J. C.
Nevins, J. R.
O'Connell, F. M.
Ruddell, W. H.
Santrayer, W. J.
Stark, E. A.
Twist, C. F.
Weber, E. G. L.
Zokelt, C. G.

SPokane

DeLong, H. B.
Nelson, R. L.

YAKIMA

Huntley, F. A.

WEST VIRGINIA

Charleston—
Matthews, J. K.
Shanklin, J. R.

MORGENTHAU

Zeck, A.

WHEELING

Hare, E. S.
Seabright, L. C.

WISCONSIN

Eau Claire—
Grosbold, F. E.

FOND DU LAC

Ahern, T. L.

FORT ATKINSON

Shodron, J. G.

GREEN BAY

Kingsbury, J. W.

LA CROSSE

Anderegg, R. H.
Davidson, H. M.
Johnson, T. R.
Trane, R. N.

MADISON

Larson, G. L.

MILWAUKEE

Bassler, E. M.
Bowers, A. F.
Cook, H. R.
Downey, F. E.
Ellis, H. W.
Grassler, E.
Guntton, W.
Jackson, C. H.
Jung, J. S.
Juttner, O. J.
Lomasney, E. J.
Meadows, F. H.
Meyer, E. A.
Miller, C. W.
Miller, H. M.
Mueller, P. E.
Noll, W. F.
Olson, R. G.
Ostrander, L. F.
Rice, C. J.
Schwab, H. E.
Volk, J. H.
Welmer, F. G.
Wilson, W. H.
Wolf, J. C.
Worthing, E.
Zuehlke, R.

STURTEVANT

Page, H. W.

SUPERIOR

Jarvis, G. E.

WAUSAU

Cornwell, F. E.
Holmskog, O. S.
Sargent, L. F.

WYOMING

Cheyenne—
Meyring, A. S.

ROLL OF MEMBERSHIP

FOREIGN COUNTRIES

CANADA

Calgary, Alberta—
Clarke, S. S.

Galt, Ont.—

Evans, J.
McCahey, H. G.

Hallfax, N. S.—

Eagar, R. F.
Gray, G. A.
Harrington, C.

Hamilton, Ont.—

Henion, H. D.

Kingston, Ont.—

Arkley, L. M.
Druce, J. J.

Montreal, Que.—

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.
Tucker, E. J.
Wiggs, G. L.

Toronto, Ont.—

Addy, E.
Angus, H. H.
Baldwin, W. H.
Blackhall, W. R.
Carruthers, K. L.
Church, H. J.
Clifton, W. F.
Dickey, A. J.
Doughty, C. J.
Duncan, G. M.
Duncan, J. M.
Ellis, F. E.
Flett, H. R.
Griffith, M. R.
Hopper, G. H.
Jennings, S. A.
Kinsey, A. J.
Laidlaw, E. J.

Leitch, A. S.

McCreery, H. J.
McHenry, R. W. M.
Mansell, P. C.
Owens, C. B.

Paterson, J. S.

Peterkin, S. M.
Playfair, G. A.
Purdy, A. K.

Shears, M. W.

Sheffield, E. B.

Sheppard, W. G.

Smith, P. J.

Sparling, C. M.

Thomas, M. F.

Worthington, T.

Vancouver, B. C.—

Leek, W.

Stephen, A. M.

Windsor, Ont.—

Bowden, F.

Winnipeg—

Fulton, W. J.

Mackie, J.

Kirk, C. D.

CHINA

Peking—

Hopkins, R. D.

Shanghai—

Alt, H. L.
Cooper, T. R.
Cowell, R. J.
Hauss, C. F.

Tientsin—

Baker, H. W. H.

DENMARK

Copenhagen—

Berggreen, P. H.
Reck, A. B.

ENGLAND

Hull—

Hill, E. G. T.

Leeds—

Jennins, H. H.

Leicester—

Nesbit, D. M.

Liverpool—

Honiball, C. R.

London—

Barker, A. H.

Craig, F. B.

Groom, S. L.

Herring, E.

Jennings, F. W.

Nobbs, W. W.

Pickup, H.

Robinson, S. W.

Russell, J. N.

Wheeler, K. E.

Manchester—

Row, O. M.

Vates, W.

Sheffield—

Biggin, F.

Southport—

Atkinson, R. E.

Sunderland—

Vaux, N.

Trowbridge—

Haden, G. N.

Haden, W. N.

York—

Fryer, F. G.

FRANCE

Paris—

Beaurienne, A.
Downe, H. S.

GERMANY

Stuttgart—

Klein, A. R.

IRELAND

Cork—

Barry, P. I.

JAPAN

Tokyo—

Kitaura, S.

Sekido, K.

Shozo, S.

NEW ZEALAND

Dunedin—

Davies, G. W.

NORWAY

Christiania—

Tjersland, A.

RUSSIA

Petrograd—

Sakouta, M. L.

SWEDEN

Stockholm—

Theorell, H. G. T.

SWITZERLAND

Winterthur—

Meier, K.

TURKEY

Constantinople—

Scipio, L. A.

PAST OFFICERS

AMERICAN SOCIETY of HEATING and VENTILATING ENGINEERS

1894

President..... Edward P. Bates
1st Vice-President..... Wm. M. Mackay
2nd Vice-President..... Wilsie F. Wolfe
3rd Vice-President..... Chas. S. Onderdonk
Treasurer..... Judson A. Goodrich
Secretary..... L. H. Hart

Board of Managers

Chairman, Fred P. Smith
Henry Adams..... A. A. Cary
Hugh J. Barron..... James A. Harding
Edward P. Bates, Pres. L. H. Hart, Secy.

Council

Chairman, R. C. Carpenter
Albert A. Cryer..... Chas. W. Newton
F. W. Foster..... Ulysses G. Scollay, Secy.

1895

President..... Stewart A. Jellett
1st Vice-President..... Wm. M. Mackay
2nd Vice-President..... Chas. S. Onderdonk
3rd Vice-President..... D. M. Quay
Treasurer..... Judson A. Goodrich
Secretary..... L. H. Hart

Board of Managers

Chairman, James A. Harding
Geo. B. Cobb..... Ulysses G. Scollay
Wm. McMannis..... B. F. Stangland
Stewart A. Jellett, Pres. L. H. Hart, Secy.

Council

Chairman, R. C. Carpenter
Henry Adams..... T. J. Waters
Edward P. Bates..... Albert A. Cryer, Secy.

1896

President..... R. C. Carpenter
1st Vice-President..... D. M. Quay
2nd Vice-President..... Edward P. Bates
3rd Vice-President..... F. W. Foster
Treasurer..... Judson A. Goodrich
Secretary..... L. H. Hart

Board of Managers

Chairman, Wm. M. Mackay
Hugh J. Barron..... Stewart A. Jellett
W. S. Hadaway, Jr. Wilsie F. Wolfe
R. C. Carpenter, Pres. L. H. Hart, Secy.

Council

Chairman, A. A. Cary
Albert A. Cryer..... B. F. Stangland
Wm. McMannis..... J. J. Blackmore, Secy.

1897

President..... Wm. M. Mackay
1st Vice-President..... H. D. Crane
2nd Vice-President..... Henry Adams
3rd Vice-President..... A. E. Kenrick
Treasurer..... Judson A. Goodrich
Secretary..... H. M. Swetland

Board of Managers

Chairman, R. C. Carpenter
Edward P. Bates..... Stewart A. Jellett
W. S. Hadaway, Jr. Wilsie F. Wolfe
Wm. M. Mackay, Pres. H. M. Swetland, Secy.

Council

Chairman, Albert A. Cryer
John A. Fish..... James Mackay
Wm. McMannis..... B. F. Stangland

1898

President..... Wilsie F. Wolfe
1st Vice-President..... J. H. Kinealy
2nd Vice-President..... A. E. Kenrick
3rd Vice-President..... John A. Fish
Treasurer..... Judson A. Goodrich
Secretary..... Stewart A. Jellett

Board of Managers

Chairman, Wm. M. Mackay
Thomas Barwick..... A. C. Mott
John A. Connolly..... Francis A. Williams
Wilsie F. Wolfe, Pres. Stewart A. Jellett, Secy.

Council

Chairman, R. C. Carpenter
Henry Adams..... W. S. Hadaway, Jr.
Albert A. Cryer..... Wm. McMannis
Wilsie F. Wolfe, Pres. Stewart A. Jellett, Secy.

1899

President..... Henry Adams
1st Vice-President..... D. M. Quay
2nd Vice-President..... A. E. Kenrick
3rd Vice-President..... Francis A. Williams
Treasurer..... Judson A. Goodrich
Secretary..... Wm. M. Mackay

Board of Managers

Chairman, Stewart A. Jellett
B. H. Carpenter..... Wm. Kent
A. A. Cary..... Wilsie F. Wolfe
Henry Adams, Pres. Wm. M. Mackay, Secy.

Council

Chairman, R. C. Carpenter
John Gormly..... Wm. McMannis
W. S. Hadaway, Jr. B. F. Stangland
Henry Adams, Pres. Wm. M. Mackay, Secy.

ROLL OF MEMBERSHIP

1900
President.....D. M. Quay
1st Vice-President.....A. E. Kenrick
2nd Vice-President.....Francis A. Williams
Treasurer.....Judson A. Goodrich
Secretary.....Wm. M. Mackay

Board of Governors
Chairman, D. M. Quay
Vice-Chm., C. B. J. Snyder
R. C. Carpenter D. M. Nesbit
John Gormly Wm. M. Mackay, *Secy.*

1901
President.....J. H. Kinealy
1st Vice-President.....A. E. Kenrick
2nd Vice-President.....Andrew Harvey
Treasurer.....Judson A. Goodrich
Secretary.....Wm. M. Mackay

Board of Governors
Chairman, J. H. Kinealy
Wm. Kent, *Vice-Chm.* John Gormly
R. C. Carpenter C. B. J. Snyder
R. P. Bolton Wm. M. Mackay, *Secy.*

1902
President.....A. E. Kenrick
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. Mehrling
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
James Mackay
R. P. Bolton B. F. Stangland
C. B. J. Snyder J. C. F. Trachsel
B. H. Carpenter Wm. M. Mackay, *Secy.*
A. B. Franklin

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.*

AMERICAN SOCIETY OF HEATING and VENTILATING ENGINEERS GUIDE, 1924-25

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.*

1916
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.

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.

