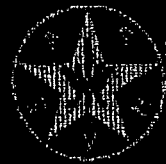


HEATING AND VENTILATING GUIDE



1923

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VOL 2 1923



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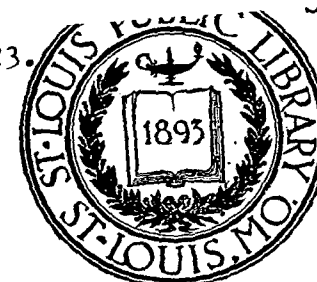


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Code of Ethics for Engineers

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

1923

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. 2

\$3.00 PER VOLUME

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AMERICAN SOCIETY OF HEATING AND VENTILATING
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AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

PREFACE

SEVERAL changes in the arrangement and style of this, the second annual edition of THE GUIDE, have been made in order to improve its service to its users in the Heating and Ventilating Industry. As in the case of the First Edition issued in 1922 the new GUIDE will provide the Engineer, Architect and Contractor with useful and reliable reference data on modern heating and ventilating practice and equipment. An additional service is given this year as the text section has been completely revised and renewed, including the latest design data available to guide the Engineer Architect and Contractor in producing the most effective installations for Heating and Ventilating various kinds of buildings. Each step in the procedure is logically taken up from the consideration of the required system, the figuring of heat losses, choice of proper equipment for heating by steam, hot water or warm-air, 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 affords an accurate Index of the Modern Equipment available. As in the case of the First Edition all Catalog Data have been carefully edited in an effort to eliminate exaggerated statements or claims for, it is believed that data of this character is of greatest interest and of most value to the 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.

It has been the endeavor of Guide Publications Committee to materially improve this Second Edition of THE GUIDE from the suggestions of its Users, for it is believed that this enthusiastic cooperation from the Profession at large will result in making THE GUIDE the standard reference work in our field, thereby performing a needed and valuable service in the advancement of the Art, both as to Engineering and Equipment.

The AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS having for its purposes 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 Publication Committee releases THE GUIDE 1923 with the sincere hope that it will render a real service and take its place as a useful and worthy Reference Book on modern Heating and Ventilating Practice and Equipment.

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AMERICAN SOCIETY of HEATING AND VENTILATING ENGINEERS GUIDE

1923

HEATING

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 steam 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 (See Model Ordinance for Construction of Chimneys, (A. S. H. & V. E. JOURNAL, Dec., 1921, also GUIDE, 1922 p. 35), 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 (See paper, Heating the Home Economically, A. S. H. & V. E. JOURNAL, January, 1922, p. 21).

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 according to the A. S. H. & V. E. Code for Testing Low Pressure Heating Boilers (See TRANSACTIONS, Vol. 25, p. 143 also GUIDE, 1922, p. 27); *second*, for the proper performance of the boiler when operated under standard code 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. (See Boiler Rated Capacity, p. 43 and 48).

Material for this section on Heating also the sections on Heat Losses From Buildings, Steam Heating, Pipe Sizes for Steam Heating, and The Boiler, were especially prepared for THE GUIDE 1923 by P. J. Dougherty, Utica, N. Y., who hereby acknowledges the many valuable suggestions made by W. L. Durand, New York, W. H. Driscoll, New York, and C. V. Haynes, Philadelphia, Pa.



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 is like a chain that is no stronger than its weakest link.

STRIKING A HEAT BALANCE

The engineer in designing a heating system must strike a balance between the output or heat loss from the building and the input of heat from the system and boiler principally. The output falls under three classifications; infiltration, transmission, and line losses. The proper input depends upon the proper size and type of radiators, the proper design and sizes of piping and valves, and the proper capacity and type of boiler installed. The correct balance of these six major factors means a properly installed heating system, and with proper and intelligent operating conditions will give efficient performance.

The total heat the heating apparatus must furnish, includes the total heat loss plus a heating-up-factor.

The heating-up-factor is determined by the rate at which initial heat is required to raise the temperature of the cold building and its contents to a desired degree in a given time.

For actual practice the heating-up-factor can be 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, depends on its construction, exposure, number and type of windows, doors, etc.

Air changes for average conditions, without providing for ventilation, can be figured as follows:

Rooms, 1 side exposed	=1	Air change	per hr.
" 2 " "	=1½	"	" "
" 3 " "	=2	"	" "
" 4 " "	=2	"	" "
Entrance halls	=2 to 3	"	" "
Reception halls	=2	"	" "
Living rooms	=1 to 2	"	" "
Dining rooms	=1 to 2	"	" "
Bath rooms	=2	"	" "
Drug stores	=2 to 3	"	" "
Clothing stores	=1	"	" "
Churches	-	"	" "
Factories	=1 to 3	"	" "
Lofts, etc.		"	" "

To heat 1 cu. ft. of air 1 deg. Fahr. requires 0.02 B.t.u., then the cubic contents of a room times the number of air changes times 0.02 times the difference in temperature between the outside and inside (for which the system is designed), will give the number of B.t.u. required for heating up and infiltration. This added to the transmission losses gives the total B.t.u. required for heating.

HEAT LOSSES FROM BUILDINGS

INFILTRATION

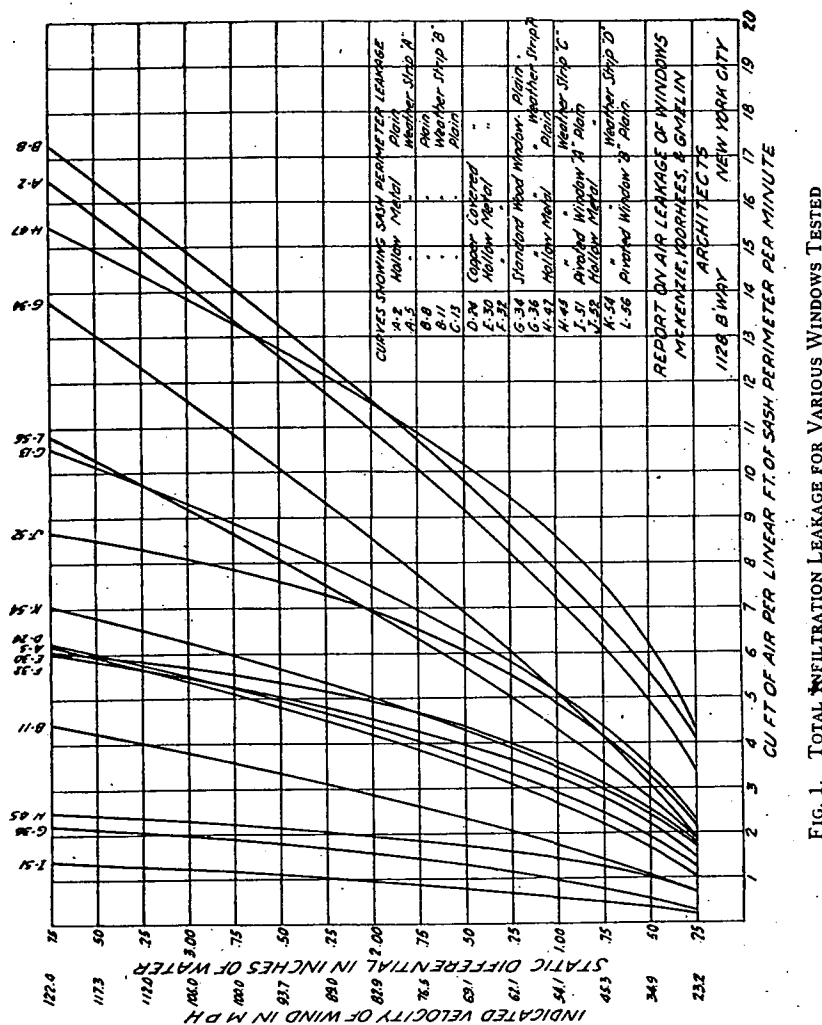
INFILTRATION losses are due to the leakage of cold air into and warm air out of the building. Those losses are figured either on a basis of the number of air changes per hour or on a basis of window leakage (Table 1). The infiltration losses depend upon the nature and tightness of the building construction, the lineal feet of window and door cracks, the amount of air admitted for ventilation, the presence of open fireplaces, and vent registers, and the air admitted by opening and closing of doors and other openings.

Infiltration losses can be materially reduced by the use of storm doors and windows, metal weather strips on doors and windows, by calking around door and window casings, and in frame construction by close fitting tongue and groove siding covered with heavy building paper, and by the use of plaster board in place of lath. The infiltration loss through brick walls is usually high, while that through hollow tile walls is very high due to the many chipped openings and the thin plaster bearing points where the ends of tile abut. Besides the wind factor in transmission, the high infiltration loss in windy weather is the reason, according to Whitten and March, (See A. S. H. & V. E. TRANSACTIONS, Vol. 22, p. 195), that it is as difficult to heat a room at 20 deg. above zero with a 35-mile wind blowing, as it would be to heat the same room at 20 deg. below zero with no wind blowing. Strong winds very seldom prevail at temperatures below 15 deg. above zero. The drop in temperature for each mile wind velocity is given in Table 11 and it can readily be seen that this matter of wind velocity must receive careful consideration in planning and designing a house heating plant that will render efficient service in all weather conditions.

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. (GUIDE, 1922, p. 166), 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. Therefore, in order to obtain the heat loss due to infiltration multiply together these four factors; (1) contents of room in cubic feet



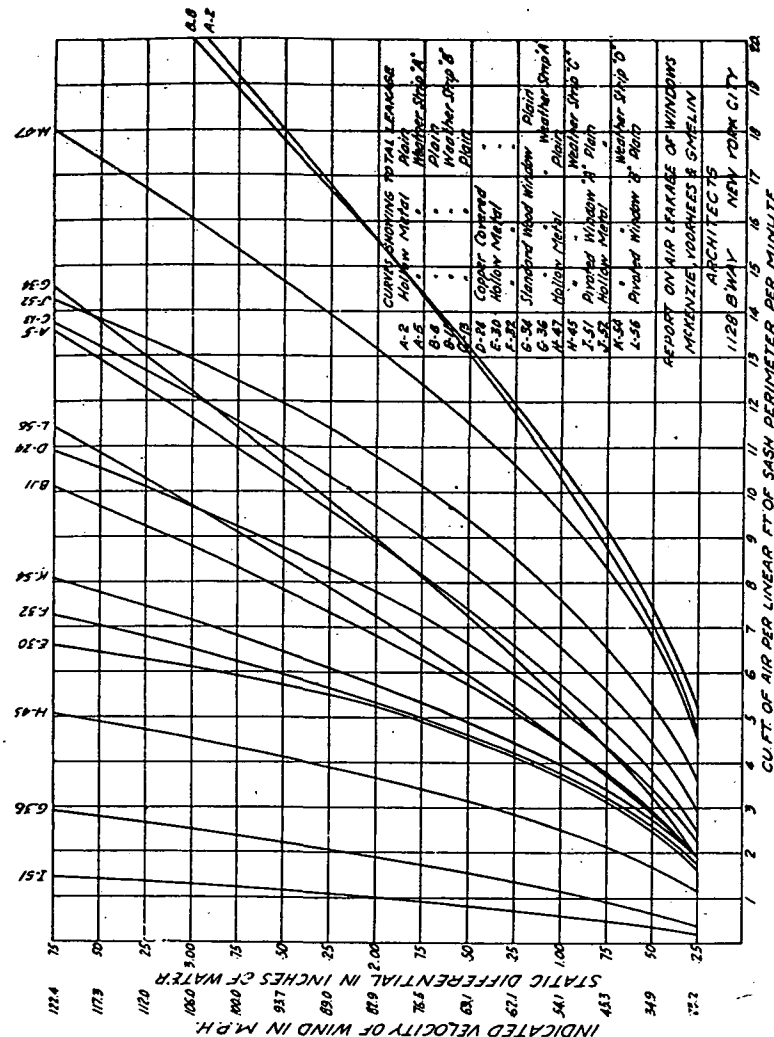
times (2) number of air changes per hour times (3) the difference in temperature between the inside and outside times (4) 0.02 heat units.

Example.—What is the heat loss through infiltration from a living room containing 2,000 cu. ft. of space to be heated to 70 deg. in zero weather and figuring two air changes per hour?

$$2000 \times 2 \times 70 \times 0.02 = 5,600 \text{ heat units.}$$



Instead of using a certain number of air changes as a basis for estimating infiltration losses many engineers use the lineal feet of window and outside of door cracks. Where the glass and door area is small in



proportion to the cubical contents the loss should be checked with the air change method, so that a minimum equivalent to one air change is allowed. This is necessary in order that sufficient heat will be available



to bring the room quickly up to temperature after it has been cooled down.

TABLE 1. APPROXIMATE HEAT LOSS THROUGH WINDOWS BY INFILTRATION.*

CONSTRUCTION	B.t.u. Per Hr. Per Ft. of Crack
Poor ($\frac{1}{8}$ in. Sash Clearance).....	2.4
Good ($\frac{1}{32}$ in. Sash Clearance).....	1.2
Weather Stripped Sash.....	0.6

* (See Paper by Stephen F. Voorhees and Henry C. Meyers, Jr., in TRANSACTIONS, Vol. 22, p. 183).

Due to the fact the leakage of cold air inward occurs on the windward side of the building or room, and the warm air leaks out on the leeward side, figure only the total lineal feet of sash and door crack existing in the one outside wall having the maximum glass and door area and not the total lineal feet of crack in the room.

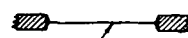
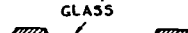
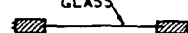
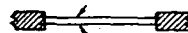
By this method the loss of good construction due to infiltration will be for 70 deg. inside and 0 deg. outside, the product of (1) the number of lineal feet of crack, times (2) the temperature difference or 70, times (3) the heat loss per foot per degree difference or 1.2 heat units which for two 3 x 6 ft. windows equals:— $42 \times 70 \times 1.2 = 3528$ heat units.

The crackage in each window is $(3 \times 3) + (2 \times 6)$ or 21 ft., or for the two windows, 42 ft. If the construction of those two windows was poor (as is frequently the case), the crack area per foot of crack would be at least equal to $12 \times \frac{1}{8}$, or $\frac{3}{4}$ sq. in. and for 42 ft. of crack, the total crack area equals $42 \times \frac{3}{4}$ or 32 sq. in., the equivalent in area of a hole 4 in. x 8 in. The value of metal weather strips and storm windows is quite evident in stopping the equivalent of such a large opening in two standard windows.

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.

TABLE 2. HEAT TRANSMISSION FROM WINDOWS, ROOF GLASS AND SKYLIGHTS

	1.10 B.t.u.
	0.60 "
	1.10 "
	0.60 "
	1.10 "
	0.60 "
	0.60 "



The accompanying heat transmission tables are for average conditions of construction and the rate of transmission for any material is given in 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 & VENTILATING ENGINEERS are making heat transmission tests of different material and when results are published, all heat transmission tables may be revised.

TABLE 3. HEAT TRANSMISSION FROM FLOORS

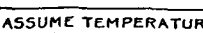
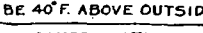
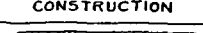
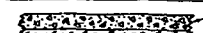
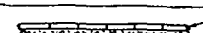
CONSTRUCTION	B.T.U.
 4" CONCRETE GROUND	.31
 4" CONCRETE CINDER FILL GROUND	.29
 1" TILE 4" CONCRETE GROUND	.30
 2 1/2" BRICK 4" CONCRETE GROUND	.29
 1 1/2" WOOD FLOOR WATERPROOFING 3" CONCRETE GROUND	.10
 1 1/2" WOOD FLOOR 3" CONCRETE CINDER FILL SLEEPERS GROUND	.07
 1 1/2" WOOD FLOOR 5" CINDER FILL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

TABLE 4. HEAT TRANSMISSION FROM CEILINGS

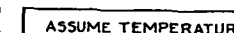
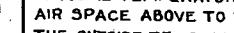
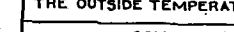
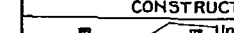
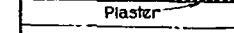
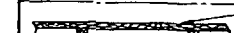
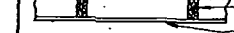
CONSTRUCTION	B.T.U.
 Unheated Space Joists Lath Plaster	.60
 Floor Joists Lath Plaster	.26
 Floor Joists Metal Ceiling	.36
 1" Floor Joists	.40
 Floor Paper Floor Joists	.21
 Floor 4" Reinforced Concrete	.41
 4" Reinforced Concrete	1.00
 6" Reinforced Concrete	.86
 8" Reinforced Concrete	.41
 10" Reinforced Concrete	.36

TABLE 5. 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 6. 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 7. HEAT TRANSMISSION FROM WOOD DOORS AND WOOD PARTITIONS

¾" to 1" Thick Tongued and Grooved = 0.65 B.t.u.	
1" " 1½" " " " " " = 0.60 "	
1½" " 1½" " " " " " = 0.50 "	
1½" " 2" " " " " " = 0.42 "	
2" " 2½" " " " " " = 0.35 "	
2½" " 3" " " " " " = 0.30 "	

TABLE 8. HEAT TRANSMISSION FROM WALLS OF VARIOUS CONSTRUCTIONS

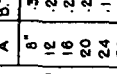
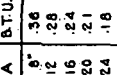
THICKNESS OF BOARD IN IN.	TWO BOARDS WITH PAPER BETWEEN	BOARD AND CORRUGATED IRON	BOARD AND SHEET IRON
½"	0.32 B.t.u.	0.45 B.t.u.	0.50 B.t.u.
1"	0.24 "	0.36 "	0.40 "
1½"	0.19 "	0.30 "	0.33 "
2"	0.16 "	0.26 "	0.28 "
2½"	0.14 "	0.23 "	0.25 "

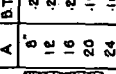
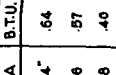
TABLE 9. HEAT TRANSMISSION FROM WALLS OF CLAPBOARD

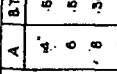
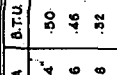
CONSTRUCTION	B.t.u.
Clapboard on Studs.....	0.62
Clapboard on Studs, Lath and Plaster.....	0.48
Clapboard, Paper, Studs, Lath and Plaster.....	0.34
Clapboard, Studs, 1" Sheathing.....	0.57
Clapboard, Sheathing, Studs, Lath and Plaster.....	0.37
Clapboard, Paper, Sheathing, Studs, Lath and Plaster.....	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

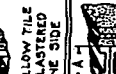
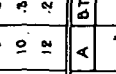
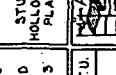
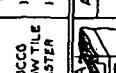
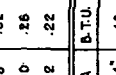


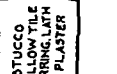
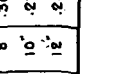
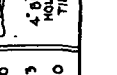
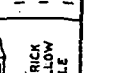
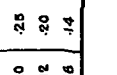
TABLE 10. HEAT TRANSMISSION FROM VARIOUS TYPES OF WALL CONSTRUCTION

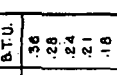
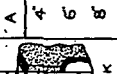
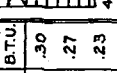
				
A	A	A	A	A
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36	36	36	36	36
28	28	28	28	28
24	24	24	24	24
20	20	20	20	20
16	16	16	16	16
12	12	12	12	12
8"	8"	8"	8"	8"
4"	4"	4"	4"	4"
.28	.28	.28	.28	.28
.24	.24	.24	.24	.24
.21	.21	.21	.21	.21
.19	.19	.19	.19	.19
.16	.16	.16	.16	.16
.15	.15	.15	.15	.15
.13	.13	.13	.13	.13
.14	.14	.14	.14	.14
PLAIN BRICK	PLAIN BRICK	PLAIN BRICK	PLAIN BRICK	PLAIN BRICK

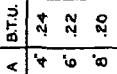
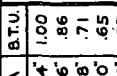
				
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28	28	28	28	28
24	24	24	24	24
20	20	20	20	20
16	16	16	16	16
12	12	12	12	12
8"	8"	8"	8"	8"
4"	4"	4"	4"	4"
.28	.28	.28	.28	.28
.24	.24	.24	.24	.24
.21	.21	.21	.21	.21
.19	.19	.19	.19	.19
.16	.16	.16	.16	.16
.15	.15	.15	.15	.15
.13	.13	.13	.13	.13
.14	.14	.14	.14	.14
BRICK FURRED LATHED & PLASTERED	BRICK FURRED LATHED & PLASTERED	BRICK FURRED LATHED & PLASTERED	BRICK FURRED LATHED & PLASTERED	BRICK FURRED LATHED & PLASTERED

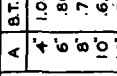
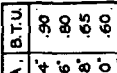
				
A	A	A	A	A
8"	8"	8"	8"	8"
36	36	36	36	36
28	28	28	28	28
24	24	24	24	24
20	20	20	20	20
16	16	16	16	16
12	12	12	12	12
8"	8"	8"	8"	8"
4"	4"	4"	4"	4"
.28	.28	.28	.28	.28
.24	.24	.24	.24	.24
.21	.21	.21	.21	.21
.19	.19	.19	.19	.19
.16	.16	.16	.16	.16
.15	.15	.15	.15	.15
.13	.13	.13	.13	.13
.14	.14	.14	.14	.14
BRICK FURRED LATHED & PLASTERED	BRICK FURRED LATHED & PLASTERED	BRICK FURRED LATHED & PLASTERED	BRICK FURRED LATHED & PLASTERED	BRICK FURRED LATHED & PLASTERED

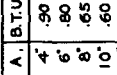
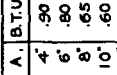
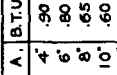
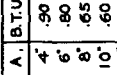
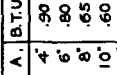
				
A	A	A	A	A
8"	8"	8"	8"	8"
36	36	36	36	36
28	28	28	28	28
24	24	24	24	24
20	20	20	20	20
16	16	16	16	16
12	12	12	12	12
8"	8"	8"	8"	8"
4"	4"	4"	4"	4"
.28	.28	.28	.28	.28
.24	.24	.24	.24	.24
.21	.21	.21	.21	.21
.19	.19	.19	.19	.19
.16	.16	.16	.16	.16
.15	.15	.15	.15	.15
.13	.13	.13	.13	.13
.14	.14	.14	.14	.14
BRICK FURRED LATHED & PLASTERED	BRICK FURRED LATHED & PLASTERED	BRICK FURRED LATHED & PLASTERED	BRICK FURRED LATHED & PLASTERED	BRICK FURRED LATHED & PLASTERED

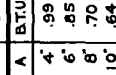
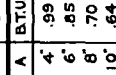
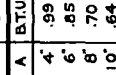
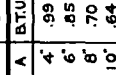
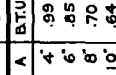
				
A	A	A	A	A
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28	28	28	28	28
24	24	24	24	24
20	20	20	20	20
16	16	16	16	16
12	12	12	12	12
8"	8"	8"	8"	8"
4"	4"	4"	4"	4"
.28	.28	.28	.28	.28
.24	.24	.24	.24	.24
.21	.21	.21	.21	.21
.19	.19	.19	.19	.19
.16	.16	.16	.16	.16
.15	.15	.15	.15	.15
.13	.13	.13	.13	.13
.14	.14	.14	.14	.14
BRICK FURRED LATHED & PLASTERED	BRICK FURRED LATHED & PLASTERED	BRICK FURRED LATHED & PLASTERED	BRICK FURRED LATHED & PLASTERED	BRICK FURRED LATHED & PLASTERED

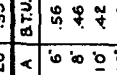
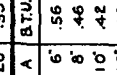
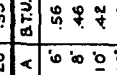
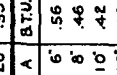
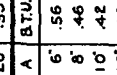
				
A	A	A	A	A
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24	24	24	24	24
20	20	20	20	20
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8"	8"	8"	8"	8"
4"	4"	4"	4"	4"
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.24	.24	.24	.24	.24
.21	.21	.21	.21	.21
.19	.19	.19	.19	.19
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PLAIN BRICK	PLAIN BRICK	PLAIN BRICK	PLAIN BRICK	PLAIN BRICK

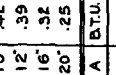
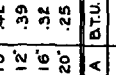
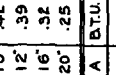
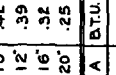
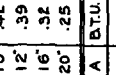
				
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20	20	20	20	20
16	16	16	16	16
12	12	12	12	12
8"	8"	8"	8"	8"
4"	4"	4"	4"	4"
.28	.28	.28	.28	.28
.24	.24	.24	.24	.24
.21	.21	.21	.21	.21
.19	.19	.19	.19	.19
.16	.16	.16	.16	.16
.15	.15	.15	.15	.15
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.14	.14	.14	.14	.14
PLAIN BRICK	PLAIN BRICK	PLAIN BRICK	PLAIN BRICK	PLAIN BRICK

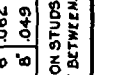
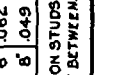
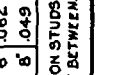
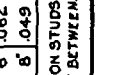
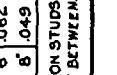
				
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24	24	24	24	24
20	20	20	20	20
16	16	16	16	16
12	12	12	12	12
8"	8"	8"	8"	8"
4"	4"	4"	4"	4"
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.24	.24	.24	.24	.24
.21	.21	.21	.21	.21
.19	.19	.19	.19	.19
.16	.16	.16	.16	.16
.15	.15	.15	.15	.15
.13	.13	.13	.13	.13
.14	.14	.14	.14	.14
PLAIN BRICK	PLAIN BRICK	PLAIN BRICK	PLAIN BRICK	PLAIN BRICK

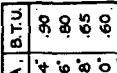
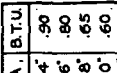
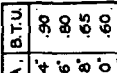
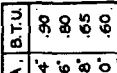
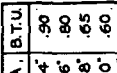
				
A	A	A	A	A
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36	36	36	36	36
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24	24	24	24	24
20	20	20	20	20
16	16	16	16	16
12	12	12	12	12
8"	8"	8"	8"	8"
4"	4"	4"	4"	4"
.28	.28	.28	.28	.28
.24	.24	.24	.24	.24
.21	.21	.21	.21	.21
.19	.19	.19	.19	.19
.16	.16	.16	.16	.16
.15	.15	.15	.15	.15
.13	.13	.13	.13	.13
.14	.14	.14	.14	.14
PLAIN BRICK	PLAIN BRICK	PLAIN BRICK	PLAIN BRICK	PLAIN BRICK

				
A	A	A	A	A
8"	8"	8"	8"	8"
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28	28	28	28	28
24	24	24	24	24
20	20	20	20	20
16	16	16	16	16
12	12	12	12	12
8"	8"	8"	8"	8"
4"	4"	4"	4"	4"
.28	.28	.28	.28	.28
.24	.24	.24	.24	.24
.21	.21	.21	.21	.21
.19	.19	.19	.19	.19
.16	.16	.16	.16	.16
.15	.15	.15	.15	.15
.13	.13	.13	.13	.13
.14	.14	.14	.14	.14
PLAIN BRICK	PLAIN BRICK	PLAIN BRICK	PLAIN BRICK	PLAIN BRICK

				
A	A	A	A	A
8"	8"	8"	8"	8"
36	36	36	36	36
28	28	28	28	28
24	24	24	24	24
20	20	20	20	20
16	16	16	16	16
12	12	12	12	12
8"	8"	8"	8"	8"
4"	4"	4"	4"	4"
.28	.28	.28	.28	.28
.24	.24	.24	.24	.24
.21	.21	.21	.21	.21
.19	.19	.19	.19	.19
.16	.16	.16	.16	.16
.15	.15	.15	.15	.15
.13	.13	.13	.13	.13
.14	.14	.14	.14	.14
PLAIN BRICK	PLAIN BRICK	PLAIN BRICK	PLAIN BRICK	PLAIN BRICK

				
A	A	A	A	A
8"	8"	8"	8"	8"
36	36	36	36	36
28	28	28	28	28
24	24	24	24	24
20	20	20	20	20
16	16	16	16	16
12	12	12	12	12
8"	8"	8"	8"	8"
4"	4"	4"	4"	4"
.28	.28	.28	.28	.28
.24	.24	.24	.24	.24
.21	.21	.21	.21	.21
.19	.19	.19	.19	.19
.16	.16	.16	.16	.16
.15	.15	.15	.15	.15
.13	.13	.13	.13	.13
.14	.14	.14	.14	.14
PLAIN BRICK	PLAIN BRICK	PLAIN BRICK	PLAIN BRICK	PLAIN BRICK

				
A	A	A	A	A
8"	8"	8"	8"	8"
36	36	36	36	36
28	28	28	28	28
24	24	24	24	24
20	20	20	20	20
16	16	16	16	16
12	12	12	12	12
8"	8"	8"	8"	8"
4"	4"	4"	4"	4"
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.24	.24	.24	.24	.24
.21	.21	.21	.21	.21
.19	.19	.19	.19	.19
.16	.16	.16	.16	.16
.15	.15	.15	.15	.15
.13	.13	.13	.13	.13
.14	.14	.14	.14	.14
PLAIN BRICK	PLAIN BRICK	PLAIN BRICK	PLAIN BRICK	PLAIN BRICK

				
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CALCULATING HEAT LOSS

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 10x10x8 ft. with two windows 3x5 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	= 10x10x8	= 800 cu. ft.
Windows	= 3x5 + 3x5	= 30 sq. ft.
Gross wall	= 10+10x8	= 160 sq. ft.
Net wall	= 160-30	= 130 sq. ft.

Refer to Table 9 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 as the surrounding space is also to be heated. Then,

Cubical contents	800x1 1/2x0.02x70	= 1,480 B.t.u.
Glass	30x1.1x70	= 2,310 B.t.u.
Net wall	130x0.3x70	= 2,730 B.t.u.
Total heat loss from room		= 6,520 B.t.u.



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 to computed heat losses.

Then, $6,520 \times 1.15 = 7,498$, 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 4 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	800x1 1/2x0.02x70	= 1,480 B.t.u.
Glass	30x1.1x70	= 2,310 B.t.u.
Net wall	130x0.3x70	= 2,730 B.t.u.
Ceiling	100x0.26x35	= 910 B.t.u.
Total Heat Loss from Room		= 7,430 B.t.u.
Adding 15 per cent for Northern Exposure		= 8,544 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 12), 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 11. 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 would 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 12. CLIMATIC CONDITIONS COMPILED FROM U. S. WEATHER BUREAU RECORDS

COL. A	COL. B	COL. C	COL. D	COL. E	COL. F
State	City	Average Temp., Oct. 1st-May 1st	Lowest Temperature	Average Wind Velocity Dec. Jan., Feb. Miles per Hr.	Direction of Prevailing Wind, Dec. Jan., Feb.
Ala.	Mobile.....	57.7	-1	8.3	N
	Birmingham.....	53.9	-10	8.6	N
Ariz.	Phoenix.....	59.5	16	3.9	E
	Flagstaff.....	34.9	-25	6.7	SW
Ark.	Fort Smith.....	49.5	-15	8.0	E
	Little Rock.....	51.6	-12	9.9	NW
Cal.	San Francisco.....	54.3	29	.....	N
	Los Angeles.....	58.6	28	.....	NE
Colo.	Denver.....	39.3	-29	7.4	S
	Grand Junction.....	39.2	-16	5.6	SE
Conn.	New Haven.....	38.0	-14	9.3	N
D. C.	Washington.....	43.2	-15	7.3	NW
Fla.	Jacksonville.....	61.9	10	8.2	NE
Ga.	Atlanta.....	51.4	-8	11.8	NW
	Savannah.....	58.4	8	8.3	NW
Idaho.	Lewiston.....	42.5	-13	4.7	E
	Pocatello.....	36.4	-20	9.3	SE
Ill.	Chicago.....	36.4	-23	17	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
	Springfield.....	43.0	-29	11.3	SE
Mont.	Billings.....	34.7	-49	.....	W
	Hayre.....	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 12. CLIMATIC CONDITIONS COMPILED FROM U. S. WEATHER BUREAU RECORDS.
(Continued)

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

ROOM TEMPERATURES
USUALLY SPECIFIED

In the accompanying Table 13 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 13. 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		

STEAM HEATING

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 14 to 21 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 22 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. high, figure as above and then add 2 per cent for each additional foot of height over 12 ft.

For rooms over 20 ft. in height, figure as above and add 25 per cent for total height.

If the rooms are to be heated in the day time only, figure as before, making proper allowance for heights of rooms, and add 10 per cent to the radiation.

If the building is to be heated intermittently, at long intervals of unheated periods add 25 per cent to the radiation.



Table 17 conforms very closely to ratings for direct radiation as given by the large radiator manufacturers.

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 the heat loss from a room $15 \times 15 \times 10$ ft. having two 3×6 ft. windows, walls of clapboard, paper, sheathing, lathed and plastered, two sides exposed and attic space above ceiling unheated, to be 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 15 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 21 following down the first column to 5-lb. gage pressure and then following 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.

TABLE 14. HEAT EMITTED BY DIRECT RADIATION—SINGLE-COLUMN RADIATORS
Room Temperature at 70 deg. fahr.

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

TABLE 15. HEAT EMITTED BY DIRECT RADIATION—TWO-COLUMN RADIATORS

Steam Temperature at 215 deg. Fahr.										Room Temperature at 70 deg. Fahr.									
45 In.		38 In.		32 In.		26 In.		23 In.		20 In.									
No. of Sections	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	4920	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							

TABLE 16. HEAT EMITTED BY DIRECT RADIATION—THREE-COLUMN RADIATORS

Room Temperature at 70 deg. Fahr.																			
		45 In.			38 In.			32 In.			26 In.			23 In.			20 In.		
No. of Sections	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.	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							

TABLE 17. HEAT EMITTED BY DIRECT RADIATION—FOUR-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.	Rated Surface sq. ft.	Total B.t.u. per hr.	Rated Surface sq. ft.	Rated Surface sq. ft.	Total B.t.u. per hr.	Rated Surface sq. ft.	Rated Surface sq. ft.	Total B.t.u. per hr.	Rated Surface sq. ft.	Rated Surface sq. ft.	Total B.t.u. per hr.	Rated Surface sq. ft.	Rated Surface sq. ft.	Total B.t.u. per hr.	Rated Surface sq. ft.
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	10356	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	19061	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						

TABLE 18. HEAT EMITTED BY DIRECT RADIATION—HOSPITAL RADIATORS—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.	Rated Surface sq. ft.	Total B.t.u. per hr.	Rated Surface sq. ft.	Rated Surface sq. ft.	Total B.t.u. per hr.	Rated Surface sq. ft.	Rated Surface sq. ft.	Total B.t.u. per hr.	Rated Surface sq. ft.	Rated Surface sq. ft.	Total B.t.u. per hr.	Rated Surface sq. ft.	Rated Surface sq. ft.	Total B.t.u. per hr.	Rated Surface sq. ft.
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	1813	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						

TABLE 19. 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

TABLE 20. 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	60	13986
17	85	18598	63.75	14510	57	13304
18	90	19656	67.50	15336	48	11266
19	95	20710	71.25	16160	54	12625
20	100	21770	75.00	16988	51	11944

TABLE 21. HEAT EMITTED BY DIRECT RADIATION—CONVERSION FACTORS

Pressure	Temperature of Room in deg. Fahr.									
	Temp. of Steam in deg. Fahr.	75 deg. Fahr.	70 deg. Fahr.	65 deg. Fahr.	60 deg. Fahr.	50 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	2.188	2.053	1.934	1.828	1.733	1.572			
19.7	4.75	1.898	1.795	1.701	1.621	1.546	1.412			
15.3	5.99	1.669	1.590	1.517	1.451	1.391	1.285			
12.3	7.51	1.488	1.425	1.364	1.311	1.261	1.175			
8.7	9.33	1.339	1.287	1.239	1.195	1.155	1.081			
6.5	11.52	1.215	1.172	1.135	1.095	1.060	0.999			
Lb. Gage										
1	15.7	1.064	1.029	1.000	0.971	0.943	0.894			
2	16.8	1.030	1.000	0.970	0.941	0.915	0.870			
3	17.8	1.004	0.976	0.947	0.921	0.897	0.851			
4	18.9	0.982	0.954	0.929	0.902	0.878	0.835			
5	19.6	0.964	0.936	0.909	0.887	0.864	0.822			
6	20.8	0.943	0.917	0.892	0.869	0.847	0.806			
8	22.8	0.907	0.883	0.860	0.839	0.818	0.781			
10	24.9	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 22. EFFECT OF ROOM TEMPERATURE ON HEAT LOSS AND SIZE OF RADIATOR

ROOM TEMPERATURE	PROPORTIONATE LOSS IN B.T.U.	DIFFERENCE IN TEMPERATURE BETWEEN RADIATOR AND ROOM	PROPORTIONATE TRANSMISSION IN B.T.U.	ROOM TEMPERATURE	PROPORTIONATE SURFACE REQUIRED SQ. FT.
35	0.50	175	1.34	35	0.37
40	0.57	170	1.29	40	0.44
45	0.64	165	1.24	45	0.52
50	0.71	160	1.19	50	0.60
55	0.79	155	1.14	55	0.69
60	0.86	150	1.09	60	0.78
65	0.93	145	1.05	65	0.89
70†	1.00†	140†	1.00†	70†	1.00†
75	1.07	135	0.95	75	1.12
80	1.14	130	0.91	80	1.26
85	1.21	125	0.87	85	1.40
90	1.29	120	0.82	90	1.56
95	1.36	115	0.78	95	1.74
100	1.43	110	0.74	100	1.93
105	1.50	105	0.70	105	2.15
110	1.57	100	0.66	110	2.39
115	1.64	95	0.62	115	2.66
120	1.71	90	0.58	120	2.95

†Standard Conditions.

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

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

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

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

The preceding table may be used to find the proportionate amount of radiation necessary to heat a room to any desired inside temperature, other than 70 deg., when the outside minimum temperature is other than zero, and with a radiator temperature other than standard. Find the



difference between the outside temperature and the room temperature in the first column; divide the proportionate heat loss opposite this amount, in the second column, by the proportionate transmission opposite the difference in temperature between the radiator and the room, as given in the fourth column, and the result will be the proportionate amount of radiation required.

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

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

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. 3 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 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

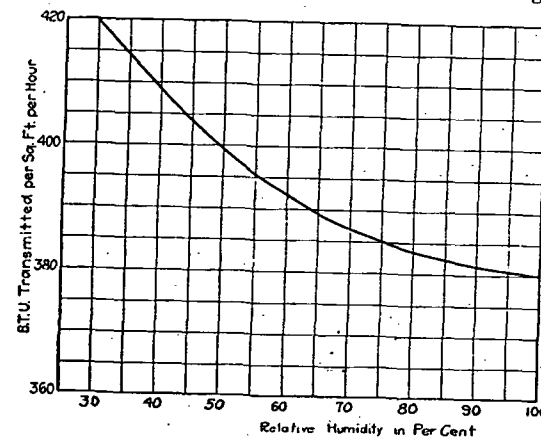


FIG. 3. EFFECT OF HUMIDITY ON HEAT TRANSMISSION

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

TABLE 23. 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. 4 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.

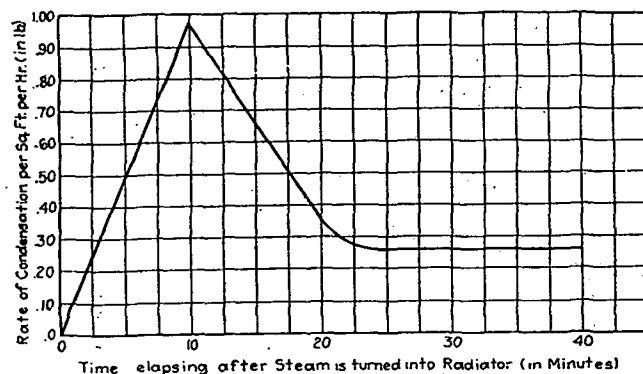


FIG. 4. CHART SHOWS DEMAND UPON BOILER FOR HEATING-UP PLANT

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. 5, 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. 6. 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.

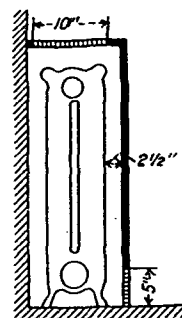


FIG. 5

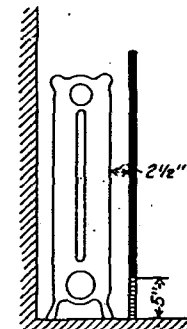


FIG. 6

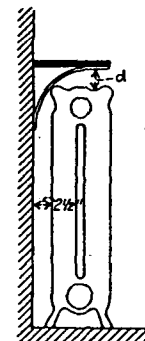


FIG. 7

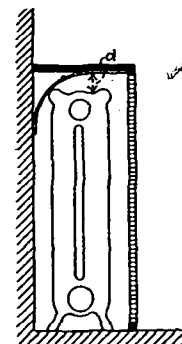


FIG. 8

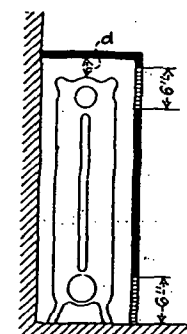


FIG. 9

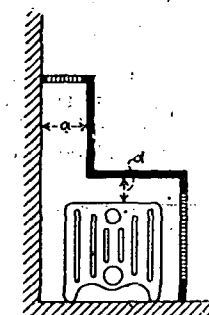


FIG. 10

DIFFERENT ARRANGEMENTS OF RADIATORS IN ENCLOSURES

Case No. 3.—Radiators often have placed over them a flat shelf, as shown in Fig. 7. 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. 8. 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. 9. 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. 10. 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.

EFFECT OF POSITION

The effect of position on the heat transmission of a radiator is a subject that has been investigated only to a very limited extent. The experiments that are available show that the heat loss from a radiator is about the same whether it is placed at the floor, at the ceiling, or in the center of the room. It seems to make very little difference whether it is placed close to the wall or in the middle of the room. Placing a radiator close to an outside wall heats the wall immediately behind the radiator and if no insulation is placed behind the radiator this may represent a loss of from 3 to 5 per cent.

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

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 condensation 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 de-

terminated 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 24 to the straight run of pipe plus 25 ft. for entrance to last radiator to obtain the total equivalent length.

TABLE 24. 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.							
$W = 87.5 \sqrt{\frac{P D d^5}{\left(1 + \frac{3.6}{d}\right) L}}$ $P = .000131 \left(1 + \frac{3.6}{d}\right) \frac{W^2 L}{D d^5}$							
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	0.648	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 hr. 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 $1.615 \times 60 = 96.9$ lb. per hr.

Above 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 as 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 24 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 25 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 25 find:

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

Table 24, under Column 4, gives factors for changing amounts of radiation as given in Table 26 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 26 for 4-in. pipe 100 ft. run and multiply by factor given in Column 4 Table 24. Factor for 250 ft. run as taken from Column 4 Table 24 = 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 26 = 2,866 sq. ft., then, $2,866 \times 0.632 = 1,811$ 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 25 gives this in units of length, in feet, to be added to the measured length of pipe for a given kind of fitting.

TABLE 25. 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
2½"	7	20	3	25	12
3"	10	26	3	33	16
3½"	12	31	4	39	19
4"	14	35	5	45	22
5"	18	44	7	57	28
6"	22	50	9	70	32
7"	26	55	10	82	37
8"	31	63	12	94	42
9"	35	69	13	105	47
10"	39	76	15	118	52
12"	47	90	18	140	63
14"	53	105	20	160	72

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

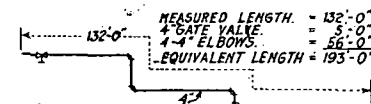




TABLE 26. PRESSURE LOSSES WITH LOW PRESSURE STEAM

Capacities of pipes for various pressure losses in ounces per 100 ft. straight pipe or its equivalent, allowing for condensation in covered piping, steam and condensation flowing in same direction, given in terms of square feet of direct radiation based on $\frac{1}{4}$ lb. condensation per sq. ft. per hr.

For capacities of pipes other than 100 ft. long, multiply the capacities given below by the factor for required length as given in Table 24, Column No. 4.

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

Press. Loss in Oz. 100'	COMMERCIAL PIPE SIZE										
	$\frac{1}{4}$ "	1"	1 $\frac{1}{4}$ "	1 $\frac{1}{2}$ "	2"	2 $\frac{1}{2}$ "	3"	3 $\frac{1}{2}$ "	4"	4 $\frac{1}{2}$ "	5"
0.25	12	23	51	79	158	262	480	717	1,014	1,379	1,887
0.50	16	32	71	111	224	370	678	1,013	1,433	1,949	2,667
1.00	23	46	101	157	316	524	959	1,431	2,027	2,757	3,773
1.50	28	56	124	192	387	641	1,174	1,754	2,481	3,374	4,618
2.00	32	64	142	222	447	741	1,356	2,026	2,866	3,898	5,334
2.50	36	73	160	248	500	829	1,517	2,266	3,205	4,358	5,904
3.00	39	79	175	272	548	908	1,662	2,482	3,511	4,774	6,534
3.50	43	86	189	293	591	980	1,794	2,680	3,790	5,155	7,055
4.00	46	91	202	314	632	1,048	1,919	2,866	4,054	5,513	7,543
4.50	48	97	214	333	671	1,111	2,035	3,039	4,299	5,847	8,002
5	51	102	226	351	707	1,172	2,145	3,204	4,532	6,104	8,435
6	56	112	247	384	774	1,283	2,349	3,509	4,964	6,751	9,349
7	60	121	267	415	836	1,386	2,537	3,790	5,361	7,281	9,961
8	64	129	286	443	894	1,482	2,713	4,052	5,732	7,796	10,667
9	68	137	303	470	949	1,572	2,878	4,299	6,012	8,167	11,223
10	72	145	319	496	1,000	1,657	3,033	4,532	6,410	8,716	11,928
11	76	152	335	520	1,049	1,738	3,181	4,721	6,707	9,101	12,211
12	79	159	350	543	1,095	1,815	3,334	4,963	7,020	9,548	13,068
13	82	165	364	565	1,140	1,889	3,461	5,161	7,308	9,929	13,589
14	85	172	378	587	1,183	1,960	3,588	5,360	7,580	10,310	14,110
15	88	178	391	607	1,226	2,029	3,713	5,546	7,843	10,668	14,598
16	91	184	404	627	1,265	2,096	3,838	5,732	8,108	11,026	15,086
17	94	189	416	647	1,304	2,159	3,954	5,904	8,353	11,410	15,544
18	97	195	428	665	1,342	2,222	4,070	6,072	8,598	11,794	16,003
19	99	200	440	683	1,378	2,283	4,180	6,242	8,830	12,061	16,437
20	102	205	452	701	1,414	2,344	4,290	6,407	9,063	12,328	16,870
24	112	225	495	768	1,548	2,566	4,697	7,018	9,928	13,501	18,697

TABLE 27. ONE-PIPE STEAM
Capacity in Sq. Ft. of Radiation

A Com- mercial Pipe Size	B Supply Main, Branch to Risers (dripped), Steam and water flowing same direc- tion.	C Supply Main, Branch to Risers; Up-Feed Risers. Steam and water flowing op- posite direction.	D BRANCHES TO RADIATORS		E Wet Drip Main	F DRY DRIP MAIN (Grade in Inches)				G Radiator Valve Sizes	H Allowance in feet of pipe for	
			5 ft. in length or less	5 ft. to 10 ft. in length		Vertical or 1 inch in 5 ft.	1 inch in 10 ft.	1 inch in 20 ft.	1 inch in 30 ft.		Ells	Globe Valves
			24	24		180	140	100	80			
1/4"	40	40	24	24	800	420	300	210	170	24	0.8	1.2
1/2"	75	75	60	60	1,800	900	650	450	370	60	1.3	1.9
3/4"	150	150	100	100	3,000	1,500	1,000	700	600	100	2.1	3.2
1"	300	300	200	200	6,000	3,000	2,000	1,400	1,200	200	2.8	4.2
1 1/4"	600	600	400	400	10,000	4,800	3,200	2,200	1,800	300	5.	7.5
1 1/2"	900	900	600	600	18,000	8,400	5,600	3,800	3,000	400	7.	10.
2"	1,500	1,500	1,000	1,000	28,000	13,600	9,000	6,000	4,800	600	12.	18.
2 1/2"	2,000	2,000	1,300	1,300	37,000	18,000	12,000	8,000	6,400	800	14.	21.
3"	2,800	2,800	1,800	1,800								
3 1/2"	3,600	3,600	2,400	2,400								
4"	4,000	4,000	2,600	2,600								
4 1/2"	4,500	4,500	2,800	2,800								
5"	5,000	5,000	3,000	3,000								
6"	6,000	6,000	3,600	3,600								
7"	9,000	9,000	5,400	5,400								
8"	13,000	13,000	7,800	7,800								
10"	23,000	23,000	13,800	13,800								
12"	37,000	37,000	22,200	22,200								

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 determine the carrying capacity of the pipe.

Length in Feet 200 300 400 500 1,000
Factors.....0.710 0.576 0.500 0.447 0.316

To obtain size of supply mains (not dripped) and down feed risers where steam and water are flowing in the same direction, add amount of radiation the pipe is to supply steam to, and $\frac{1}{4}$ the radiation the pipe is carrying water from, and size as for steam mains (Column B). Where main is dripped at each point of reduction or often use Column E.

The end of steam mains, if reduced, to be one size larger than table calls for. On circuit mains where reduced and not dripped use eccentric coupling for making reduction.

In installations in buildings 3 stories or more in height each up-feed riser should be separately dripped into wet drip main. In tall buildings where risers are 100 ft. in length, or over, horizontal run-outs, to permit expansion or, where necessary, due to the design of building, should have separate drips carried down to basement into drip return line.

TABLE 28. TWO-PIPE STEAM
Capacity of Pipes in Sq. Ft. of Radiation

A Com- mercial Pipe Sizes	B Supply Main Branch (Up-Feed); 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 (Grade in Inches)				G Radiator Valves		H Allowance in ft. of Pipe for
			5 ft. in length or less	5 ft. in length 10 ft. in length		Vertical or 1 inch in 5 ft.	1 inch in 10 ft.	1 inch in 20 ft.	1 inch in 30 ft.	Supply	Re- turn	
1	40	40	24	.....	800	180	140	100	80	20	40	0.8
1 1/4	75	75	40	.....	1,800	420	300	210	170	40	80	1.2
1 1/2	150	150	80	.....	3,000	800	650	450	370	80	160	1.9
2	300	170	100	.....	5,000	1,500	1,000	700	600	160	320	3.2
2 1/4	500	220	200	.....	8,000	2,100	1,500	1,000	800	320	640	4.2
3	900	340	.....	.....	10,000	3,000	2,100	1,500	1,200	.....	.....	5.0
3 1/4	1,500	480	.....	.....	18,000	4,900	3,500	2,500	1,800	.....	.....	7.0
4	2,000	600	.....	.....	28,000	9,000	6,400	4,500	3,700	.....	.....	10.0
			.....	.....	37,000	.....	14,000	9,700	8,000	.....	.....	12.0
			.....	.....						.....	.....	14.0
4 1/4	2,800											15.0
5	3,600											18.0
6	6,000											22.0
7	9,000											26.0
8	13,000											31.0
10	23,000											39.0
12	37,000											47.0

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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 200 300 400 500 1,000 2,000 3,000
Factors.....0.710 0.576 0.500 0.447 0.318 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 dripped 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-foot 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 29. LOW PRESSURE GRAVITY VAPOR WITHOUT USE OF RADIATOR RETURN TRAPS
Capacity in Pipes in Sq. Ft. of Radiation

A Com- mercial Pipe Sizes	B Supply Main Up-feed to Risers (dripped); Branches to Risers 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 (Grade in Inches)				G Allowance in feet of Pipe for			
			5 ft. in length or less	5 ft. to 10 ft. in length		Vertical or 1 inch in 5 ft.	1 inch in 10 ft.	1 inch in 20 ft.	1 inch in 30 ft.	Ells	Globe Valves		
1/4	40	40	24	.....	800	180	140	100	80	0.8	1.2		
1 1/4	75	75	40	.....	1,800	420	300	210	170	1.3	1.9		
1 1/2	150	150	80	.....	3,000	800	650	450	370	2.1	3.2		
2	300	300	160	.....	5,000	1,500	1,000	700	600	2.8	4.2		
2 1/4	500	500	200	.....	6,000	3,000	2,100	1,500	1,200	5.	19.		
3	900	900	.....	.....	10,000	4,900	3,500	2,500	1,800	7.	26.		
3 1/4	1,500	1,500	.....	.....	18,000	9,000	6,400	4,500	3,700	10.	33.		
4	2,000	600	.....	.....	28,000	.....	.....	6,800	5,600	12.	39.		
			.....	.....	37,000	.....	14,000	9,700	8,000	14.	45.		
4 1/2	2,800					DRIPS FOR RISERS						15.	54.
5	3,600	.....	.....	.....		Drips to Returns		Drips to Returns		18.	58.		
6	6,000	.....	.....	.....	Steam Risers	Drips to Returns		Steam Risers	Dry	22.	70.		
						Wet.	Dry	Wet				Dry	
7	9,000	.....	.....	.....	1	2 1/2	1	1 1/4	1 1/4	26.	82.		
8	13,000				1 1/4	3	1 1/4	1 1/4	1 1/4	31.	84.		
10	23,000				1 1/2	4	1 1/4	1 1/4	1 1/4	38.	117.		
12	37,000				2	4	1	1 1/4	1 1/4	47.	140.		

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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 200 300 400 500 1,000 2,000 3,000
Factors.....0.710 0.576 0.500 0.447 0.318 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 dripped 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 30 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 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. = 2½" Main
 50' from end of main = 450 sq. ft.
 Total load to this point = 730 sq. ft. = 3½" Main
 Near boiler = 400 sq. ft.
 Total load to boiler = 1,130 sq. ft. = 4" Main

TABLE 30. 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	.....	.....	.....	.....
2½	550	450	390	347	310	275
3	1,000	810	710	632	578	500
3½	1,500	1,215	1,065	948	860	750
4	2,100	1,700	1,500	1,325	1,200	1,050
4½	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 31. CAPACITY OF DRY RETURN MAINS IN SQ. FT.

COL. A SIZE OF PIPE	LENGTH IN FT. FROM BOTTOM OF RISER TO DIFFERENTIAL CONNECTION					
	Col. B 100'	Col. C 150'	Col. D 200'	Col. E 250'	Col. F 300'	Col. G 400'
1"	320	300	288	272	245	210
1½"	670	630	600	570	535	470
1¾"	1,300	1,215	1,170	1,100	1,045	910
2"	2,300	2,185	2,070	1,955	1,840	1,610
2½"	3,800	3,610	3,420	3,200	3,040	2,660
3"	7,000	6,650	6,300	5,950	5,600	4,990
3½"	10,000	9,500	9,000	8,500	8,000	7,000
4"	15,000	14,250	13,500	12,750	12,000	10,500



TABLE 32. CAPACITY OF WET RETURN MAINS IN SQ. FT.

SIZE OF PIPE	1¼"	1½"	2"	2½"	3"	3½"
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

TABLE 33. 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
1¼"	75	60	53	47	43	37
1½"	150	120	105	95	86	75
2"	300	240	210	190	173	150
2½"	500	400	355	315	285	250
3"	900	730	630	565	520	450

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

RETURN RISERS

Size of Pipe	¾"	1"	1¼"	1½"
Capacity in Sq. Ft.	300	630	1,300	2,200

TABLE 34. RADIATOR CONNECTIONS

Vertical Inlet Pipe to Valve	SUPPLY		RETURN	
	Horizontal Runout from Vertical Inlet Pipe to Riser or Main.		Stub to Valve	Horizontal Runout to Riser or Main
	Up to 5' Long	Over 5' Long		
1½"	24 sq. ft. = 1"	16 sq. ft. = 1"	½"	¾"
¾"	70 sq. ft. = 1¼"	60 sq. ft. = 1¼"		
1¼"	150 sq. ft. = 1½"	130 sq. ft. = 1½"		
1½"	200 sq. ft. = 2"	175 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 ½ 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.

TABLE 35. CAPACITY OF SUPPLY MAINS IN SQ. FT.

COL. A SIZE OF PIPE	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	.....	.....	.....
2½"	1,570	1,115	800	785	.....	.....	.....
3"	2,800	1,988	1,610	1,400	1,250	1,090	880
3½"	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
4½"	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



PIPE SIZES FOR VACUUM HEATING

Table 35 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 36. CAPACITIES OF RETURN MAINS IN SQ. FT.

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

TABLE 37. CAPACITIES OF SUPPLY RISERS IN SQ. FT.

SIZE OF PIPE	1"	1¼"	1½"	2"	2½"	3"	3½"
**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 38. CAPACITIES OF RETURN RISERS IN SQ. FT.

SIZE OF PIPE	¾"	1"	1¼"				
*Length 200'	700	1,400	3,150	.....	.....	.....	.....
" 400'	560	1,120	2,480	.....	.....	.....	.....
" 600'	420	840	1,750	.....	.....	.....	.....
" 1,000'	350	700	1,470	.....	.....	.....	.....
" 2,000'	230	460	1,050	.....	.....	.....	.....

* Length equals measured distance from 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 36, 37, 38, includes allowances for elbows, tees, etc.

TABLE 39. 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	¾"	¾"	1"	½"	½"	¾"
101 to 200	1"	1"	1¼"	½"	½"	¾"
201 to 300	1¼"	1¼"	1½"	¾"	¾"	¾"

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

THE BOILER

FUNCTIONS OF BOILER, PIPING
VALVES, AND RADIATION

A STEAM heating plant consists of three major parts, the *boiler*, the *piping* 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 *piping 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 to be reliable should be established according to the A. S. H. & V. E. Boiler Testing Code. Such commercial rating is the 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 standard code conditions, as to: Condition of boiler, quantity of draft, kind and quality of coal burned per hour, and efficient method of firing and operation as indicated by the CO₂ recorder.

No heating boiler can be expected to develop its rated capacity unless those standard code conditions are complied with, since the ratings are developed under those conditions. 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 and rated according to the A. S. H. & V. E. Boiler Testing Code. Look for the evidence of such testing in his catalog as to fuel capacity, evaporative power and on the smaller boilers, length of firing period. 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 standard code operating conditions any code rated 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 Model Chimney Ordinance mentioned, 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:

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

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.

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 sq. ft. of grate per hr., according to the height of the stack. Large heating boilers are being attached to stacks 100 ft. to 300 ft. high. Small round boilers require from 0.1 in. 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 in. to about 0.5 in. of draft. Smokeless boilers require from 0.4 in. 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 increases or decreases the draft required to develop the rated capacity of any boiler.

FACTORS DETERMINING RATED CAPACITY OF HEATING BOILERS

There are three, and only three major factors that can ever enter into the proper equation for determining the rated capacity of any heating boiler. These factors are as given in the A. S. H. & V. E. Boiler Testing Code as follows:

$$\frac{C \times H}{T} = \text{boiler capacity per hr. in B.t.u..}$$

C = number of pounds of dry fuel consumed (during the firing period).

T = duration of firing period in hrs.

H = total B.t.u. available at the boiler outlet per pound of dry fuel.

Hence the available fuel in pounds, times the efficiency of the boiler in heat units per pound of fuel burned, divided by the length of firing period in hours, is the only boiler capacity rule that has any engineering merit to it. The hit or miss boiler capacity rules, based on grate area and heating surface cannot be applied to any two complete lines of boilers of



different design on the market and have no engineering value (see article by P. J. Dougherty on Heating Surface vs. Boiler Capacity, TRANSACTIONS, Vol. 26, p. 147).

The length-of-firing-period factor, T , in the code rule makes it flexible enough to apply to all types and sizes of heating boilers and at the same time specific enough to apply to each and every case. 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-hr. 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 minutes. 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 1,000 sq. ft., capacity—	3	gallons
" " " 2,000 "	4	"
" " " 4,000 "	5	"
" " " 6,000 "	7	"

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

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.

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.

TABLE 40. 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.

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 slugs of water—similar to A, Fig. 11. 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.

WATER HAMMER



FIG. 11. 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.

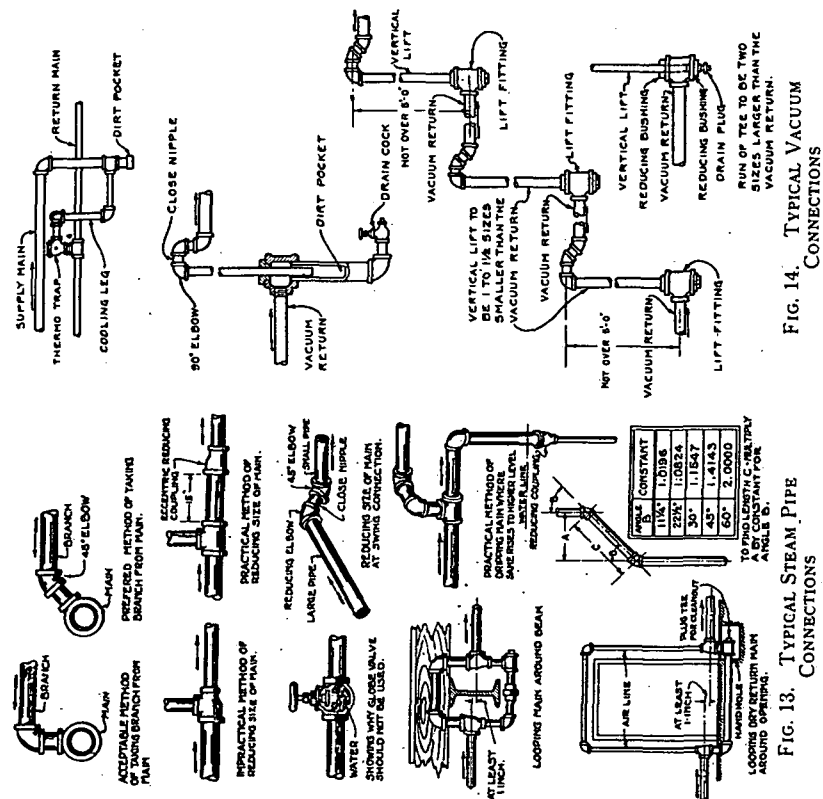


FIG. 13. TYPICAL STEAM PIPE CONNECTIONS

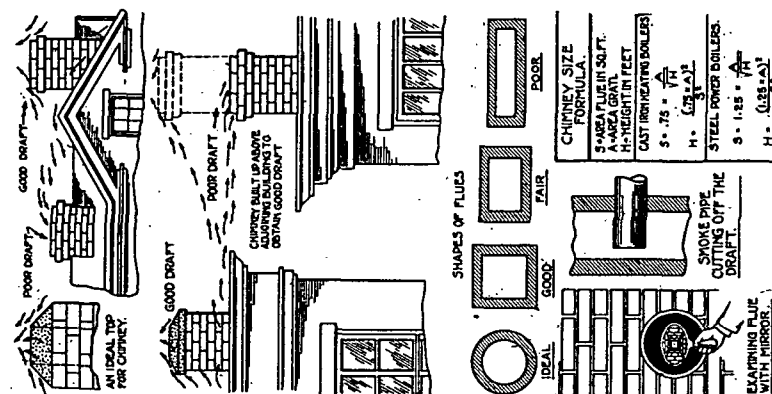


FIG. 12. EXAMPLES OF CHIMNEY OPERATING CONDITIONS AND CONSTRUCTION



FIG. 16. TYPICAL EXPANSION CONNECTIONS

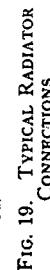


FIG. 19. TYPICAL RADIATOR CONNECTIONS

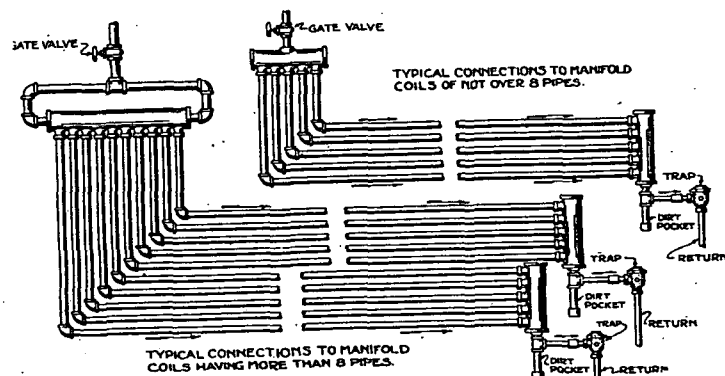


FIG. 20. TYPICAL CONNECTIONS TO MANIFOLD COILS HAVING MORE THAN 8 PIPES.

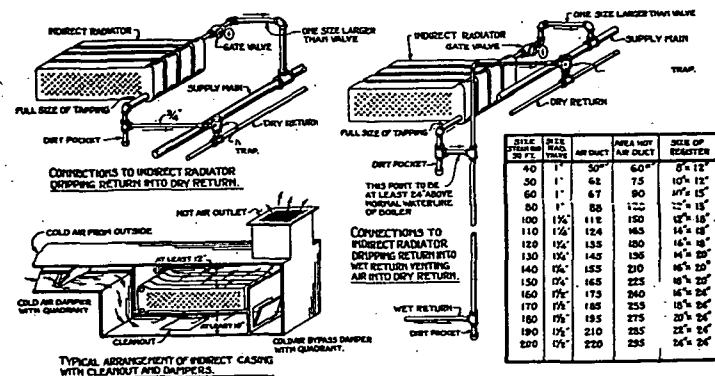


FIG. 21. INDIRECT RADIATOR CONNECTIONS

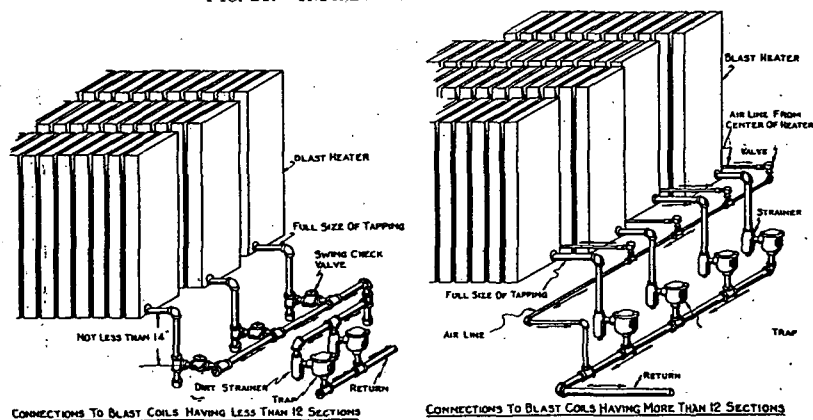


FIG. 22. RETURN CONNECTIONS TO BLAST COILS

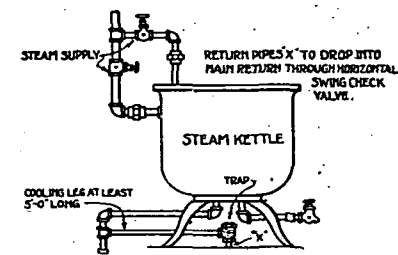
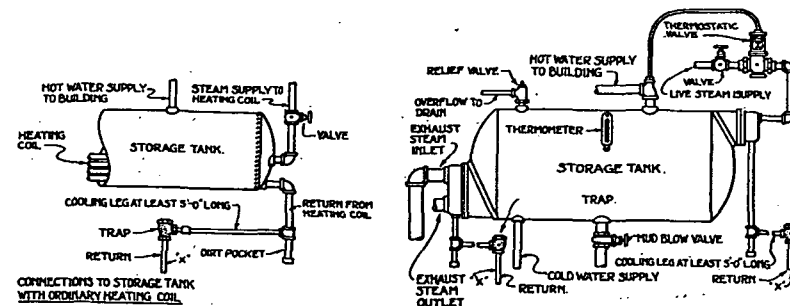


FIG. 23. CONNECTIONS TO COILS IN TANKS

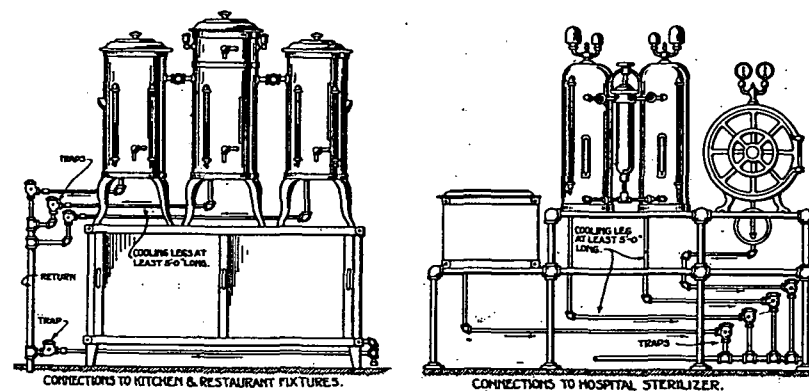


FIG. 24. TYPICAL CONNECTIONS TO KITCHEN AND HOSPITAL EQUIPMENT

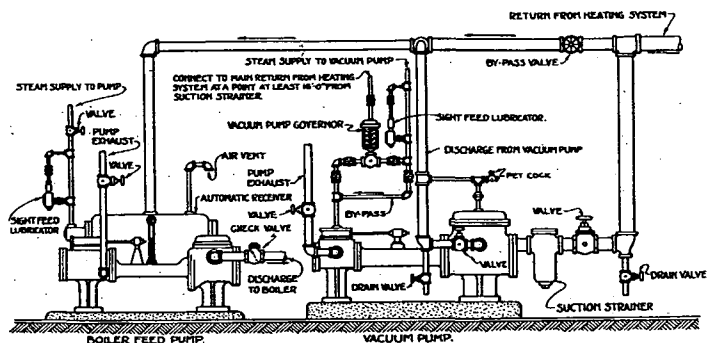


FIG. 25. TYPICAL VACUUM CONNECTIONS

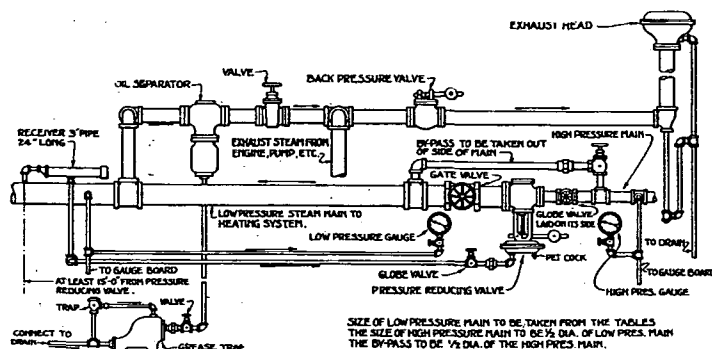


FIG. 26. TYPICAL VACUUM CONNECTIONS

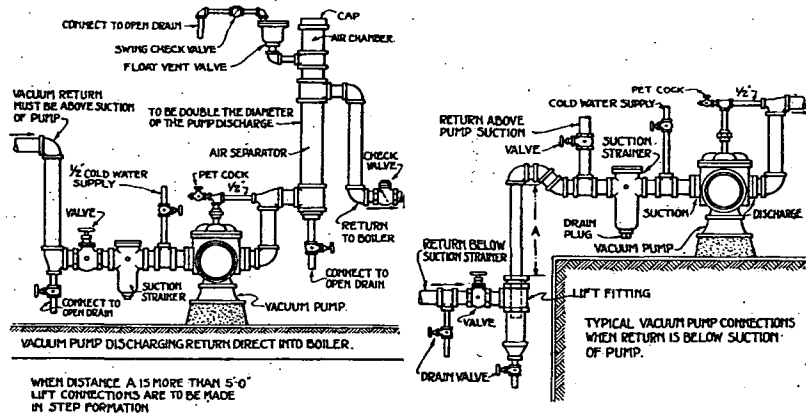


FIG. 27. TYPICAL VACUUM CONNECTIONS

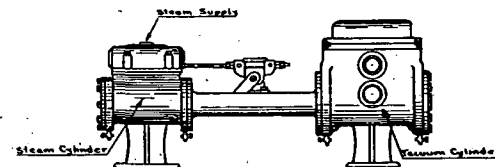


TABLE 41. STEAM DRIVEN VACUUM PUMPS

MINIMUM STEAM PRESS.	SIZE PUMP			SQ. FT. OF RADIATION SETTING IN 70 DEG. FAHR.	STEAM	EXHAUST	SUCTION	DIS- CHARGE
	Steam Cylinder	Water Cylinder	Length Stroke					
10 lb.	8	3	6	1,500	3/4"	1"	2"	1 1/2"
" "	8	3 1/2	6	2,200	3/4"	1"	2"	1 1/2"
" "	8	4	6	2,800	3/4"	1"	2"	1 1/2"
" "	12	5	8	5,600	1 1/4"	2"	2 1/2"	2"
" "	12	6	8	7,900	1 1/4"	2"	3"	2 1/2"
20 lb.	6 3/8	3	6	1,500	3/4"	1"	2"	1 1/2"
" "	6 1/2	3 1/2	6	2,200	3/4"	1"	2"	1 1/2"
" "	6 1/8	4	8	3,600	3/4"	1"	2"	1 1/2"
" "	8 1/2	5	8	3,600	1"	1 1/2"	2 1/2"	2"
" "	8 1/2	6	8	7,900	1"	1 1/2"	3"	2 1/2"
" "	12	6	10	8,800	1 1/4"	2"	3"	2 1/2"
" "	12	8	10	15,600	1 1/4"	2"	4"	3 1/2"
" "	12	8	12	18,800	1 1/4"	2"	4"	3 1/2"
60 lb.	3	3 1/2	4	1,800	3/8"	1/2"	2"	1 1/2"
" "	4	3 1/2	5	2,200	1/2"	3/4"	2"	1 1/2"
" "	4	3 1/2	6	2,500	1/2"	3/4"	2"	1 1/2"
" "	4	4	6	2,800	1/2"	3/4"	2"	1 1/2"
" "	4 1/2	4	8	3,600	1/2"	3/4"	2"	1 1/2"
" "	5	5	6	4,300	1/2"	3/4"	2 1/2"	2"
" "	5	6	6	6,100	1/2"	3/4"	3"	2 1/2"
" "	6	6	8	7,900	3/4"	1"	3"	2 1/2"
" "	6	6	10	8,800	3/4"	1"	3"	2 1/2"
" "	7	7	10	12,000	3/4"	1"	3 1/2"	3"
" "	8 1/2	8	10	15,600	1"	1 1/2"	4"	3 1/2"
" "	8 1/2	9	10	19,830	1"	1 1/2"	5"	4"
" "	8 1/2	10	10	24,500	1"	1 1/2"	5"	4"
" "	10	10	12	29,400	1 1/4"	2"	5"	4"
" "	12	12	12	42,300	1 1/4"	2"	5"	4"

TABLE 41a. RECIPROCATING VACUUM PUMPS
Maximum Speed for Steam Driven Pumps

LENGTH OF STROKE INCHES	NUMBER OF SINGLE STROKES PER MIN.	PISTON SPEED FT. PER MIN. S.	LENGTH OF STROKE INCHES	NUMBER OF SINGLE STROKES PER MIN.	PISTON SPEED FT. PER MIN. S.
3	100	25	12	60	60
4	90	30	14	57	66½
5	84	35	15	56	70
6	80	40	16	55	73
7	69	40	18	53	80
8	67½	45	20	51	85
10	60	50	22	49	90

Maximum Speed for Power Driven Pumps

Length of Stroke Inches	Rev. per Min. Crank Shaft	Single Strokes per Min.	Piston Speed Ft. per Min. S.	Length of Stroke Inches	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.

Gross Capacity in Gallons of Pump Cylinders per Foot Piston Speed

Dia. Cylinder Inches	Gal. per Foot G	Dia. Cylinder Inches	Gal. per Foot G	Dia. Cylinder Inches	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.

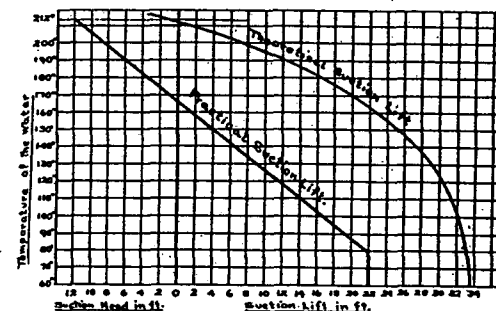
S=piston speed in ft. per min.

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



TABLE 42. 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 " " "	13.33 " " "	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 43. 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	333.0
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



TABLE 43. PROPERTIES OF SATURATED STEAM—Continued

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		
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

CAPACITIES OF STEAM HEATING RISERS

AS AFFECTED BY CRITICAL VELOCITY OF
STEAM AND CONDENSATE MIXTURES

THE flow of steam in pipes has been the object of a great many investigations in the past, both practical and theoretical. These investigations have resulted in a large number of formulae and expressions giving relationships between weight of steam flowing, density of steam, pressure drop, and diameter of the pipe. This phase of the subject,

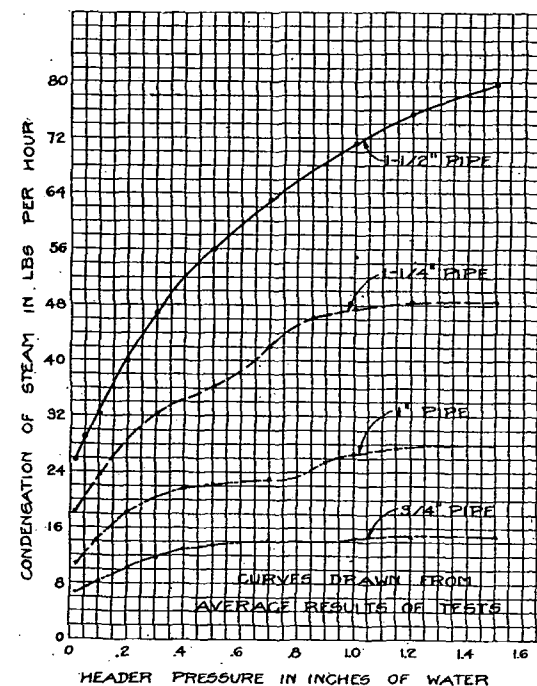


FIG. 28. CURVES SHOWING RELATION OF TOTAL CONDENSATION TO HEADER PRESSURE

however, has received very little attention and very little appears in the literature on it.

By the term *critical velocity*, as used in connection with steam and condensate mixtures, is meant the velocity at which the flow of steam and

Material for this section was prepared especially for THE GUIDE 1923 by F. C. Houghten, Pittsburgh, Pa.

the counter flow of condensed water in the same pipe seriously interfere with each other. This use of the term critical velocity must not be confused with the term velocity as used in the various branches of engineering as meaning, the velocity at which stream line flow of any fluid, under given conditions, ceases and turbulent flow begins.

The critical velocity of steam and condensate mixtures has many applications in steam heating. In some cases where it is desired to carry the water along with the steam, it is desirable to so size the pipe that the velocity of the steam is above the critical point. Often, however, it is desired to have the water of condensation flow counter to the steam. In such cases it is necessary to so size the pipe that the velocity of the steam is below the critical point.

In connection with this investigation the following problems have thus far been studied, at the Research Laboratory of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS:

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.

CRITICAL VELOCITY IN ONE-PIPE RISERS

A series of tests were made on 10 ft. risers of the following nominal diameters: $\frac{3}{4}$ in., 1 in., $1\frac{1}{4}$ in. and $1\frac{1}{2}$ in. In order that the data should apply to pipe as found on the market several pieces of each size, with a varying degree of internal smoothness were tested. Figs. 28 and 29 show the average results of such test. In Fig. 28, the total condensation in pounds per hour is plotted against header pressure in inches of water. The velocity of the steam in feet per second as computed from the total condensation and measured area of the pipe is plotted against header pressure in inches of water in Fig. 29.

On analyzing the data obtained from tests on these pipes including the data plotted in Fig. 28 and Fig. 29, the following points seem of significance:

1. The smaller the size of the pipe and thus the smaller the internal area of the pipe, the more pronounced is the wave portion. As the size of the pipe increases the wave becomes less pronounced. For the $1\frac{1}{2}$ -in. pipe it practically disappears. However, a distinct change in slope from the vertical towards the horizontal can still be found. If tests were run at very small increments of pressure change, 0.01 in. of water instead of 0.10 in., it may be that the wave portion would show much more clearly for larger size pipes.
2. The point of critical velocity for all tests ranging from a very rough to a very smooth pipe varies from 22.5 ft. per sec. to 29 ft. per sec. A very good average for the entire set of tests would be 25.0 ft. per sec. The maximum variation in capacity of the various sizes of pipes tested is given in Table 45.
3. The header pressure at which the critical velocity was found in all the tests on pipe ranging from rough to smooth varies from 0.30 in. of water to 0.40 in.
4. In view of 2 and 3 it may be said that for the sizes of pipe tested and within the limits of experimental error the critical velocity is independent of the size.

EFFECT OF ENTRANCE SHAPE UPON CRITICAL VELOCITY

A series of tests were made on 1-in. risers with various shaped entrances as shown in Fig. 30. The maximum capacities obtained in these tests are as follows:

		Per Cent Decrease
Reamed entrances.....	24.7 lb. per hr.	.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

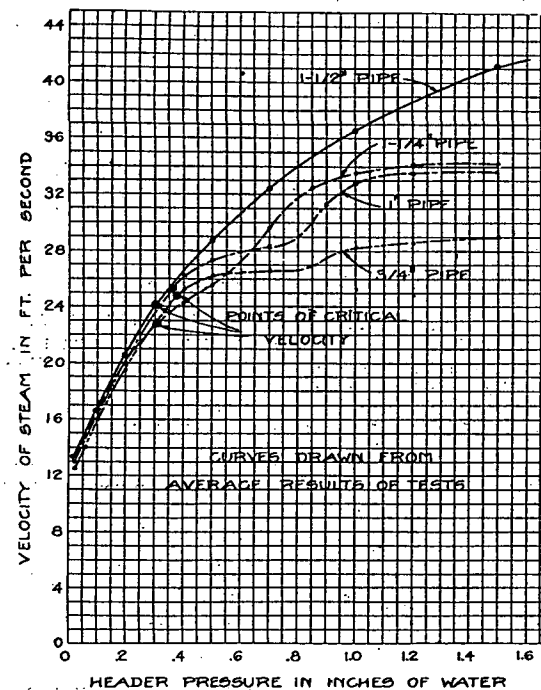


FIG. 29. CURVES SHOWING RELATION OF VELOCITY OF STEAM TO HEADER PRESSURE

As was expected, the results show a maximum capacity for the reamed pipe, slightly smaller for the rounded entrances and so on. While the results indicate a slight difference between the single and three-wheel cutter, due to the insufficiency of the data obtained, there is no attempt made here to designate the one cutter as giving a higher capacity than the other. It may be stated, however, that any cutting tool which leaves a burr in the entrance of the pipe may reduce the capacity of that pipe as much as 30 per cent. The amount of reduction depends upon the



amount of burr made by the cutter. From a practical viewpoint, since any burr will decrease the capacity, care should be taken that all burr is removed from the pipe and furthermore that all pipe is reamed. This fact has been well known, nevertheless the results of these tests bring it out conclusively.

EFFECT OF UNIONS, COUPLINGS AND ORIFICES UPON CAPACITY

A series of tests were conducted to note the effect of unions and couplings upon the critical capacity. The results of these tests indicate that there is no apparent changes in the capacities due to these fittings in the line, if they do not constrict the free area of the pipe. Some unions were found however, which did constrict this free area and accordingly reduced the capacity of the riser.

A series of tests were run to determine the extent to which short constrictions in a pipe will decrease the capacity of the system. Orifices of 1 in., $\frac{3}{4}$ in., $\frac{1}{2}$ in. and $\frac{1}{4}$ in. diameter were inserted in a union in the center of the 1-in. risers. The results of these tests are indicated by points A, B, C and D in Fig. 31 and will be discussed later.

EFFECT OF SMOOTHNESS AND SIZE OF THE PIPE

It is significant to note the variation in the capacity of pipe upon the market that may be due to either variation in size or internal smoothness. The variation in size alone may be 0.05 in. or even more. The variation in internal smoothness may also be very great.

TABLE 44. EFFECT OF VARIATION OF SIZE AND SMOOTHNESS OF PIPE.
Per Cent Difference due to Variation of Pipe

	MAXIMUM CONDENSATION, LB. PER HR.			
	$\frac{3}{4}$ "	1"	$1\frac{1}{4}$ "	$1\frac{1}{2}$ "
Capacity of Pipe.....				
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

The maximum capacity of the pipe for carrying steam and condensate mixtures is plotted against the inside area of the pipe in square inches, Fig. 31. The points of maximum capacity for this curve were obtained from the flat portion of the capacity-header pressure curves in Fig. 28. This curve indicates that the maximum capacity varies greatly with the size of the pipe.

Points A, B, C and D represent the maximum capacities obtained with 1 in., $\frac{3}{4}$ in., $\frac{1}{2}$ in. and $\frac{1}{4}$ in. orifices inserted in a union in the 1-in. pipe as mentioned before. As can be seen, points A, C and D all fall very close to the maximum capacity curve. However, for some reason not discov-



ered, point B for the $\frac{3}{4}$ in. diameter orifice, fell some what lower than was expected.

The results obtained for the maximum capacity of the 1-in. pipe cut by the one- and three-wheel cutters and not reamed, are also plotted against the free area of the pipes left at the constrictions. These points fall close to the maximum capacity curve.

This curve shows conclusively that the effect of any constriction in a pipe, no matter how short the constriction, is to reduce the capacity of the pipe to that of a pipe equal in internal diameter to the free area of the constriction.

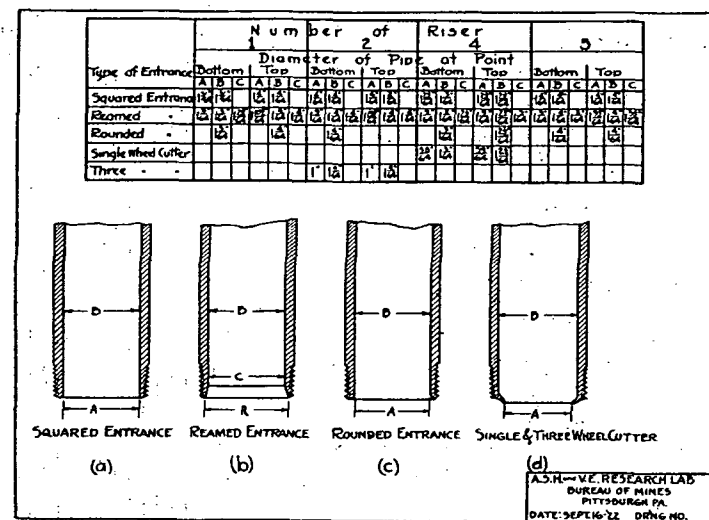


FIG. 30. DETAILS OF FOUR TYPES OF ENTRANCES TESTED

A second curve in Fig. 31 gives the capacity of the pipe at the critical velocity for any area. This curve is found to be a straight line. Furthermore at very small pipe areas the maximum capacity and critical capacity curves coincide. This would indicate that for very small sizes of pipe the critical velocity and maximum velocity are practically the same. This is borne out by the curves in Fig. 28.

The sizes of risers allowable for carrying steam, with the counter flow of condensate, without serious interference is given in Table 45. The values in the first column are based on 18 ft. per sec., which allows a factor of safety of approximately 20 per cent. The values in the second column are based on a velocity of 22 ft. per sec. or the minimum velocity found for any pipe tested. The values for the 2-in. pipe were not determined by test, but are based on the conclusion drawn from the tests that the critical velocity for the 2-in. pipe is the same as that for the pipes tested.

TABLE 45. 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.
3/4	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
1 1/4	25.2	24,460	101.9	30.8	29,890	124.5
1 1/2	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

The table gives the capacity of the pipe in pounds of steam per hour, B.t.u. transmitted per hour, and square feet of radiation based on 240 B.t.u. per sq. ft.

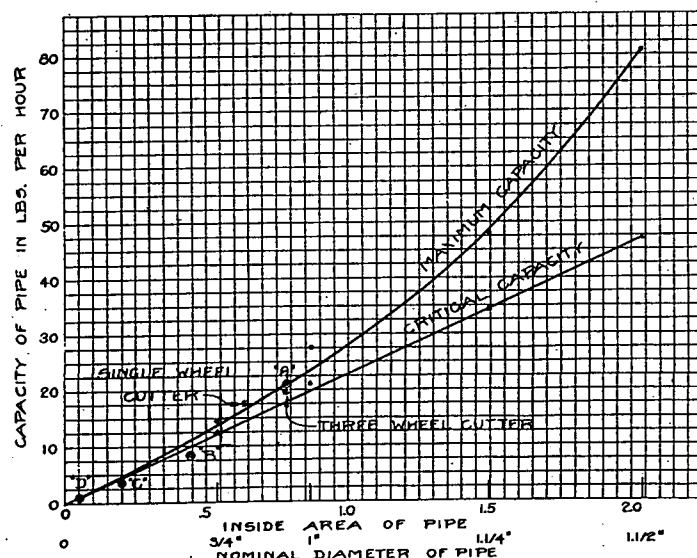


FIG. 31. CURVES SHOWING EFFECT OF CONSTRICTIONS IN VARIOUS SIZES OF PIPE

The investigation has brought out the following outstanding points which seem of sufficient importance to the heating industry to be summarized:

1. All pipe should be reamed—pipe cut by an ordinary wheel cutter and not reamed will decrease the capacity of a one-pipe system by as much as 30 per cent;
2. Pipe with any unusually large bump, blister, or other constriction on the inside should not be used—the capacity of a one-pipe system is no greater than the capacity of the free area left by its greatest constriction;
3. Unions and all other fittings entering into a riser should be of full size opening;
4. The size of pipe for one-pipe risers carrying any quantity of steam should be determined in accordance with Column 1 of Table 45, or by Column 2 after applying the desired factor of safety.

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. 32. 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. 33 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.

In actual practice, the circulation of water in a hot-water heating system is much more complicated than that shown in a simple circuit

Material for this section was prepared especially for THE GUIDE 1923 by William Hutton, Winsted, Conn., in collaboration with Philip Parker, Woburn, Mass., W. P. Elder, Sherman Parker and A. F. Karlson, Fitchburg, Mass.



like Fig. 32. 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. 35, 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.

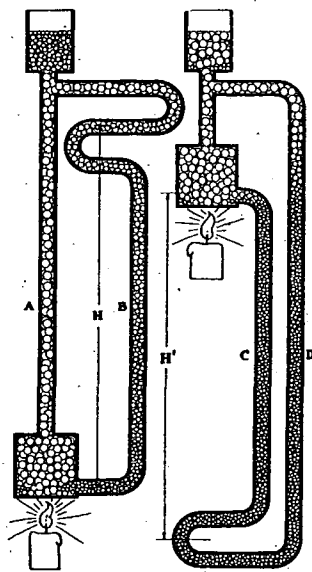


FIG. 32. ILLUSTRATES PRINCIPLE OF GRAVITY CIRCULATION

With gravity hot-water heating the force tending to cause circulation is very small. For 40 deg. drop, it only amounts to $\frac{3}{16}$ 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 formulas from tests made on large cast iron pipes; such as are used in city water works. These formulas 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.

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 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.



The charts, Fig. 34, 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. 35. 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. 35, 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.

The chart in Fig. 36 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.

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. 35 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

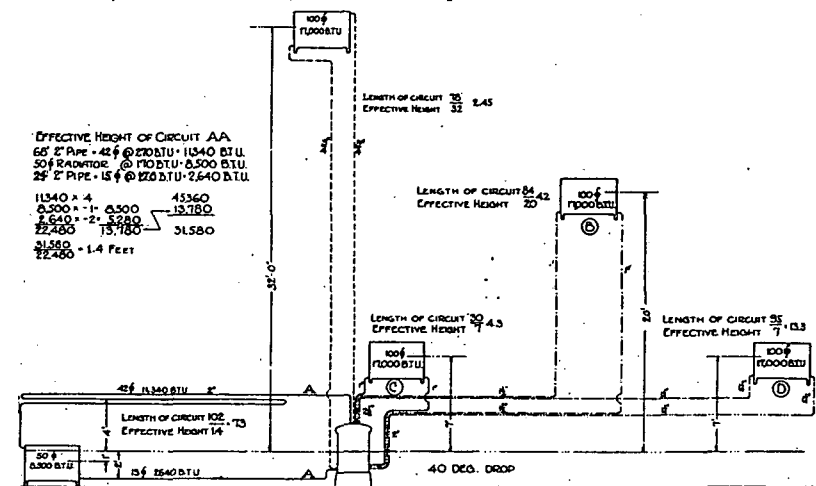


FIG. 35. DIAGRAM SHOWING EFFECTIVE CIRCUIT HEIGHTS WITH RADIATORS ABOVE AND AT BOILER LEVEL AND METHOD OF CALCULATING CAPACITY OF CIRCUITS FROM CHARTS IN FIG. 34.

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. 35, with a slightly lower drop at B and the lowest at D. Then the water would have a gradually falling tempera-

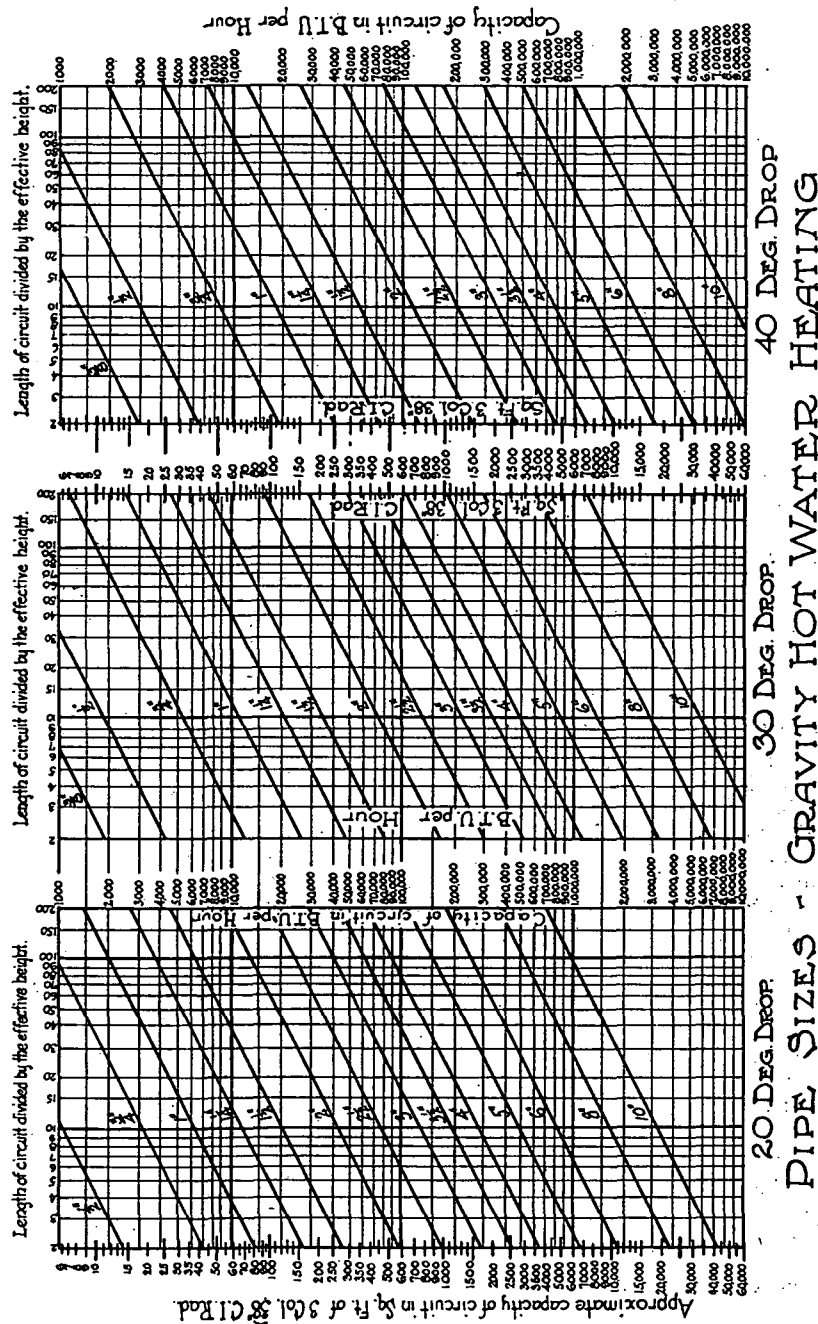


FIG. 34. PIPE SIZES REQUIRED FOR VARIOUS TEMPERATURE DROPS



ture 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. 37 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. 38 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.

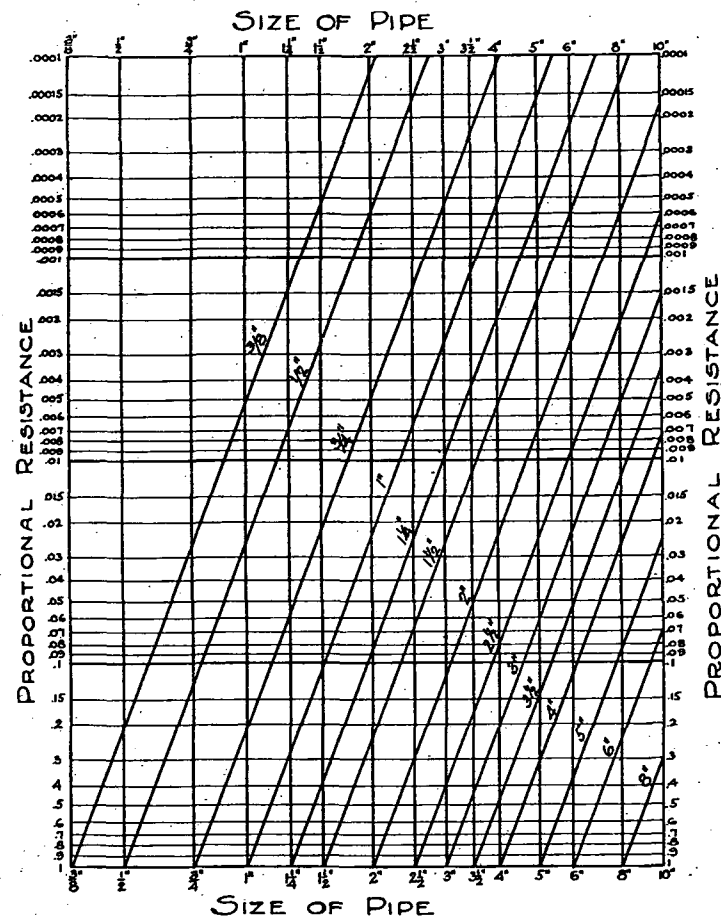


FIG. 36. CHART SHOWING PROPORTIONAL RESISTANCE OF PIPES

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

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. 39.

GREENHOUSE HEATING BY HOT WATER

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 certain conditions 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. In practically all other types of buildings the fires are banked at night. Greenhouse radiation is almost exclusively made up of piping. The temperatures demanded are almost always below 70 deg. and with lower temperatures and radiating surface giving a higher rate of heat emission, special care must be given to the selection of the boiler.

TABLE 46. TEMPERATURES 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

The matter of levels also affects the design and proportions of the heating mains. In many greenhouse ranges the walk levels are not more than 2 ft. 6 in., or 3 ft., above the top of the boiler and where all of the radiating surface is made up of pipe coils on a level not higher than 1 ft. 6 in. above

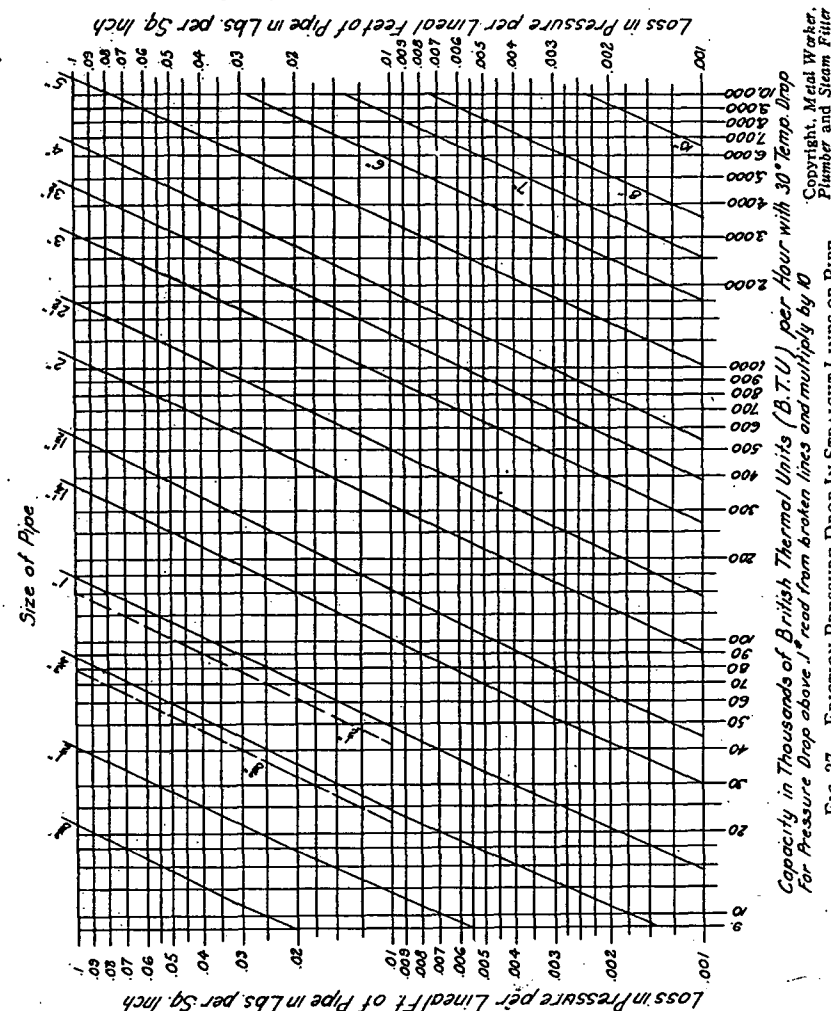


FIG. 37. FRICTION PRESSURE DROP IN STRAIGHT LINES OF PIPE

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 46.

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

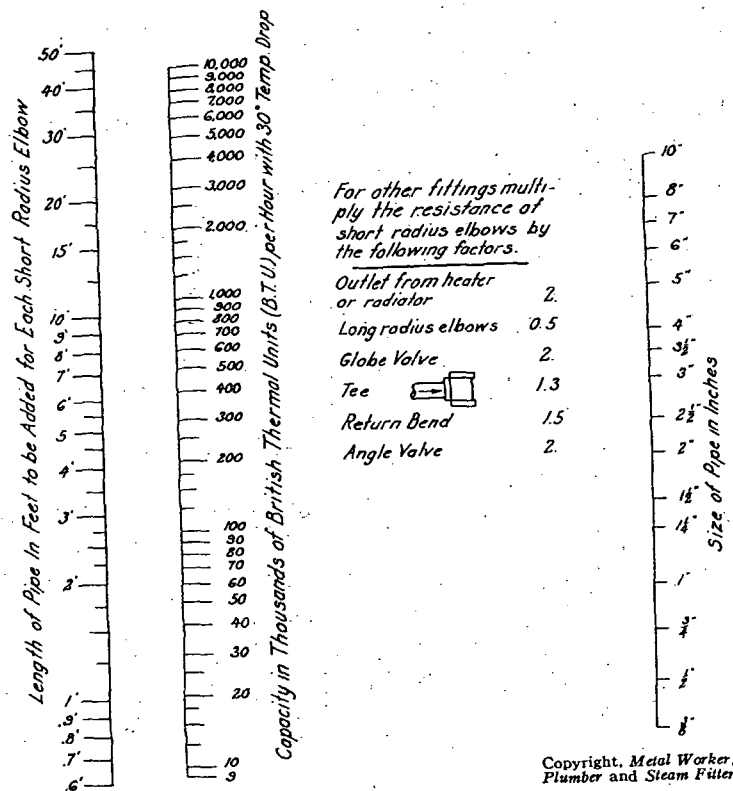


FIG. 38. CHART FOR FINDING FRICTION LOSS THROUGH FITTINGS

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 only for the purpose of 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 24x24 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.

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 47. FACTORS FOR GLASS SURFACES

For 70 to 75 deg. divide sq. ft. of glass and equivalent by 1.8
 For 65 to 70 deg. divide sq. ft. of glass and equivalent by 2.28
 For 60 to 65 deg. divide sq. ft. of glass and equivalent by 2.62
 For 55 to 60 deg. divide sq. ft. of glass and equivalent by 3.
 For 50 to 55 deg. divide sq. ft. of glass and equivalent by 3.46
 For 45 to 50 deg. divide sq. ft. of glass and equivalent by 4.
 For 40 to 45 deg. divide sq. ft. of glass and equivalent by 4.67
 For 35 to 40 deg. divide sq. ft. of glass and equivalent by 5.5.

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



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

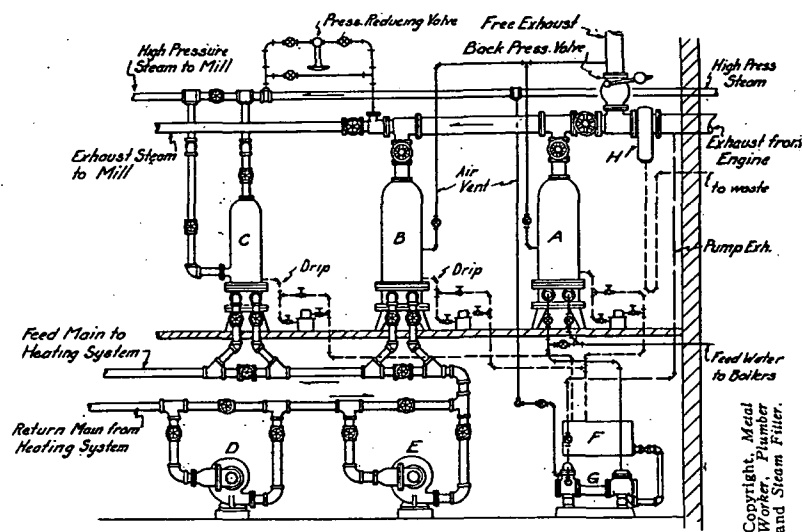


FIG. 39. TYPICAL ARRANGEMENT OF PUMPS AND HEATERS FOR FORCED CIRCULATION SYSTEM

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.

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. 40 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. Steam mains are usually carried overhead on columns, sometimes with the return mains in trenches. The greenhouse heating engineer and contractor uses 3½-in. cast iron pipe mainly for private greenhouse heating with hot water. This pipe holds about two quarts to the 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 47 for the temperature desired, and accepts the result obtained as the required number of lines of 3½-in. cast iron pipe, this size providing about 1 sq. ft. of surface to the lineal foot of pipe (1.05 sq. ft.).

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



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 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

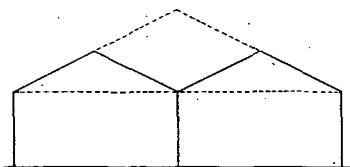


FIG. 40. SKETCH SHOWS RELATION OF CUBIC CONTENTS AND ROOF GLASS SURFACES

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.

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.

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 any standard text on heating and ventilation, 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. 41, 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. 43).
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 1923 by Arthur C. Willard, Urbana, Ill.

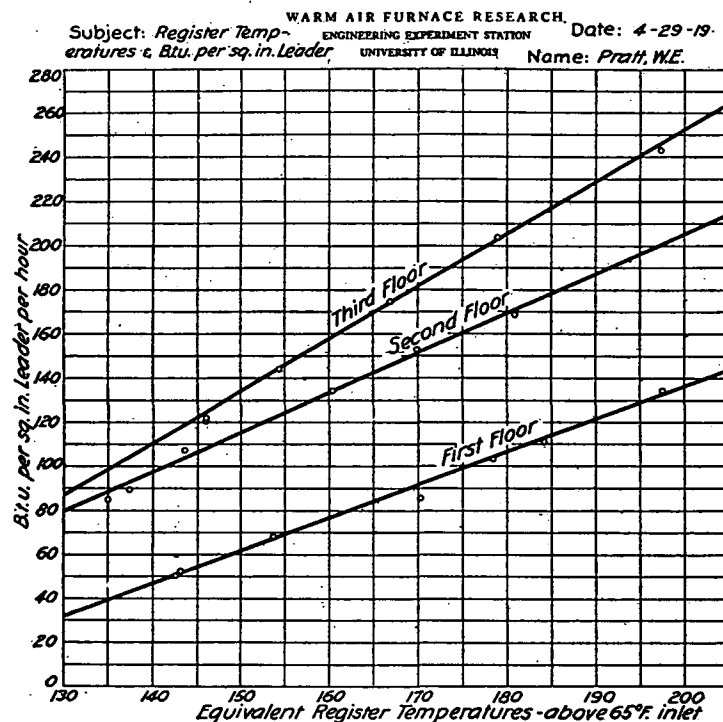


FIG. 41. CURVES SHOWING EFFECT OF REGISTER TEMPERATURE ON LEADER CAPACITIES

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.

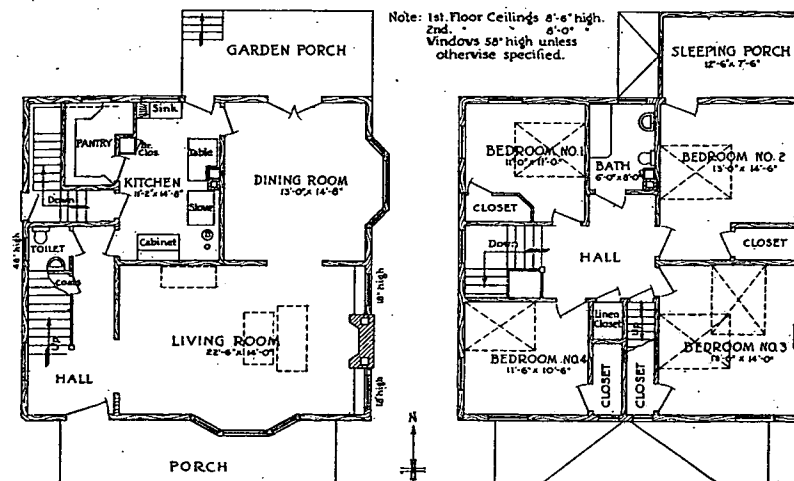


FIG. 42. FLOOR PLANS OF HOUSE USED IN TYPICAL DESIGN PROBLEM

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 9 x 12 in. clear inside and for the larger furnaces should be 12 x 12 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 $\frac{1}{4}$ 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. 41 have been plotted from the data obtained in seven tests on the main plant, Fig. 45 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. 46, 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 48.

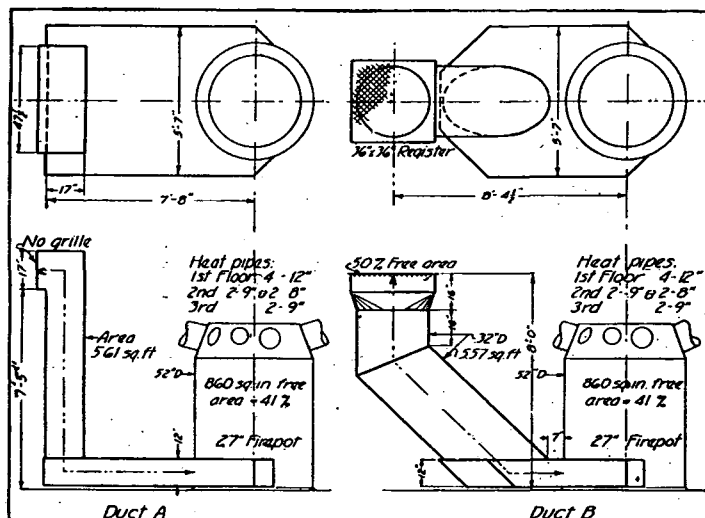


FIG. 43. TWO TYPES OF RETURN AIR DUCTS

Taking the first floor rooms of the house plan shown in Fig. 42, and assuming a register temperature for a zero day of 185 deg. fahr. from the curve for the first floor, it is evident that one square inch 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 one square inch 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 one square inch 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 $\frac{16,600}{115} = 144$ 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. 42 and the size of leader pipe as

TABLE 48. 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 20 per cent greater heat loss.....	8400	40	8	50
	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.

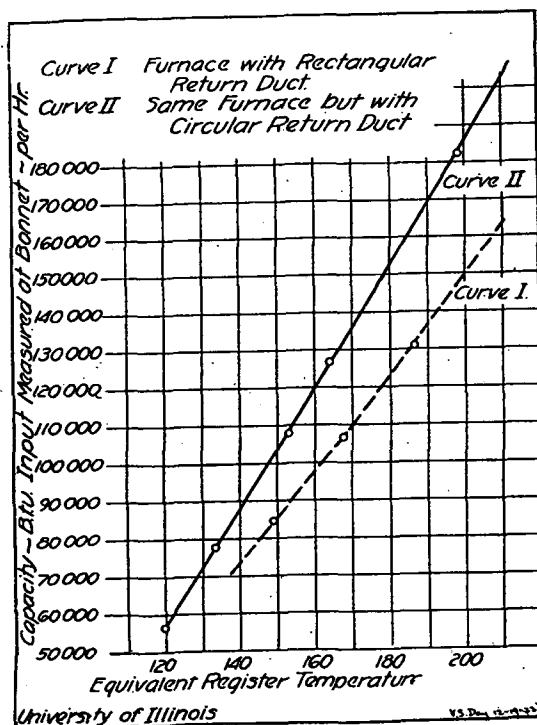


FIG. 44. CURVES SHOWING RELATION OF CAPACITY TO SHAPE OF RETURN DUCT

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 effect 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 and*

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.



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. 45 used in the tests was identical for both cases except for the changes necessary, Fig. 43, 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. 45, 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. 43.
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 temperatures, for this condition. The essential features of this plant are shown in Duct B, Fig. 43.

RESULTS OF TESTS

The results of the tests are shown in the curves of Fig. 44, 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 incapacity Fig. 44 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 49 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 grill, 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 49. 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. 44. 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. 45 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.

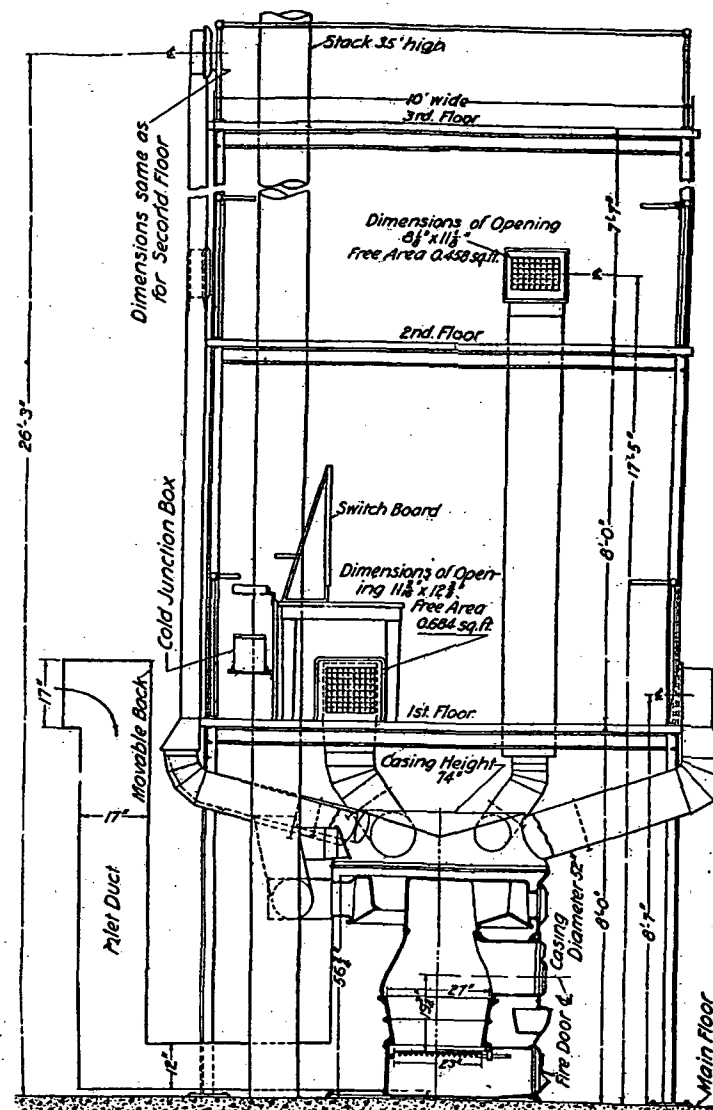


FIG. 45 ELEVATION OF PIPED FURNACE TESTING PLANT—NOTE ALTERNATIVE AND BETTER ARRANGEMENT OF RECIRCULATING DUCT IN FIG. 46



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. 45 are presented in Fig. 47 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

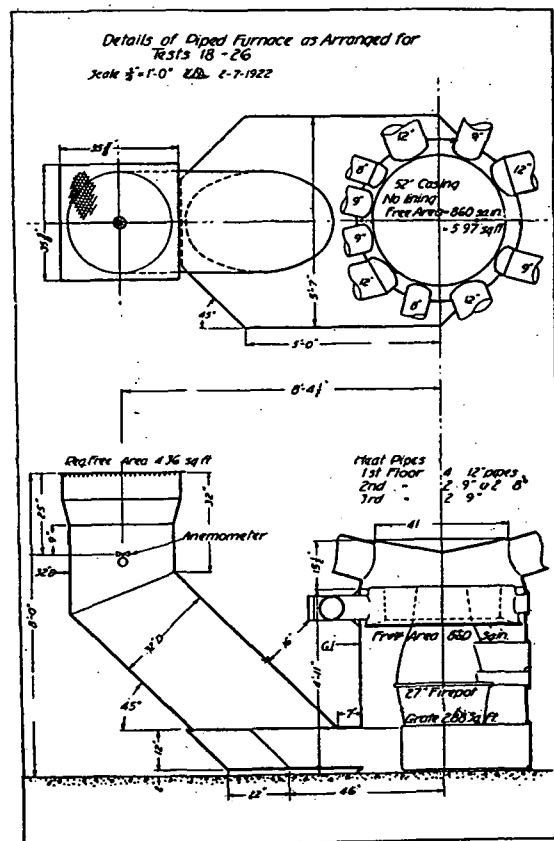


FIG. 46. AN IMPROVED RECIRCULATING DUCT WHICH INCREASED LEADER

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. 47.

The left-hand half of Fig. 47 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.)

$$\begin{array}{l} 452 \times 134 = 60,500 \\ 228 \times 168 = 38,400 \\ 128 \times 243 = 31,000 \end{array}$$

130,000 B.t.u. per hr.

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.*

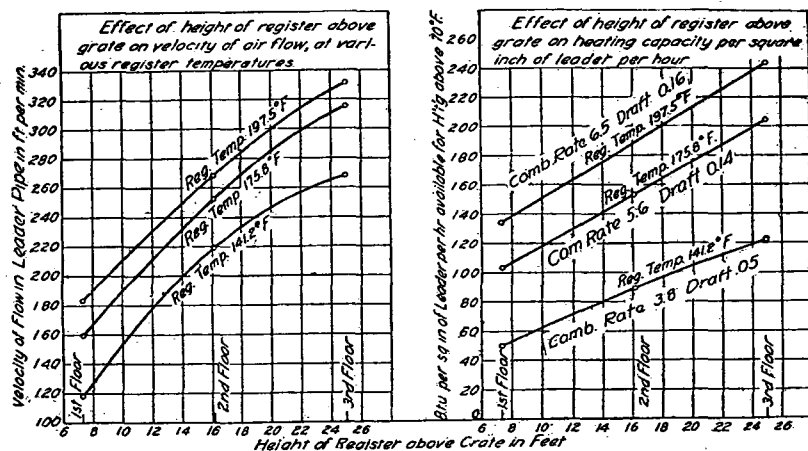


FIG. 47. CHARTS SHOWING EFFECT OF HEIGHT OF REGISTER ABOVE GRATE UPON VELOCITY OF AIR FLOW AND HEATING CAPACITY

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.

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 1923 by E. P. Bailey, Jr., Cleveland, and H. C. Eckenroth, San Francisco, Cal. 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. 48 and 49, 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

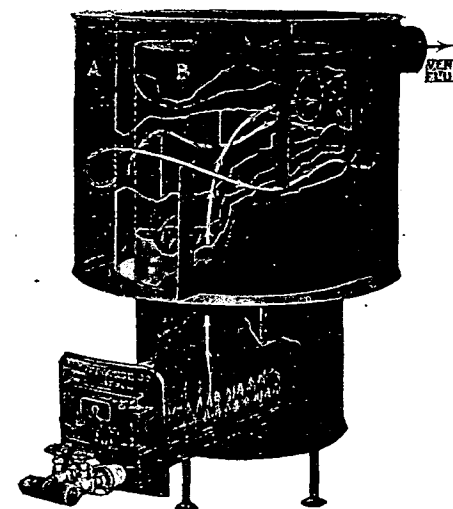


FIG. 48. VIEW OF GAS FIRED WARM AIR FURNACE

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 50.



TABLE 50. 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 51 gives an approximate idea of fuel requirements in various climates, and is based upon a heating season of seven calendar months:

TABLE 51. 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

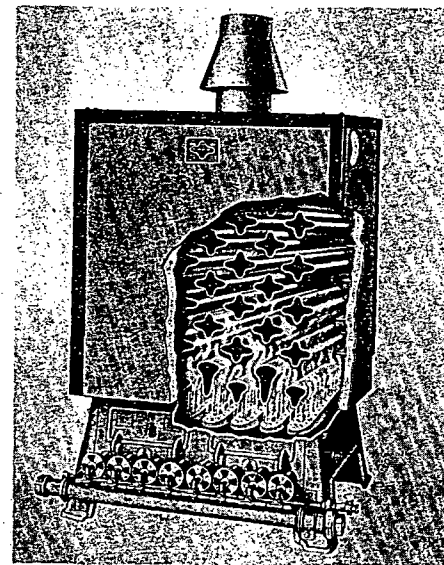


FIG. 49. STEAM HEATING UNIT FOR HOUSE HEATING SERVICE

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 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

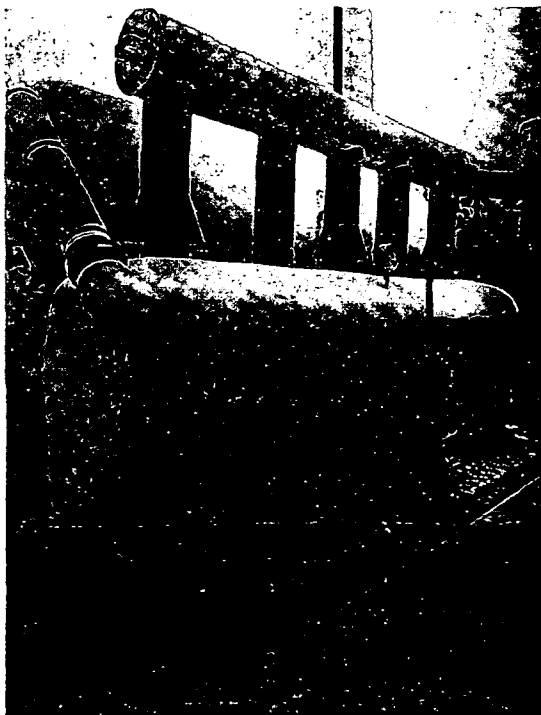


FIG. 50. GAS FIRED HOT WATER HEATING UNIT IN PACIFIC COAST MANUFACTURING PLANT

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.

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 practicably 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.

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

Material for this section was prepared especially for THE GUIDE 1923 by S. R. Lewis, Chicago, Ill., who is indebted to G. H. Blanding, John Hornung, F. W. Powers, of Chicago, and C. W. Sweatt, Minneapolis, for their hearty and helpful cooperation.

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. P.P. 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 expandable 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 simpler 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 theater 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 bypass 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.

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 52, 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.

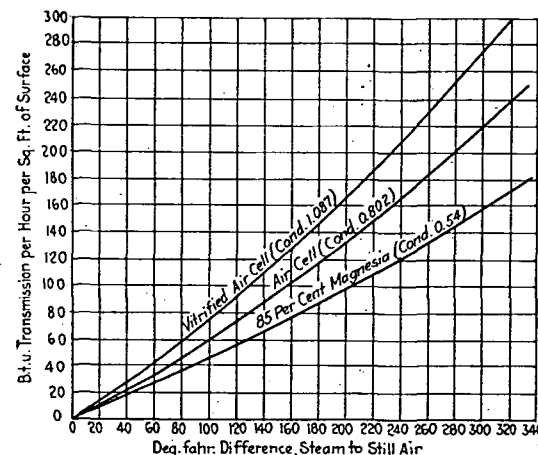


FIG. 51. HEAT TRANSMISSION IN B.T.U. PER HOUR PER SQUARE FOOT OF COVERED PIPE (1 IN. COVERING)

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 53 in B.t.u. per square foot per hour per degree fahr. temperature difference. Pounds of coal used are given per 100 sq. ft. per month assuming continuous use of the

Material for this section was prepared especially for THE GUIDE 1923 by L. L. Barrett and L. B. McMillan, New York.

TABLE 15—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.	HOT WATER			10 Lb.			239.4 deg. Fahr.			80 Lb.			324.0 deg. Fahr.			120 Lb.			350.0 deg. Fahr.			160 Lb.			370.7 deg. Fahr.			200 Lb.			387.9 deg. Fahr.			200 Lb. AND 100 DEG. FAHR. SUPERHEAT.			275 Lb. AND 250 DEG. FAHR. SUPERHEAT.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
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1 1/2"	1.32	528	605	2.24	897	.670	3.92	1568	.779	4.51	1805	.815	5.25	2010	.846	5.63	2210	.875	5.80	2340	8.60	3440	1.040	1.375	16.15	6460	1.375	5280	605	2.24	897	.670	3.92	1568	.779	4.51	1805	.815	5.25	2010	.846	5.63	2210	.875	5.80	2340	8.60	3440	1.040	1.375																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
1"	1.91	763	978	3.78	1308	1.373	5.72	2280	1.586	9.28	2601	1.778	7.27	2915	1.742	8.07	3230	1.280	12.96	5028	1.520	30.55	1.920	2.620	2.920	3.780	4.680	5.180	5.780	6.780	7.380	8.380	9.380	10.380	11.380	12.380	13.380	14.380	15.380	16.380	17.380	18.380	19.380	20.380	21.380	22.380	23.380	24.380	25.380	26.380	27.380	28.380	29.380	30.380	31.380	32.380	33.380	34.380	35.380	36.380	37.380	38.380	39.380	40.380	41.380	42.380	43.380	44.380	45.380	46.380	47.380	48.380	49.380	50.380	51.380	52.380	53.380	54.380	55.380	56.380	57.380	58.380	59.380	60.380	61.380	62.380	63.380	64.380	65.380	66.380	67.380	68.380	69.380	70.380	71.380	72.380	73.380	74.380	75.380	76.380	77.380	78.380	79.380	80.380	81.380	82.380	83.380	84.380	85.380	86.380	87.380	88.380	89.380	90.380	91.380	92.380	93.380	94.380	95.380	96.380	97.380	98.380	99.380	100.380	101.380	102.380	103.380	104.380	105.380	106.380	107.380	108.380	109.380	110.380	111.380	112.380	113.380	114.380	115.380	116.380	117.380	118.380	119.380	120.380	121.380	122.380	123.380	124.380	125.380	126.380	127.380	128.380	129.380	130.380	131.380	132.380	133.380	134.380	135.380	136.380	137.380	138.380	139.380	140.380	141.380	142.380	143.380	144.380	145.380	146.380	147.380	148.380	149.380	150.380	151.380	152.380	153.380	154.380	155.380	156.380	157.380	158.380	159.380	160.380	161.380	162.380	163.380	164.380	165.380	166.380	167.380	168.380	169.380	170.380	171.380	172.380	173.380	174.380	175.380	176.380	177.380	178.380	179.380	180.380	181.380	182.380	183.380	184.380	185.380	186.380	187.380	188.380	189.380	190.380	191.380	192.380	193.380	194.380	195.380	196.380	197.380	198.380	199.380	200.380	201.380	202.380	203.380	204.380	205.380	206.380	207.380	208.380	209.380	210.380	211.380	212.380	213.380	214.380	215.380	216.380	217.380	218.380	219.380	220.380	221.380	222.380	223.380	224.380	225.380	226.380	227.380	228.380	229.380	230.380	231.380	232.380	233.380	234.380	235.380	236.380	237.380	238.380	239.380	240.380	241.380	242.380	243.380	244.380	245.380	246.380	247.380	248.380	249.380	250.380	251.380	252.380	253.380	254.380	255.380	256.380	257.380	258.380	259.380	260.380	261.380	262.380	263.380	264.380	265.380	266.380	267.380	268.380	269.380	270.380	271.380	272.380	273.380	274.380	275.380	276.380	277.380	278.380	279.380	280.380	281.380	282.380	283.380	284.380	285.380	286.380	287.380	288.380	289.380	290.380	291.380	292.380	293.380	294.380	295.380	296.380	297.380	298.380	299.380	300.380	301.380	302.380	303.380	304.380	305.380	306.380	307.380	308.380	309.380	310.380	311.380	312.380	313.380	314.380	315.380	316.380	317.380	318.380	319.380	320.380	321.380	322.380	323.380	324.380	325.380	326.380	327.380	328.380	329.380	330.380	331.380	332.380	333.380	334.380	335.380	336.380	337.380	338.380	339.380	340.380	341.380	342.380	343.380	344.380	345.380	346.380	347.380	348.380	349.380	350.380	351.380	352.380	353.380	354.380	355.380	356.380	357.380	358.380	359.380	360.380	361.380	362.380	363.380	364.380	365.380	366.380	367.380	368.380	369.380	370.380	371.380	372.380	373.380	374.380	375.380	376.380	377.380	378.380	379.380	380.380	381.380	382.380	383.380	384.380	385.380	386.380	387.380	388.380	389.380	390.380	391.380	392.380	393.380	394.380	395.380	396.380	397.380	398.380	399.380	400.380	401.380	402.380	403.380	404.380	405.380	406.380	407.380	408.380	409.380	410.380	411.380	412.380	413.380	414.380	415.380	416.380	417.380	418.380	419.380	420.380	421.380	422.380	423.380	424.380	425.380	426.380	427.380	428.380	429.380	430.380	431.380	432.380	433.380	434.380	435.380	436.380	437.380	438.380	439.380	440.380	441.380	442.380	443.380	444.380	445.380	446.380	447.380	448.380	449.380	450.380	451.380	452.380	453.380	454.380	455.380	456.380	457.380	458.380	459.380	460.380	461.380	462.380	463.380	464.380	465.380	466.380	467.380	468.380	469.380	470.380	471.380	472.380	473.380	474.380	475.380	476.380	477.380	478.380	479.380	480.380	481.380	482.380	483.380	484.380	485.380	486.380	487.380	488.380	489.380	490.380	491.380	492.380	493.380	494.380	495.380	496.380	497.380	498.380	499.380	500.380	501.380	502.380	503.380	504.380	505.380	506.380	507.380	508.380	509.380	510.380	511.380	512.380	513.380	514.380	515.380	516.380	517.380	518.380	519.380	520.380	521.380	522.380	523.380	524.380	525.380	526.380	527.380	528.380	529.380	530.380	531.380	532.380	533.380	534.380	535.380	536.380	537.380	538.380	539.380	540.380	541.380	542.380	543.380	544.380	545.380	546.380	547.380	548.380	549.380	550.380	551.380	552.380	553.380	554.380	555.380	556.380	557.380	558.380	559.380	560.380	561.380	562.380	563.380	564.380	565.380	566.380	567.380	568.380	569.380	570.380	571.380	572.380	573.380	574.380	575.380	576.380	577.380	578.380	579.380	580.380	581.380	582.380	583.380	584.380	585.380	586.380	587.380	588.380	589.380	590.380	591.380	592.380	593.380	594.380	595.380	596.380	597.380	598.380	599.380	600.380	601.380	602.380	603.380	604.380	605.380	606.380	607.380	608.380	609.380	610.380	611.380	612.380	613.380	614.380	615.380	616.380	617.380	618.380	619.380	620.380	621.380	622.380	623.380	624.380	625.380	626.380	627.380	628.380	629.380	630.380	631.380	632.380	633.380	634.380	635.380	636.380	637.380	638.380	639.380	640.380	641.380	642.380	643.380	644.380	645.380	646.380	647.380	648.380	649.380	650.380	651.380	652.380	653.380	654.380	655.380	656.380	657.380	658.380	659.380	660.380	661.380	662.380	663.380	664.380	665.380	666.380	667.380	668.380	669.380	670.380	671.380	672.380	673.380	674.380	675.380	676.380	677.380	678.380	679.380	680.380	681.380	682.380	683.380	684.380	685.380	686.380	687.380	688.380	689.380	690.380	691.380	692.380	693.380	694.380	695.380	696.380	697.380	698.380	699.380	700.380	701.380	702.380	703.380	704.380	705.380	706.380	707.380	708.380	709.380	710.380	711.380	712.380	713.380	714.380	715.380	716.380	717.380	718.380	719.380	720.380	721.380	722.380	723.380	724.380	725.380	726.380	727.380	728.380	729.380	730.380	731.380	732.380	733.380	734.380	735.380	736.380	737.380	738.380	739.380	740.380	741.380	742.380	743.380	744.380	745.380	746.380	747.380	748.380	749.380	750.380	751.380	752.380	753.380	754.380	755.380	756.380	757.380	758.380	759.380	760.380	761.380	762.380	763.380	764.380	765.380	766.380	767.380	768.380	769.380	770.380	771.380	772.380	773.380	774.380	775.380	776.380	777.380	778.380	779.380	780.380	781.380	782.380	783.380	784.380	785.380	786.380	787.380	788.380	789.380	790.380	791.380	792.380	793.380	794.380	795.380	796.380	797.380	798.380	799.380	800.380	801.380	802.380	803.380	804.380	805.380	806.380	807.380	808.380	809.380	810.380	811.380	812.380	813.380	814.380	815.380	816.380	817.380	818.380	819.380	820.380	821.380	822.380	823.380	824.380	825.380	826.380	827.380	828.380	829.380	830.380	831.380	832.380	833.380	834.380	835.380	836.380	837.380	838.380	839.380	840.380	841.380	842.380	843.380	844.380	845.380	846.380	847.380	848.380	849.380	850.380	851.380	852.380	853.380	854.380	855.380	856.380	857.380	858.380	859.380	860.380	861.380	862.380	863.380	864.380	865.380	866.380	867.380	868.380	869.380	870.380	871.380	872.380	873.380	874.380	875.380	876.380	877.380	878.380	879.380	880.380	881.380	882.380	883.380	884.380	885.380	886.380	887.380	888.380	889.380	890.380	891.380	892.380	893.380	894.380	895.380	896.380	897.380	898.380	899.380	900.380	901.380	902.380	903.380	904.380	905.380	906.380	907.380	908.380	909.380	910.380	911.380	912.380	913.380	914.380	915.380	916.380	917.380	918.380	919.380	920.380	921.380	922.380	923.380	924.380	925.380	926.380	927.380	928.380	929.380	930.380	931.380	932.380	933.380	934.380	935.380	936

*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.



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 53. HEAT LOSS FROM UNINSULATED SURFACES

	Temperature Deg. Fahr.	Heat Loss* B.t.u.	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° fahr. superheat	488	3.88	12,830	32.05

*B.t.u. per sq. ft. per deg. fahr. temp. difference per hour.

CONDUCTIVITY OF INSULATING MATERIALS

The conductivities in B.t.u. per square feet per hour per inch thick per degree fahr. temperature difference of the various insulating materials are given in Table 54. It should be emphasized that in this table all variables due to differences in thickness, different pipe sizes, and different air conditions, are eliminated.

TABLE 54. CONDUCTIVITIES OF VARIOUS INSULATING MATERIALS

	Density lb. per Cu. Ft.	Conductivity	Temp. Diff. which Conductivity was Determined	Authority	Year
Asbestos Sponge Felted	23.80	0.468	300 deg. fahr.	Vol. 37, <i>Trans. A. S. M. E.</i> , p. 968	1915
Wool Felt.....	16.24	0.521	300 " "	" " " " " "	1915
85% Magnesia.....	17.20	0.54	300 " "	Vol. 40, <i>Trans. A. S. M. E.</i> , p. 667	1918
Carocel.....	21.70	0.54	300 " "	Vol. 37 <i>Trans. A. S. M. E.</i> , p. 968	1915
Nonpareil H. P.....	17.43	0.543	300 " "	" " " " " "	1915
Plastic, 85% Magnesia	.....	0.587	300 " "	" " " " " "	1915
Asbestocel.....	12.16	0.595	300 " "	" " " " " "	1915
Expanded Asbestos	22.49	0.598	300 " "	" " " " " "	1915
Indented.....	21.24	0.686	300 " "	" " " " " "	1915
Molded Asbestos.....	29.86	0.778	300 " "	" " " " " "	1915
Air Cell.....	11.70	0.802	300 " "	" " " " " "	1915
Vitribestos.....	29.73	1.087	300 " "	" " " " " "	1915
Asbestos Fire Felt.....	26.59	1.093	300 " "	" " " " " "	1915
Corboard.....	9.90	0.304	36 " "	Vol. 26 A. S. H. & V., <i>E. JOURNAL</i> , p. 625	1915
Hair Felt.....	17.00	0.246	36 " "		1920

HEAT LOSS FROM INSULATED SURFACES

Fig. 51 gives the heat loss per square foot of pipe per hour of piping where the pipe is covered with 1 in. thick covering. Inasmuch as the 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. 52. When coverings are used other than those for which curves are given reference should be made to Table 54 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 55 shows the thickness of covering required for maximum net saving with coal at \$4 per ton.

TABLE 55. 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° super- heat 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. 51 it is necessary to know the number of square feet of radiating surface in 1 linear ft. of pipe. Table 56 gives this data for the various standard pipe sizes.

TABLE 56. 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 57.

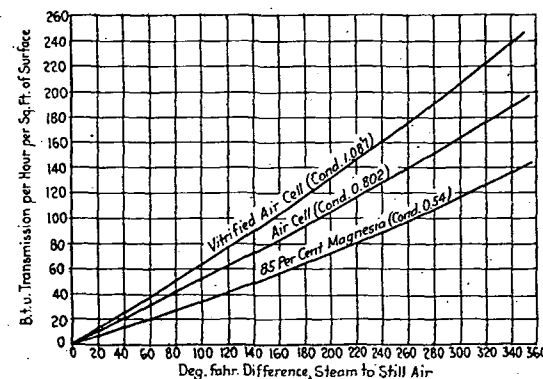


FIG. 52. HEAT TRANSMISSION IN B.T.U. PER HOUR PER SQUARE FOOT OF FLAT INSULATED SURFACE. (1 IN. COVERING)

Coverings made in thicknesses as shown in Table 57 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. 51 can be used in the case of standard thick coverings without error or practical

TABLE 57. 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.

INFILTRATION

THE problem of inleakage or infiltration is always a serious problem confronting the heating engineer in figuring on the heating of any building. The cracks around windows and doors permit the entrance of cold air, dust, soot, rain, etc., and the amount of this inleakage is in proportion to the number and size of openings and its volume has been found to be in proportion to the wind velocity.

In the construction of any building, it is necessary to build the brick, tile or stone work around the frame of a window or door. The frame being exposed to rain and atmospheric conditions in addition to being in contact with the mortar in the brick or tile work, absorbs moisture, which causes considerable swelling of the wood. Later when the building is plastered more moisture is absorbed. While the frames are in this swelled condition, the sashes are fitted, due allowances being made in fitting the sashes and doors for further swelling by the sash. To allow free operation of the sashes, a crack between the sash and frame of at least $\frac{1}{16}$ in. is necessary, but very often a crack of $\frac{1}{8}$ in. is made. When the heating plant is put in operation, the process of shrinking usually begins and continues for an indefinite period, and cases have been found, at the end of the second heating season, where the crack between the sash and the frame has been increased to $\frac{1}{4}$ in. in size.

Assuming an average crack all around the sashes is only $\frac{1}{8}$ in. the infiltration through a 3x7 ft. window would be equal to the volume of air that would pass, at a given velocity, through an orifice having an area of $34\frac{1}{2}$ in., therefore the infiltration is directly proportional to the area of the crack aperture. This is fundamental and not conditional. As long as it is necessary for a building to have windows and doors for the purpose of light and ventilation, infiltration will be the first essential in determining the size and operation of a heating plant.

According to tests (See report of S. F. Voorhees in A. S. H. V. E. GUIDE 1922, and O. W. Armspach in *Heating and Ventilating Magazine*, April, 1916), the infiltration through a double hung window can be figured on a basis of 114 cu. ft., 55.8 cu. ft. and 24. cu ft. of air per hr. per lineal foot of crack (the last two are through metal weather strips of a different type.)

The B.t.u. losses due to infiltration can be computed from the expression, $W_p \times I \times 0.02 (T_i - T_o)$

in which W_p = Window crack perimeter

I = Infiltration in cubic feet per hour per lineal foot of cracks

T_i = Inside temperature

T_o = Outside temperature

Material for this section was prepared especially for THE GUIDE 1923 by E. P. Bradley, Jr., St. Louis, Mo.

If it is desired to figure on a basis of the number of air changes the expression would be $N = \frac{W_p \times I_h}{C}$

in which N = Number of air changes

W_p = Window crack perimeter

I_h = Infiltration per hour per lineal foot of cracks

C = Cubical contents

The crack perimeter of a double hung window is four times the height, and three times the width of the lower sash.

The perimeter of doors is the width plus the height times two, single casements the same, double casements twice the width and three times the height.

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

Window, 3 x 7 ft. Crack, 23 lin. ft.

Wind, 20 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)

Net B.t.u. = $13,080 \times 0.65 = 8500$ B.t.u. effective leakage.

A. Unstripped window, 114 cu. ft. per hr. per ft. crack

B. Plain Rib Strip (3 miles), 55.8 cu. ft. per hr. per ft. crack

C. Metal Weather Strip, 24 cu. ft. per hr. per ft. crack

$$A. \frac{23 \times 114 \times 1.439}{8500} = 0.445 \text{ lb. coal per hr.}$$

$$\frac{0.445 \times 24 \times 130}{2000} = \frac{1385}{2000} = 0.694 \text{ tons per season}$$

$$\$6.00 \times .694 = \$4.16 \text{ per season}$$

$$B. \frac{23 \times 55.8 \times 1.439}{8500} = 0.218 \text{ lb. coal per hr.}$$

$$\frac{0.218 \times 24 \times 130}{2000} = \frac{680}{2000} = 0.34 \text{ tons per season}$$

$$\$6.00 \times .34 = \$2.04 \text{ per season}$$

$$C. \frac{23 \times 24 \times 1.439}{8500} = 0.0935 \text{ lb. coal per hr.}$$

$$\frac{0.0935 \times 24 \times 130}{2000} = \frac{292}{2000} = 0.146 \text{ tons per season}$$

$$\$6.00 \times 0.146 = \$0.875 \text{ per season}$$

SUMMARY

A	\$4.16	A	\$4.16	B	\$2.04
B	2.04	C	.875	C	.875
A-B	\$2.12	A-C	\$3.285	B-C	\$1.165

Fuel cost per window—

Without weather strips.....	\$4.16
With Rib strip.....	2.04
With metal adjustable.....	.875

Fuel saved with—

Rib strip.....	\$2.12
Metal adjustable.....	3.285
Metal vs. Rib.....	1.165

The above is based on infiltration on windward side of building.

Room, 15×15×10=2250 cu. ft.
 Wall, 300 net = 264 sq. ft.
 Crack Aperture, 42 ft.
 Glass, 36 = 36 sq. ft.
 Ceiling, = 225 sq. ft.
 Two windows, 3 x 6, crack aperture, 2 x 21 ft. x 1/8 in.
 Wind velocity, 20 miles per hr.

INFILTRATION PER HOUR PER FOOT OF CRACK	NO. STRIP	RIB STRIP	METAL STRIP
	114 Cu. Ft.	55.8 Cu. Ft.	24 Cu. Ft.
Wall.....	5540 B.t.u.	5540 B.t.u.	5540 B.t.u.
Glass.....	2520 "	2520 "	2520 "
Crack Infiltration.....	6900 "	3375 "	1450 "
Ceiling.....	4725 "	4725 "	4725 "
	19,685 B.t.u.	16,160 B.t.u.	14,235 B.t.u.

With equal consumption and radiation, inside temperature would be as follows:

$$\frac{19,685 \text{ B.t.u.}}{240 \text{ rad. eff.}} = 59 \text{ sq. ft. rad. } 38 \text{ in., } 2 \text{ col., } \begin{cases} 60 \text{ deg. inside} \\ 0 \text{ deg. outside} \end{cases}$$

$$\frac{16,160 \text{ B.t.u.}}{240 \text{ rad. eff.}} = 59 \text{ sq. ft. rad. } 38 \text{ in., } 2 \text{ col., } \begin{cases} 65 \text{ deg. inside} \\ 0 \text{ deg. outside} \end{cases}$$

$$\frac{14,235 \text{ B.t.u.}}{240 \text{ rad. eff.}} = 59 \text{ sq. ft. rad. } 38 \text{ in., } 2 \text{ col., } \begin{cases} 70 \text{ deg. inside} \\ 0 \text{ deg. outside} \end{cases}$$

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 twenty 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 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

Material for this section was prepared especially for THE GUIDE 1923, 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.

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 an 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 58. STANDARD PIPE—BLACK AND GALVANIZED*

All Weights and Dimensions are Nominal

Size	DIAMETERS		Thickness	WEIGHT PER FOOT		Threads per inch	COUPLINGS			TEST PRESSURE IN POUNDS	
	External	Internal		Plain ends	Threads and couplings		Diameter	Length	Weight	Butt	Lap
1/8	.405	.269	.068	.244	.245	27	.562	3/4	.029	700	-----
1/4	.540	.364	.088	.424	.425	18	.685	1	.043	700	-----
3/8	.675	.493	.091	.567	.568	18	.848	1 1/4	.070	700	-----
1/2	.840	.622	.109	.850	.852	14	1.024	1 1/2	.116	700	-----
3/4	1.050	.824	.113	1.130	1.134	14	1.281	1 3/4	.209	700	-----
1	1.315	1.049	.133	1.678	1.684	11 1/2	1.576	1 3/4	.343	700	-----
1 1/4	1.660	1.380	.140	2.272	2.281	11 1/2	1.950	2 1/4	.535	700	1000
1 1/2	1.900	1.610	.145	2.717	2.731	11 1/2	2.218	2 3/4	.743	700	1000
2	2.375	2.067	.154	3.652	3.678	11 1/2	2.760	2 3/4	1.208	700	1000
2 1/2	2.875	2.469	.203	5.793	5.819	8	3.276	2 3/4	1.720	800	1000
3	3.500	3.068	.216	7.575	7.616	8	3.948	3 3/4	2.498	800	1000
3 1/2	4.000	3.548	.226	9.109	9.202	8	4.591	3 3/4	4.241	800	1000
4	4.500	4.026	.237	10.790	10.889	8	5.091	3 3/4	4.741	-----	1000
4 1/4	5.000	4.506	.247	12.538	12.642	8	5.591	3 3/4	5.241	-----	1000
5	5.563	5.047	.258	14.617	14.810	8	6.296	4 1/4	8.091	-----	1000
6	6.625	6.065	.280	18.974	19.185	8	7.358	4 1/4	9.554	-----	1000
7	7.625	7.023	.301	23.544	23.769	8	8.358	4 1/4	10.932	-----	1000
8	8.625	8.071	.277	24.696	25.000	8	9.358	4 1/4	13.905	-----	800
8	8.625	7.981	.322	28.554	28.809	8	9.358	4 1/4	13.905	-----	1000
9	9.625	8.941	.342	33.907	34.188	8	10.358	5 1/4	17.236	-----	900
10	10.750	10.192	.279	31.201	32.000	8	11.721	6 1/4	29.877	-----	600
10	10.750	10.136	.307	34.240	35.000	8	11.721	6 1/4	29.877	-----	800
10	10.750	10.020	.365	40.483	41.132	8	11.721	6 1/4	29.877	-----	900
11	11.750	11.000	.375	45.557	46.247	8	12.721	6 1/4	32.550	-----	800
12	12.750	12.090	.330	43.773	45.000	8	13.958	6 1/4	43.098	-----	600
12	12.750	12.000	.375	49.562	50.706	8	13.958	6 1/4	43.098	-----	800
14 O. D.	14.000	13.250	.375	54.568	55.824	8	15.208	6 1/4	47.152	-----	700
15 O. D.	15.000	14.250	.375	58.573	60.375	8	16.446	6 1/4	59.493	-----	700
16 O. D.	16.000	15.250	.375	62.579	64.500	8	17.446	6 1/4	63.294	-----	600
17 O. D.	17.000	16.214	.393	69.704	72.602	8	18.683	7 1/4	90.941	-----	600
18 O. D.	18.000	17.182	.409	76.840	80.482	8	19.921	7 1/4	108.672	-----	600
20 O. D.	20.000	19.182	.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 59. 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	.405	.215	.095	.314	700	-----
1/4	.540	.302	.119	.535	700	-----
3/8	.675	.423	.126	.738	700	-----
1/2	.840	.546	.147	1.087	700	-----
3/4	1.050	.742	.154	1.473	700	-----
1	1.315	.957	.179	2.171	700	-----
1 1/4	1.660	1.278	.191	2.996	1500	2500
1 1/2	1.900	1.500	.200	3.631	1500	2500
2	2.375	1.939	.218	5.022	1500	2500
2 1/2	2.875	2.323	.276	7.661	1500	2000
3	3.500	2.900	.300	10.252	1500	2000
3 1/2	4.000	3.364	.318	12.505	-----	2000
4	4.500	3.826	.337	14.983	-----	2000
4 1/2	5.000	4.290	.355	17.611	-----	1800
5	5.563	4.813	.375	20.778	-----	1800
6	6.625	5.761	.432	28.573	-----	1800
7	7.625	6.625	.500	38.048	-----	1500
8	8.625	7.625	.500	43.388	-----	1500
9	9.625	8.625	.500	48.728	-----	1500
10	10.750	9.750	.500	54.735	-----	1200
11	11.750	10.750	.500	60.075	-----	1100
12	12.750	11.750	.500	65.415	-----	1100
14 O. D.	14.000	13.000	.500	72.091	-----	1000
15 O. D.	15.000	14.000	.500	77.431	-----	1000
16 O. D.	16.000	15.000	.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 remaining cost covering the items of fittings, valves, installation, shop costs, supervision and overhead.

TABLE 60. 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	1/4	.540	.367	.424	.750	1.000	.059
	3/8	.675	.489	.567	.968	1.343	.156
	1/2	.840	.617	.850	1.078	1.343	.168
	3/4	1.050	.819	1.130	1.312	1.531	.243
	1	1.315	1.043	1.678	1.656	1.718	.425
Buttweld and Lapweld	1 1/4	1.660	1.369	2.272	1.984	2.062	.631
	1 1/2	1.900	1.604	2.717	2.281	2.312	.884
Lapweld	2	2.375	2.060	3.652	2.750	2.500	1.100
	2 1/4	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 1/4	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 1/4	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	24.696	9.406	5.000	16.250
	8	8.625	7.967	28.554	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
	10	10.750	10.005	40.483	11.937	6.750	42.900
	11	11.750	10.985	45.557	12.937	6.750	45.900
	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	.540	.295	.535	.843	1.250	.125
	3/8	.675	.417	.738	.968	1.343	.156
	1/2	.840	.539	1.087	1.109	1.500	.200
	3/4	1.050	.735	1.473	1.406	2.125	.460
	1	1.315	.949	2.171	1.656	2.375	.625
Buttweld and Lapweld	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
Lapweld	2	2.375	1.929	5.022	2.937	3.625	2.400
	2 1/4	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 1/4	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 1/4	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 60. GENUINE WROUGHT IRON PIPE, BLACK OR GALVANIZED—Continued

STEEL OR CAST-IRON COUPLINGS					Couplings		
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	¾	.840	.226	1.714	Same as for Extra Heavy		
	¾	1.050	.413	2.440			
	1	1.315	.576	3.659			
	1¼	1.660	.874	5.214			
Buttweld and Lapweld	1½	1.900	1.078	6.408	Same as for Extra Heavy		
Lapweld	2	2.375	1.480	9.029	Same as for Extra Heavy		
	2½	2.875	1.742	13.695			
	3	3.500	2.270	18.583			
	3¼	4.000	2.697	22.850			
	4	4.500	3.119	27.541			
	4½	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% below and 5% above.

Standard pipe furnished with threads and couplings and 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									
Temperature	160°	180°	200°	212°	228°	240°	250°	259°	267°	274°
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.

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 $\frac{1}{8}$ to 10 in. o. d. and in gages from 2 to 25 B & S and Stubbs.

Copper 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 from 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 $1\frac{1}{2}$ in. pipe, would be entirely closed up when only $\frac{1}{27}$ of the thickness of its wall would have been converted into oxides, and in a 1 in. pipe only $\frac{1}{40}$. 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.*

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 61 gives weights and sizes for copper and brass tubing, in iron pipe sizes:

TABLE 61. WEIGHTS AND MEASUREMENTS OF SEAMLESS BRASS AND COPPER TUBE.
IRON PIPE SIZES. REGULAR AND EXTRA HEAVY

IRON PIPE SIZES	1/8"	1/4"	3/8"	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	1,035	1,285	1,557	1,847	2,157	2,487	2,837	3,207	3,597	4,007	4,437	4,887	5,357	5,847	6,357	6,887
Copper, weight per lineal foot.	289	456	624	824	1,056	1,316	1,596	1,896	2,216	2,556	2,916	3,296	3,696	4,116	4,556	5,016	5,496	5,996	6,516	7,056
Exact outside diameter.	2.00	2.375	2.750	3.125	3.500	3.875	4.250	4.625	5.000	5.375	5.750	6.125	6.500	6.875	7.250	7.625	8.000	8.375	8.750	9.125
Exact inside diameter.	1.750	2.125	2.500	2.875	3.250	3.625	4.000	4.375	4.750	5.125	5.500	5.875	6.250	6.625	7.000	7.375	7.750	8.125	8.500	8.875
Exact thickness of wall.	.125	.125	.125	.125	.125	.125	.125	.125	.125	.125	.125	.125	.125	.125	.125	.125	.125	.125	.125	.125
Brass, theoretical safe working pressure.	1,778	1,465	1,160	840	750	628	580	509	449	391	346	307	273	242	213	186	161	138	116	95
Copper, theoretical safe working pressure.	1,332	1,102	870	708	583	471	435	381	337	293	258	224	191	160	132	107	84	63	43	25
Internal area cross section.	.057	.104	.192	.305	.433	.583	.750	.935	1.135	1.350	1.580	1.825	2.085	2.360	2.650	2.955	3.275	3.610	3.960	4.325
Thickness of wall at bottom of thread.	.036	.040	.043	.048	.052	.059	.065	.070	.076	.082	.088	.094	.100	.106	.112	.118	.124	.130	.136	.142
<i>Extra Heavy</i>																				
Brass, weight per lineal foot.	353	593	805	1,024	1,266	1,531	1,816	2,121	2,446	2,791	3,156	3,541	3,946	4,371	4,816	5,281	5,756	6,241	6,746	7,271
Copper, weight per lineal foot.	371	624	847	1,076	1,326	1,596	1,886	2,196	2,526	2,876	3,246	3,636	4,046	4,476	4,926	5,396	5,876	6,376	6,896	7,436
Exact outside diameter.	2.00	2.375	2.750	3.125	3.500	3.875	4.250	4.625	5.000	5.375	5.750	6.125	6.500	6.875	7.250	7.625	8.000	8.375	8.750	9.125
Exact inside diameter.	1.750	2.125	2.500	2.875	3.250	3.625	4.000	4.375	4.750	5.125	5.500	5.875	6.250	6.625	7.000	7.375	7.750	8.125	8.500	8.875
Exact thickness of wall.	.125	.125	.125	.125	.125	.125	.125	.125	.125	.125	.125	.125	.125	.125	.125	.125	.125	.125	.125	.125
Brass, theoretical safe working pressure.	4,442	3,401	2,508	1,739	1,500	1,250	1,142	1,006	891	785	694	611	538	474	419	374	329	284	239	194
Copper, theoretical safe working pressure.	3,318	2,551	1,881	1,302	1,125	938	857	755	669	588	511	438	374	319	274	239	204	169	134	99
Internal area cross section.	.053	.098	.189	.321	.452	.602	.771	.956	1.156	1.371	1.596	1.836	2.091	2.361	2.646	2.946	3.261	3.591	3.936	4.296
Thickness of wall at bottom of thread.	.027	.031	.034	.038	.041	.046	.050	.054	.058	.062	.066	.070	.074	.078	.082	.086	.090	.094	.098	.102
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"	1 1/2"	1 1/2"

NOTE.—Weights are in pounds. Diameter and thickness in inches. Areas 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.

FIRECLAY BRICK AND REFRACTORY CEMENTS IN BOILER SETTINGS

FIRECLAY brick having melting points as low as 2750 deg. Fahr. are used in the construction of boiler furnaces. For most purposes, however, it is necessary to employ brick of first quality refractoriness. Such brick should have the following characteristics:

Fusion or Melting Point.....Cone 31 to 34 (3182 to 3290 deg. Fahr.)
End Cold Crushing Strength.....500 to 2500 lb. per sq. in. depending upon the burn and process of manufacture.
Porosity.....15 to 30 per cent.
Mean Thermal Conductivity from 0-1000 deg. cent......0025 calories per second, per sq. cm., per deg. cent., difference in temperature on two parallel faces of a 1 centimeter cube. The mean conductivities at any two temperatures equals $.0020 + .0000011(t_1 + t_2)$ where t_1 and t_2 are the temperatures in deg. cent. Thermal Expansion.....0.000008 per deg. cent.

Chemical Composition:

Silica.....	50.0 to 65.0 per cent
Alumina.....	30.0 to 45.0 " "
Iron Oxide.....	1.5 to 3.5 " "
Titania.....	1.5 to 3.5 " "
Lime.....	0.1 to 0.5 " "
Magnesia.....	0.1 to 0.5 " "
Soda and Potash.....	0.5 to 1.5 " "

The service obtained from first quality fireclay brick depends upon the design of the furnace, the operating conditions, and the type of firebrick used. The most satisfactory design is one in which the brick in the hottest part of the furnace are not subjected to a soaking heat. When one face of each brick is relatively cool, this brick is less liable to squeeze out of shape and allow the brickwork to settle. Likewise when the heating surface is small in comparison with the radiating surface the service obtained from the refractories is most satisfactory. Special shapes should be used only in cases of absolute necessity. They are more expensive, less uniform, and less readily available. A skillful brick mason can construct practically any kind of a furnace out of standard brick of the 9 in. series.

When furnaces are operated under a slight pressure the life of the refractories is considerably less than where there is a draft. This is due to the "soaking" effect that is more pronounced when the furnace is operated under pressure.

There is an opportunity for increasing the life of most furnaces by the proper selection of the brick. Those which are laid in the sidewalls are subjected to the action of the clinker; they are chipped and broken by the slice bar. Dense well burned brick are best suited to meet these conditions. The lighter burned brick are best suited to resist temperature

Material for this section was prepared especially for THE GUIDE 1923 by R. M. Howe, Pittsburgh, Pa.



changes. Inasmuch as temperature changes first effect the brick in the arches the lighter burned brick should be placed there.

The fireclay or refractory cement used in laying up the brick may cause immediate failure or it may actually prolong the life of the firebrick. The most consistent results are obtained when the fireclay is brought from the company supplying the brick. The joints should be made as thin as possible. Such materials as Portland cement or lime should never be added to the clay in order to give a "cold set."

In certain types of furnaces it is necessary to use firebrick of slightly different characteristics. The siliceous brick from New Jersey are used to advantage in wide arches and in arches that are heated on both sides. Their successful application lies in their ability to support a heavy load at high temperatures and under soaking heats.

In other furnaces where there is an intense local heat it is necessary to use firebrick that are high in alumina. These have melting points ranging from 3290 to 3470 deg. fahr., depending upon the alumina content of the brick. While their application is relatively new, brick of this type apparently fill a long felt want.

Much of the trouble experienced with firebrick settings may be traced to the clay with which they are laid. Other causes are found in the excessive temperatures resulting from insufficient radiation or too little draft; or temperature changed brought about by the inrush of cold air. Joints that are too thick or are made of inferior material allow the brickwork to settle; excessive temperatures cause the brickwork to squeeze out of shape; excessive temperature changes cause spalling.

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.

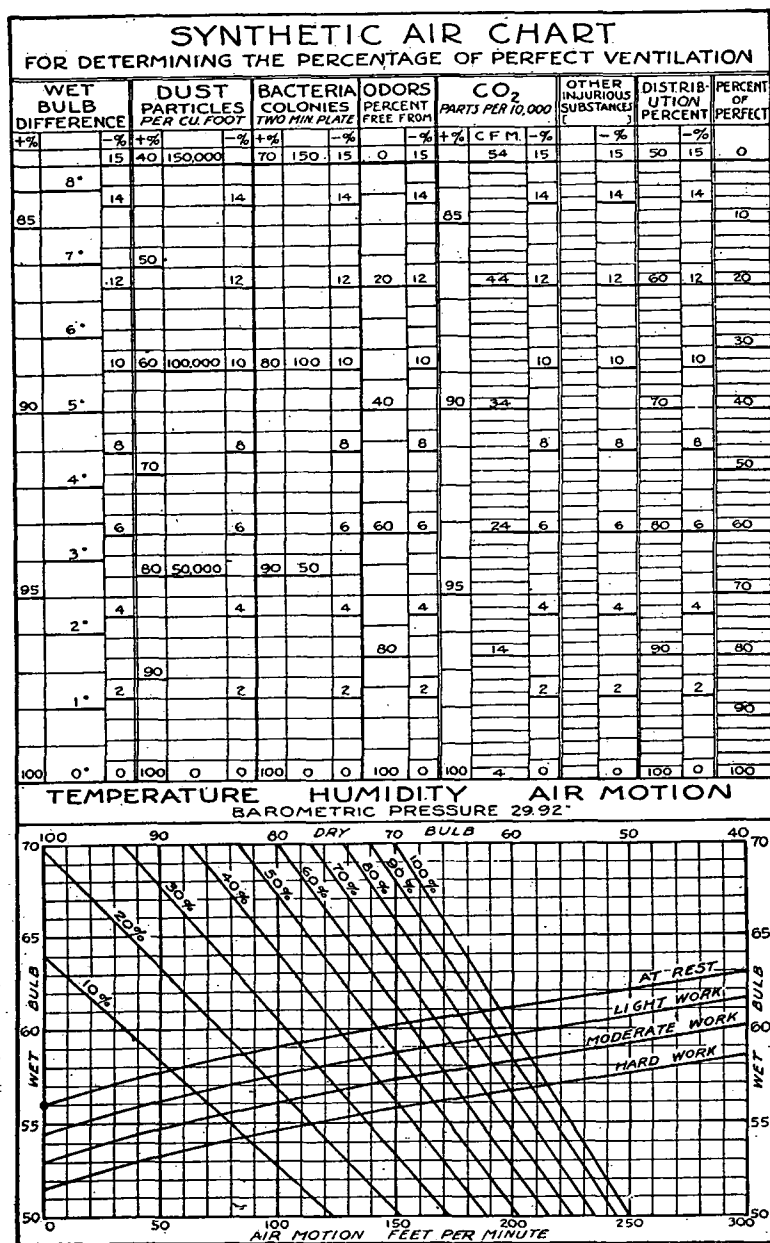


FIG. 53. THE SYNTHETIC AIR CHART

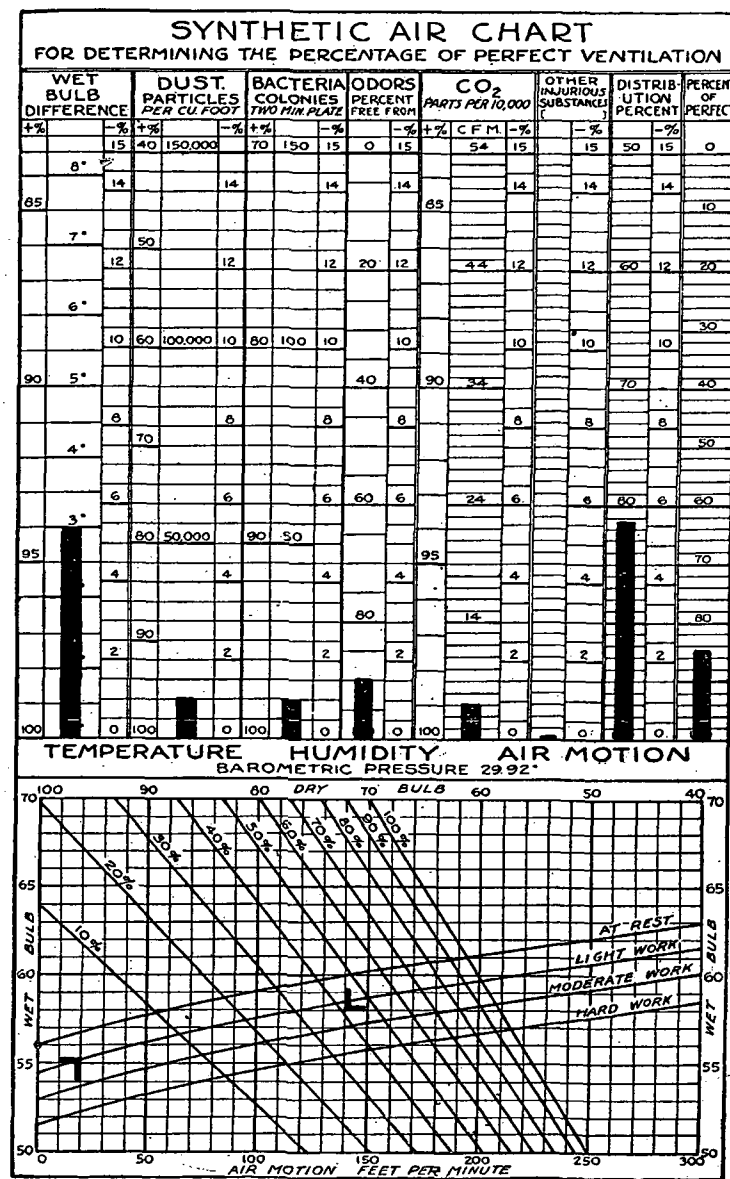


FIG. 54. ILLUSTRATION OF THE USE OF THE SYNTHETIC AIR CHART

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 $84\frac{3}{8}$ 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

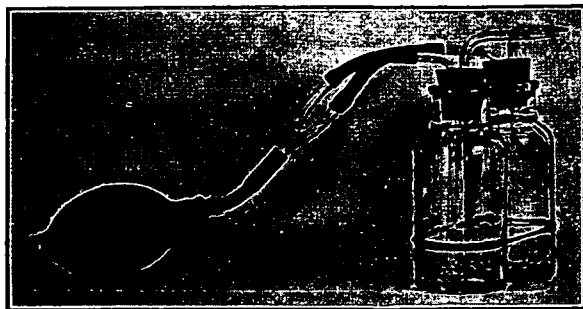


FIG. 55. AMMONIUM CHLORIDE APPARATUS FOR DETERMINING VELOCITY AND DIRECTION OF AIR CURRENTS

velocity of a puff of vapor from an ammonium-chloride apparatus, such as shown in Fig. 55. 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. 56) 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.

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

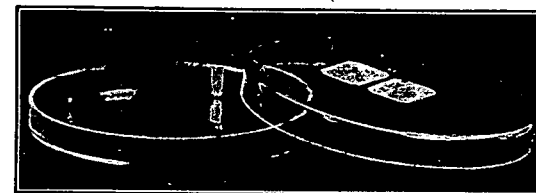


FIG. 56. CULTURE PLATES FOR DETERMINING THE BACTERIA IN AIR

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. 57. 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 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 CO_2 per 10,000 parts of air.

In the chart in Fig. 58 is shown how the air supply may be determined from the CO_2 readings. Suppose an analysis of the air sample taken in the room shows that the average CO_2 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 ver-



tically up to the curve; from the point of intersection with the curve tranverse 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

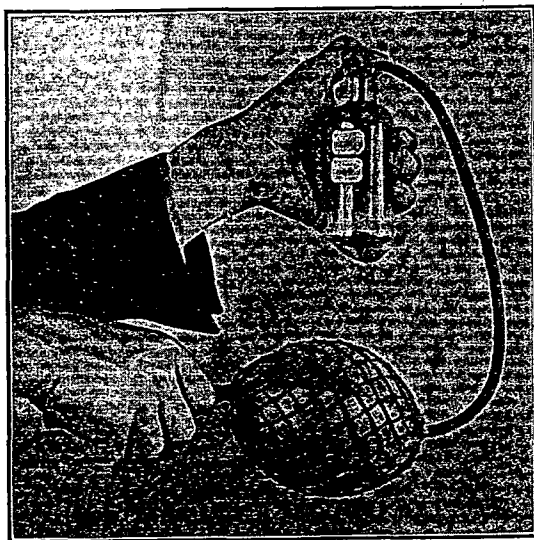


FIG. 57. TAKING AN AIR SAMPLE

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:

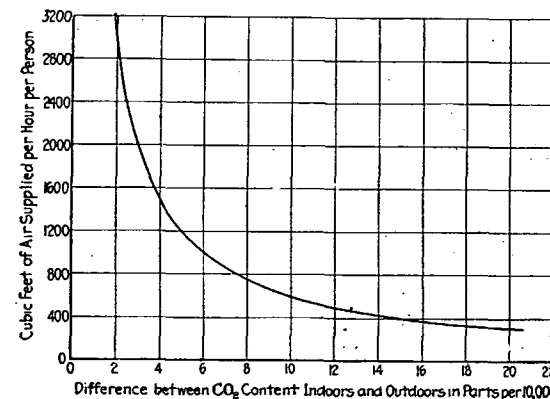
$$\frac{0.6 + 0.4 + 2.2 + 2.0}{4} = 1.3$$



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

FIG. 58. CURVE TO DETERMINE AIR SUPPLY FROM CO₂ READINGS.

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 inter-relation of temperature, humidity, and air motion is shown in the lower portion of the chart. The inter-section 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 L). 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 area in the room. One station should be allowed 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 -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, $-5\frac{5}{8}$ 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 $100 - 15\frac{3}{8} = 84\frac{5}{8}$ per cent. This value is then plotted in the last column marked Percent of Perfect.

DETERMINING EQUAL COMFORT LINES

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 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 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, VENTILATING ENGINEERS, in order to locate these lines on the psychrometric chart. In making such tests a high dry bulb temperature and low

Material for this section was prepared especially for THE GUIDE 1923 by F. C. Houghten, Pittsburgh.

relative humidity was produced in one room and a lower dry bulb temperature and higher relative humidity in the other room such that observers passing from one room to the other recorded the same feeling of warmth in the two rooms. The two air conditions thus found which give the same sense of warmth are on an equal comfort line.

The angles which the experimentally determined lines make with the dry bulb temperature on the standard psychrometric chart are plotted in Curve A, Fig. 59.

A standard psychrometric chart with the equal comfort lines superimposed is shown in Fig. 60. These lines were determined by taking the angle which they form with the dry bulb lines from Curve A, Fig. 59.

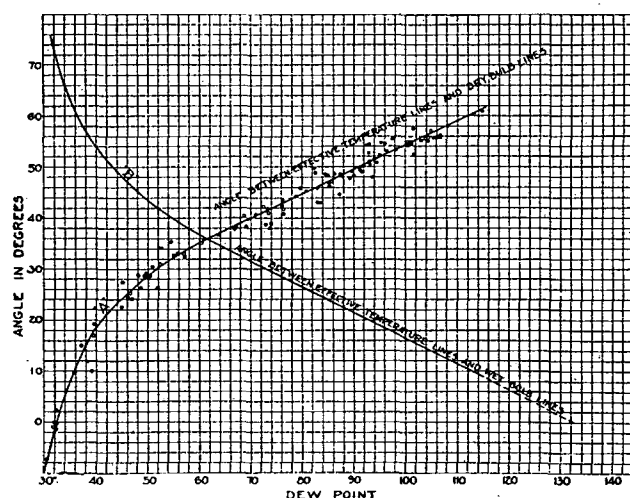


FIG. 59. CURVE A, ANGLE BETWEEN EQUAL COMFORT LINES AND DRY BULB LINES AS DETERMINED BY TEST. CURVE B, ANGLE BETWEEN EQUAL COMFORT LINES AND WET BULB LINES

It will be seen that these form a series of lines which are not parallel among themselves but approach being parallel to the wet bulb lines at high temperatures, and dry bulb lines at low temperatures. This is in accordance with expectations. At high temperatures one perspires freely and the skin approaches the condition of a perfect wet bulb, while at low temperatures the surface of the body is relatively dry and therefore is little cooled by evaporation. At low temperatures moisture in the air allows the clothing to become moist and therefore to be a better conductor of heat.

In Curve B, Fig. 59, the angles between wet bulb lines and equal comfort lines are plotted against dew-points. The intersection of Curves A and B, gives a dew-point of 61.5 at which the equal comfort line bisects



the angle between dry and wet bulb lines. For all points on this equal comfort line the dry bulb and wet bulb temperatures are of equal importance in determining comfort. Below this equal comfort line, dry bulb temperatures are of greater importance while above this line, wet bulb temperature is the chief factor in determining comfort.

Referring again to Curve *B*, Fig. 59, and extrapolating beyond the limits of the experimental data, it is found that the angle between wet bulb and equal comfort lines becomes zero at 132 deg. wet bulb. Therefore at this temperature the wet bulb lines are also equal comfort lines, or comfort depends upon wet bulb temperature alone. This could not be verified by test for the reason that it is impossible for the investigators to endure the conditions long enough to determine lines above 115 deg. saturated.

Below 32 deg. a marked reversal in the direction of the equal comfort lines occurs. Therefore for such conditions the higher the wet bulb temperature or relative humidity the greater the cooling effect of the air. This fact while not generally accepted receives ample verification from the experience of people who have dwelt in cold climates.

Below 62 deg. the angle between the equal comfort lines and the dry bulb lines diminishes rapidly, approaching zero at 32 deg. For all points on the 32 deg. equal comfort line, comfort is independent of wet bulb temperature or relative humidity.

It has already been shown that neither the wet bulb nor the dry bulb temperature alone indicates a person's feeling of warmth. The equal comfort lines do give such an index. For example, if one passes from any point on the equal comfort line intersecting the saturation curve at 90 deg. to any point on the equal comfort line intersecting the saturation curve at 91 deg., an equal increase in warmth will be noticed, regardless of the path followed. This series of equal comfort lines can therefore be thought of as a temperature scale which, unlike the wet bulb and dry bulb scale, determines accurately the feeling of warmth. The best way to fix the numerical value of the new scale is to adopt the value common to all scales at their intersection on the saturation curve.

As has already been said and will be further verified, this temperature scale accurately indicates one's feeling of warmth and determines the physiological reactions of the body. In other words, it entirely determines the effects produced upon the body. It may therefore be called a scale of effective temperature.

To further emphasize the importance of effective temperature over the wet bulb temperature in determining comfort, some experimental facts are graphically shown on the psychrometric chart Fig. 61. This data is taken from a report of an investigation of the physiological reactions of men to high temperatures, made by the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS Laboratory in cooperation with the U. S. Public Health Service and the U. S. Bureau of Mines. (Some Physiological Reactions to High Temperatures and Humidities, A. S. H. V. E. JOURNAL, March, 1923.



Conditions for the test are shown by points on the chart. The number of the test, increase in pulse rate, rise in body temperature and loss in weight per hour are given numerically in rectangles around the points. Three series of tests are given which are very close to the three comfort lines drawn. Tests No. 56, 72 and 80, falling near the 106 deg. effective temperature line, produce increases in pulse rate of 105, 128 and 124 respectively. Temperature rises and loss in weights per hour show a similar uniformity.

While these physiological reactions vary considerably among themselves they are of a different order of magnitude from those found in the next lower series, that is, near the 101 deg. effective temperature line. Near this line are four Tests, No. 53, 76, 78 and 79, which give similar physiological reactions. Again on the 95 deg. effective temperature line we have four tests which give similar physiological reactions but quite different from those of the other two series.

Test No. 53 is 1 deg. wet bulb higher than Test No. 80, but 5 deg. effective temperature lower. It is found that Test No. 80 gives an increase in pulse rate of 124 and temperature rise of 4.6 deg., while Test No. 53 gives an increase in pulse rate of 56.3 and temperature rise of 2.53 deg., which shows clearly that the physiological reactions in this region of the chart depend on effective temperature and not on wet bulb temperature. When the effective temperature is lower the physiological reactions are less marked despite the fact that the wet bulb temperature is higher.

Tests No. 44 and 79 similarly show the fact that the physiological reactions depend on effective temperature and not on wet bulb temperature. This is again brought out by Tests No. 81, 74, 45, and 83. The lower the effective temperature, the less marked the physiological reactions regardless of the wet bulb temperature.

APPLICATIONS

The applications of the psychrometric chart with equal comfort lines to the problems of heating and ventilating are many. The heating engineer is interested in the effective temperature lines in the comfort zone, that is, those temperatures and humidities which are met within heating practice. To say that a room is heated to 70 deg. does not necessarily indicate that the room is heated to a comfortable temperature. With a very low humidity 70 deg. Fahr. may be too cold for comfort while 70 deg. Fahr. with a very high humidity may be too warm.

It is not the purpose of this investigation to determine what effective temperature is best suited for true comfort. However, if results can be obtained that agree upon any point that gives true comfort the chart will indicate all other conditions which are equally comfortable. If 70 deg. dry bulb and 56 deg. wet bulb are accepted as being on the true comfort line then 63.5 deg. effective temperature will be the desired line. The maximum variation on this comfort line is from 63.5 deg. to 77 deg. dry bulb and from 47 deg. to 63.5 deg. wet bulb. However, the maximum variation is neither practical nor desirable. It has been mentioned before



that the 62 deg. effective temperature line bisects the angle between the dry and wet bulb temperature. Therefore within the comfort region the dry and wet bulb temperatures are of equal importance in determining comfort.

In industrial plants having high temperatures the efficiency engineer inquires as to what combinations of dry and wet bulb temperatures can be endured with efficient work. The U. S. Public Health Service has determined from experience and statistics conditions which men can

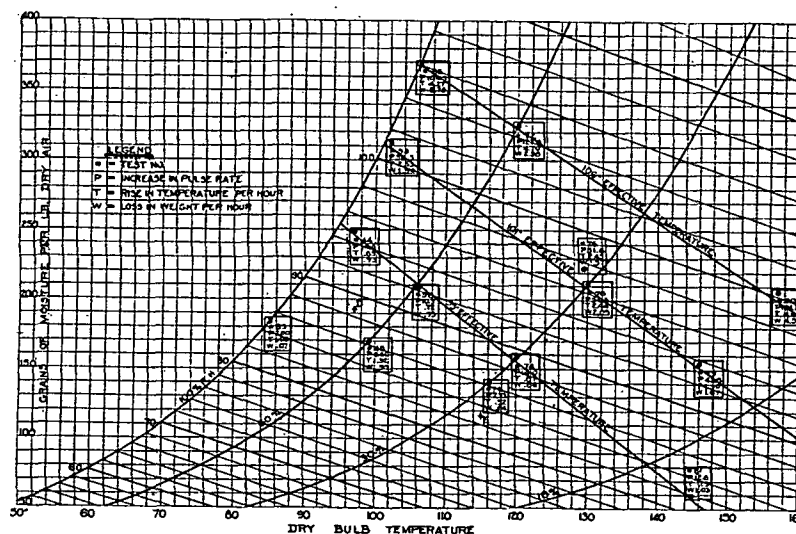


FIG. 61. PSYCHROMETRIC CHART SHOWING RELATION BETWEEN PHYSIOLOGICAL REACTIONS AND, EFFECTIVE TEMPERATURE, WET BULB TEMPERATURE AND DRY BULB TEMPERATURE, RESPECTIVELY

efficiently endure while doing various kinds of work. By accepting these points the chart will give any other conditions resulting in equally efficient work.

The air conditioning engineer is interested in knowing just what effect various changes in wet and dry bulb temperature will have on the effective temperature or sense of warmth which a person will experience. He can follow three distinct routes in producing a more desirable condition or any combination of the three.

1. He can keep the dry bulb constant varying the wet bulb and dew-point.
2. He can keep the wet bulb constant and vary the dry bulb and dew-point.



3. He can keep the dew-point constant varying the dry and wet bulb.
4. Any combination of the above three.

In any case the improvement will depend solely upon the number of the effective temperature lines crossed.

CONCLUSIONS

Comfort as determined by both sense and physiological reactions depends solely upon effective temperature. At 32 deg. the effective temperature line coincides with the dry bulb temperature line, hence in this particular case dry bulb temperature is the only factor in determining comfort.

In the comfort zone comfort depends equally on wet and dry bulb temperatures.

At about 132 deg. the effective temperature coincides with the wet bulb temperature and for this case the wet bulb temperature is the only factor.

Below 32 the effect of humidity is reversed. The lower the humidity the greater the feeling of warmth.

VENTILATORS

THE term ventilator may apply to anything from an opening through the roof of a building to a pipe with a very complicated covering over the end. As a general rule, it means a pipe leading from the roof of a building covered with some sort of a weather proofing cap. The caps, as used in practice, present a wide variation in design from that of a plain cap to prevent the direct entrance of rain and snow to very intricate designs intended to increase the capacity of a ventilator by a more efficient utilization of the wind energy.

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. It is the purpose of this discussion to show some of the basic principles upon which ventilators operate and to show some of the points in practical ventilators which increase or decrease their efficiencies.

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.

PRINCIPLE OF OPERATION

The flow of air in a ventilator pipe is caused by two distinct forces either or both of which may effect the ventilator at a given time. First, the temperature difference between the air in the ventilator pipe and the outside air, and second, the velocity of the wind around the ventilator head. The flow of air caused by either one of these forces will, for a given force, depend upon the design of the ventilator.

A draft is caused by the difference in temperature, the same as in an ordinary chimney. It depends upon the height of the ventilator and the temperature difference. Since a ventilator pipe generally extends only through the roof, the height is not as apparent as it is in an ordinary chimney. The effective height should be taken as that from the ventilator outlet to the lowest point in the room or building ventilated from which the air has free access to the ventilator, *i. e.*, if a ventilator pipe opens into

Material for this section was prepared especially for THE GUIDE 1923 by F. B. Rowley, Minneapolis, Minn.



a room which is isolated from the rest of the building, that room alone should be considered. If the air from that room has free access to others below, the total height should be considered. The temperature in the ventilator pipe may be taken as the average temperature from the ventilator outlet to the floor of the room ventilated.

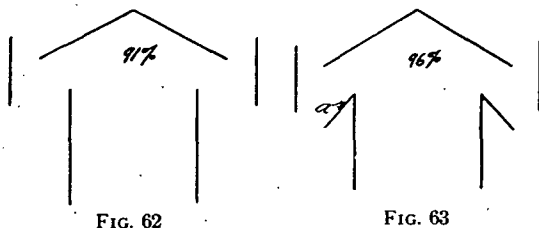


FIG. 62

FIG. 63

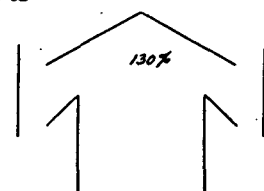


FIG. 64



FIG. 65

FIG. 66

EFFICIENCIES OF VARIOUS STYLES OF VENTILATORS

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 percent providing there is free admission of fresh air into the room or space ventilated.

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

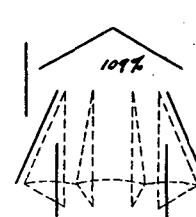


FIG. 67

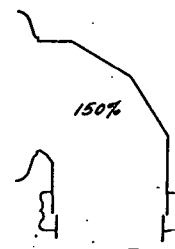


FIG. 68

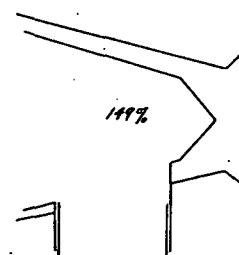


FIG. 69

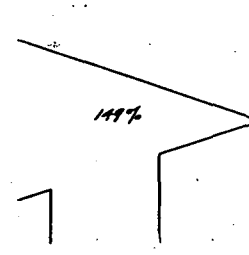


FIG. 70

EFFICIENCIES OF DIFFERENT TYPES OF VENTILATORS

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. There is not sufficient data available to cover all of the different kinds of ventilators manufactured; yet certain fundamental laws are well established which apply to all ventilators.

Figs. 62 to 66 inclusive, were taken from a preliminary report of tests made at the Bureau of Standards in 1918 on 16-in. ventilators and published in the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

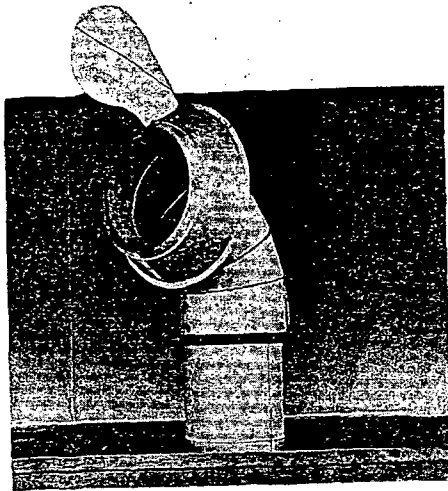


FIG. 71

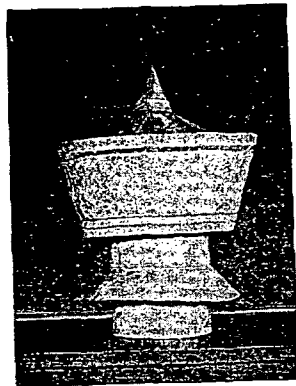


FIG. 72

FIVE STYLES
OF ROOF
VENTILATORS
TESTED



FIG. 73

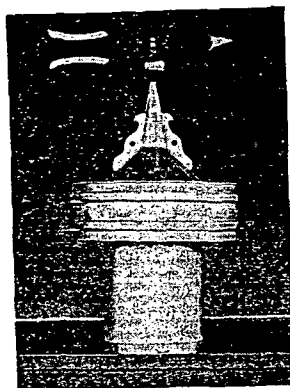


FIG. 74



FIG. 75

JOURNAL, March, 1921. These figures will serve to show how some specific points effected the efficiency. The percentage figures at the top of each cut represents the ratio of air passed through the ventilator head, compared to that passed through an open pipe under the same conditions. Figs. 62, 63 and 64 show a stationary ventilator with slight variations. In Fig. 63, a lip *A* has been added at the outlet and in Fig. 64 the band has been lengthened, to cover the lip, no other changes being made. In the ventilator of Figs. 62 and 63, part of the wind entered the head while in Fig. 64 no wind entered the head. From the percentage figures, it will be noted that 63 gained over 62 although both discharged less than an open pipe under the same conditions. Fig. 64 gained 30 per cent over an open pipe. This shows the importance of keeping the air from entering the ventilator head, of using a wide band and of providing an easy passage for the air leaving the ventilator. The wide band of Fig. 64 serves two purposes, first, to keep the air from entering the ventilator head and second, to produce a greater low pressure area on the leeward side of the ventilator head.

Fig. 65 and 66 are the same ventilators excepting that in Fig. 66 the storm band has been lengthened to cover the lower lip and prevent the wind from entering the head. This shows a gain from 91 per cent to 113 per cent by changing the band. By comparing Figs. 64 and 66, it will be noted that the principle difference is that the cap in Fig. 66 has been raised with an additional band placed in the outlet. The probable effect of this band is to increase the friction of the air leaving the head, thereby reducing the efficiency.

Fig. 67 shows a stationary siphoning ventilator in which part of the outside wind enters the ventilator head and must be discharged through the head with the air drawn up the ventilator shaft, while this ventilator is more intricate in design than that of Fig. 64, its efficiency is not as good.

Figs. 68, 69 and 70 show rotary ventilators. Fig. 68 has flaring outlet, Fig. 69 has a conical outlet and an auxiliary siphon ring and Fig. 70 has a straight conical outlet. It will be noted that these three ventilators all have about the same capacities, *i. e.* 150 per cent of an open pipe discharge. It was found that if the annular passage in Fig. 69 was closed up the results were the same, showing that the draft in this case was created by the low pressure area and not by the siphoning action of the wind.

Figs. 71 to 80, inclusive, show the photographs and dimensioned drawings of five 10-in. ventilators tested at the Experimental Engineering Laboratories, University of Minnesota.

The curve sheet, Fig. 81, shows the results of the tests. The most efficient ventilator in these tests was the rotary siphoning, Figs. 71 and 76, with the plain stationary, Figs. 72 and 77, a very close second. It will be noted that the stationary ventilator has a large head, rather a wide band which prevents outside air from entering the head, and is designed to give a fairly easy path with no abrupt turns for the exhaust air.

The stationary ventilator, Figs. 74 and 78, gives only two-thirds of the capacity of that shown for Figs. 71 and 76. Upon comparison, it will be noted that the diameter of the head is less, the width of the band is less

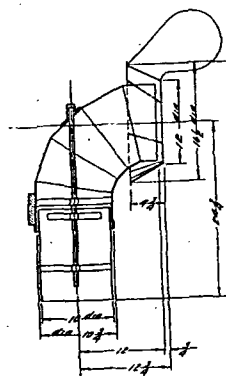


FIG. 76

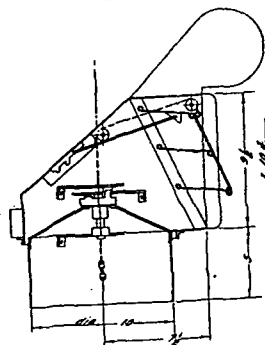


FIG. 78

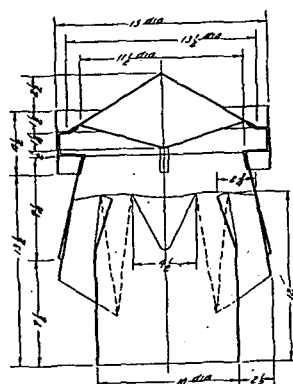


FIG. 80

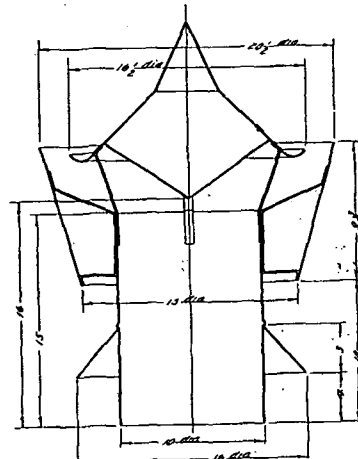


FIG. 77

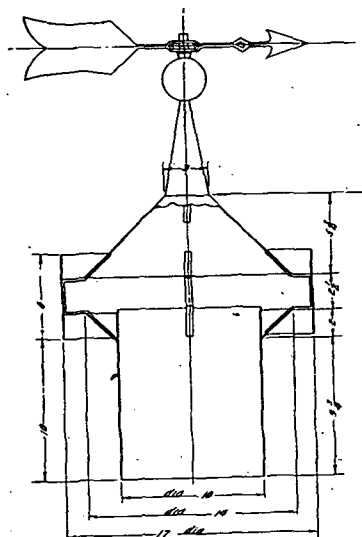


FIG. 79

DETAILS OF FIVE VENTILATORS TESTED

than two-thirds than that of the latter, and there is no inverted cone at the top to direct the flow of the exhaust outward. Further the outlet openings, as shown in Fig. 79, are small as compared with those of Fig. 76. The poorest ventilator is the stationary siphon, Figs. 75 and 80. This ventilator is so designed that the outside air enters the head; the head is small, the band is narrow and the air passages leading from the ventilators are restricted. The rotary ventilator shown in Fig. 64 has a low efficiency for this class of ventilators, due to the fact that the head is small and the air passages are restricted by louvers and frame work.

The data obtained in a series of tests on 10-in. ventilators made at Kansas State Agricultural College by Professors J. P. Calderwood, A. J. Mack and C. J. Bradley and reported in the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS JOURNAL, July, 1922, are shown in Tables 62 to 66 inclusive, and the average results of Table 66 are shown in curve sheet, Fig. 82.

TABLE 62. RESULTS OF TESTS SHOWING THE VELOCITY IN FEET PER MINUTE INDUCED THROUGH SEVEN DIFFERENT PLAIN STATIONARY VENTILATORS

VEL. OF WIND IN MILES PER HR.	VELOCITY INDUCED THROUGH VENTILATOR, FEET PER MINUTE VENTILATOR DESIGNATION							
	No. Ventilator	1	2	3	4	5	6	7
4	145	185	266	148	185	142	133	160
8	241	287	355	257	287	238	242	267
12	337	390	446	366	390	334	350	375

TABLE 63. RESULTS OF TESTS SHOWING THE VELOCITY IN FEET PER MINUTE INDUCED THROUGH SIX STATIONARY SIPHONING VENTILATORS

VEL. OF WIND IN MILES PER HR.	VELOCITY INDUCED THROUGH VENTILATOR, FEET PER MINUTE VENTILATOR DESIGNATION						
	No. Ventilator	1	2	3	4	5	6
4	145	162	157	226	189	205	206
8	241	304	292	404	315	332	369
12	337	446	426	583	440	458	532

TABLE 64. RESULTS OF TESTS SHOWING THE VELOCITY IN FEET PER MINUTE INDUCED THROUGH FOUR PLAIN ROTARY VENTILATORS

VEL. OF WIND IN MILES PER HR.	VELOCITY INDUCED THROUGH VENTILATOR, FEET PER MINUTE VENTILATOR DESIGNATION				
	No. Ventilator	1	2	3	4
4	145	208	192	191	202
8	241	246	348	354	341
12	337	484	505	518	480

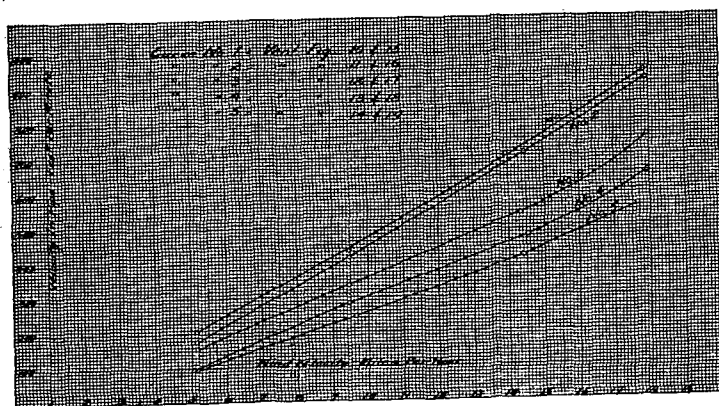


FIG. 81. CURVES SHOW EFFICIENCY OF WELL CONSTRUCTED ROTARY OR STATIONARY TYPE VENTILATOR

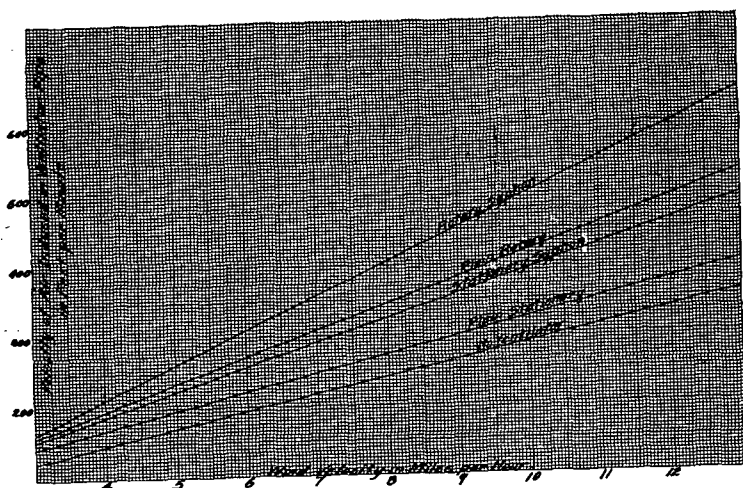


FIG. 82. CURVES RATE EFFICIENCIES OF VENTILATORS, ACCORDING TO TYPE

TABLE 65. RESULTS OF TESTS SHOWING THE VELOCITY IN FEET PER MINUTE INDUCED THROUGH FIVE ROTARY SIPHONING VENTILATORS

VEL. OF WIND IN MILES PER HR.	VELOCITY INDUCED THROUGH VENTILATOR, FEET PER MINUTE VENTILATOR DESIGNATION					
	No. Ventilator	1	2	3	4	5
4	145	257	192	222	217	204
8	241	479	370	387	410	393
12	337	702	548	553	606	582

TABLE 66. RESULTS OF TESTS SHOWING THE AVERAGE VELOCITY IN FEET PER MINUTE INDUCED THROUGH THE VARIOUS TYPES OF VENTILATORS

VEL. OF WIND IN MILES PER HR.	VELOCITY INDUCED THROUGH VENTILATOR, FEET PER MINUTE TYPE OF VENTILATOR				
	No. Ventilator	Plain Stationary	Siphoning Stationary	Plain Rotary	Rotary Siphoning
4	145	168	191	198	218
8	241	273	326	348	408
12	337	379	461	497	598

Unfortunately the detailed dimensions of these ventilators are not given, although the data shows a wide variation of ventilators of the same type or class. The curves, Fig. 82, shows the average classification in order of efficiency as rotary siphon, plain rotary, stationary siphon, plain stationary, and no ventilator. This set of curves must only be taken as a general indication of each class and as in no way determining the efficiency of any particular ventilator. By comparing the data of the plain stationary ventilators, Table 62 to Curve 2, Fig. 81, it will be observed that the best ventilator tested at the Kansas Agricultural College gave a velocity of 446 ft. per min. at a wind velocity of 12 miles per hr. whereas the best one tested at the University of Minnesota gave 560 ft. per min., at the same wind velocity. The stationary ventilator No. 5, curve sheet, Fig. 81, compares almost exactly with the average stationary ventilator shown in Fig. 82.

The velocity through an open pipe agrees very closely in the two series of tests indicating that the other differences are due to the different designs of the ventilator heads tested and not to a difference in the test conditions.

While it is apparent that the average ventilators built, fall into general classes, it is evident that there is a wide variation in ventilators of the same type and a good ventilator may be made of any type, providing a few basic principles are adhered to in the design. The rotary ventilator may have some advantages over the stationary, but it is doubtful whether the stationary siphon ventilators has any advantages over a properly designed stationary non-siphoning ventilator.

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. Provide 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.

While good or poor ventilators may be constructed of either class, Curves 1 and 2, Fig. 81, shows what may be expected from a well-constructed ventilator in either stationary or rotary type. As a general thing, however, the stationary ventilator will deliver somewhat less than that shown in Curve 2. These curves were taken from a 10-in. ventilator and somewhat better results might be expected from larger ventilators. The curves are based only on draft created by the wind, temperature in the ventilator remaining the same as that outside. The additional draft created by the temperature will depend entirely upon the temperature difference and effective height of the ventilator.

LOCATION OF VENTILATOR IMPORTANT

In order that any ventilator may function properly, some attention must be given to its location on the building. In general the action of the ventilator will be effected by the adjacent buildings height of ventilator, etc., as an ordinary chimney. Thus a ventilator if placed near a high wall would not obtain the full effect of the wind and in case it is on the windward side of the wall, a back draft might even be created in the ventilator.

The access of fresh air to the ventilated room to take the place of the exhausted air must be given consideration in determining the capacity to be expected. If the ventilator leads from a closed room with no air inlets, the capacity will be reduced accordingly.

These are points which must be given careful consideration for each installation and in any case it must be remembered that the capacity of a ventilator of this type is not positive or constant but dependent upon the wind velocity and temperature difference.

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 constitute, 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 1923 by A. M. Lissauer, New York.

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, seem 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 inter-relation 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 pressures 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 turn 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.

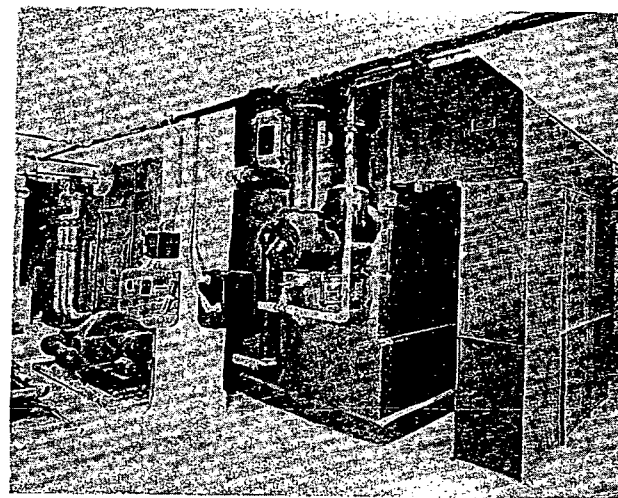


FIG. 83. AIR CONDITIONING PLANT IN CALIFORNIA THEATER

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



ing, 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 maca-



FIG. 84. CHOCOLATE DIPPING ROOM OF MIDDLE WESTERN CANDY FACTORY

roni, 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, 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.

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 1¼-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.

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 out-

Material for this section was prepared especially for THE GUIDE 1923 by Lee Nusbaum, Philadelphia, Pa.



TABLE 68. CUBIC FEET OF AMMONIA VAPOR THAT MUST BE CIRCULATED TO PRODUCE ONE TON OF REFRIGERATION IN TWENTY-FOUR HOURS

CONDENSER PRESSURE	AMMONIA VAPOR IN CUBIC FEET PER MINUTE											
	Gage	95	110	125	140	155	170	185	200	215	230	245
Temperature of Liquid	Abs.	109.7	124.7	139.7	154.7	169.7	184.7	199.7	214.7	229.7	244.7	259.7
	61° F.	74.4°	80.3°	85.8°	91°	95.8°	100.3°	104.6°	108.7°	112.8°		
SUCTION PRESSURE	TEMP. OF SUCTION											
	Gage	Abs.										
5" V.	12.2#	-33.6° F	8.58	8.74	8.87	9.00	9.12	9.25	9.35	9.47	9.57	9.67
4"	12.7	-32.3°	8.28	8.42	8.54	8.66	8.78	8.90	9.00	9.12	9.22	9.31
3"	13.2	-30.9°	7.99	8.13	8.24	8.35	8.48	8.58	8.68	8.78	8.89	9.00
2"	13.7	-29.6°	7.70	7.82	7.94	8.04	8.18	8.27	8.37	8.48	8.58	8.67
1"	14.2	-28.4°	7.45	7.55	7.68	7.78	7.91	8.00	8.10	8.20	8.30	8.40
0#	14.7	-27.1°	7.20	7.31	7.43	7.53	7.64	7.73	7.83	7.93	8.02	8.12
1#	15.7	-24.8°	6.76	6.86	6.97	7.06	7.16	7.26	7.36	7.44	7.53	7.61
2	16.7	-22.6°	6.37	6.48	6.57	6.66	6.76	6.85	6.94	7.00	7.08	7.17
3	17.7	-20.4°	6.02	6.13	6.20	6.29	6.39	6.46	6.55	6.63	6.70	6.78
4	18.7	-18.4°	5.72	5.79	5.88	5.97	6.06	6.13	6.20	6.28	6.36	6.42
5	19.7	-16.5°	5.44	5.53	5.61	5.69	5.78	5.83	5.91	5.98	6.05	6.11
8	22.7	-11.0°	4.75	4.81	4.89	4.95	5.03	5.08	5.15	5.21	5.27	5.33
10	24.7	-7.7°	4.37	4.44	4.50	4.57	4.63	4.68	4.73	4.80	4.85	4.91
12	26.7	-4.7°	4.05	4.12	4.18	4.24	4.30	4.35	4.40	4.46	4.51	4.56
15	29.7	-0.3°	3.66	3.72	3.78	3.83	3.88	3.93	3.98	4.02	4.07	4.12
20	34.7	+6.1°	3.15	3.20	3.25	3.29	3.34	3.38	3.42	3.46	3.50	3.54
25	39.7	+11.9°	2.76	2.81	2.85	2.88	2.93	2.96	3.00	3.03	3.07	3.11
30	44.7	+17.0°	2.46	2.50	2.54	2.57	2.61	2.64	2.67	2.70	2.73	2.76
35	49.7	+21.8°	2.22	2.26	2.29	2.32	2.36	2.39	2.42	2.44	2.47	2.50
40	54.7	+26.2°	2.03	2.06	2.09	2.12	2.16	2.18	2.20	2.22	2.25	2.28
45	59.7	+30.3°	1.86	1.89	1.92	1.95	1.98	2.00	2.02	2.04	2.07	2.10
50	64.7	+34.1°	1.72	1.75	1.78	1.81	1.83	1.85	1.87	1.89	1.92	1.94



TABLE 69. 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 3° 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
0.169	1.26	+29.3	-1.5	43.5	50.0	8	2.0	1.015	0.984	2.0
0.212	1.58	+28.6	-1.9	43.0	49.0	10	3.0	1.019	0.980	2.5
0.256	1.92	+27.8	-2.3	42.0	48.5	12	3.5	1.023	0.976	3.0
0.300	2.24	+27.1	-2.7	41.0	47.0	14	4.0	1.026	0.972	3.5
0.344	2.57	+26.6	-3.0	40.5	46.5	16	4.5	1.030	0.968	4.0
0.433	3.24	+25.2	-3.8	38.5	44.5	20	5.5	1.037	0.960	5.0
0.523	3.92	+23.9	-4.5	37.5	43.5	24	6.5	1.045	0.946	6.0
0.617	4.63	+22.5	-4.7	36.0	41.5	28	7.6	1.053	0.932	7.0
0.708	5.30	+21.2	-5.3	34.0	40.0	32	8.7	1.061	0.919	8.0
0.802	6.00	+19.9	-6.7	33.0	38.5	36	9.7	1.068	0.905	9.0
0.897	6.70	+18.7	-7.4	31.5	37.0	40	10.7	1.076	0.892	10.0
1.092	8.20	+16.0	-8.9	29.0	34.0	48	12.6	1.091	0.874	12.0
0.389	10.40	+12.2	-11.0	25.0	30.0	60	15.7	1.115	0.855	15.0
1.928	14.40	+6.1	-14.7	20.0	24.0	80	20.4	1.155	0.829	20.0
2.376	17.78	+1.2	-16.5	16.0	20.0	96	24.0	1.187	0.795	24.0
2.488	18.68	+0.5	-17.3	15.5	19.5	100	25.0	1.196	0.783	25.0
2.610	19.50	-1.1	-18.2	14.5	19.0	.....	25.8	1.204	0.771	26.0
.....	.....	-4.7	-20.1	12.0	15.5	.....	.....	.....	.....	29.0

TABLE 70. PROPERTIES OF CALCIUM CHLORIDE BRINE

SALT REQUIRED		FREEZING POINT		AMMONIA SOL. 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					
1/2	3 3/4	+29	-1.6	43.5°	50.0°	12	3	1.024	0.980	3
1	7 1/2	+27	-2.8	41.0	47.0	27	6	1.041	0.964	5
1 1/4	8 1/2	+25	-3.9	38.5	44.5	36	9	1.058	0.936	7
1 1/2	11 1/4	+23	-5.0	36.5	42.0	40	10	1.076	0.91	9
1 3/4	13	+21	-6.1	34.0	40.0	44	11	1.085	0.896	10
2	15	+18	-7.8	31.0	36.5	54	13	1.103	0.884	12
2 1/4	17	+14	-10.0	27.0	32.0	62	15	1.121	0.868	14
2 1/2	19	+4	-15.5	18.5	22.5	80	20	1.159	0.844	18
3	22 1/2	+1.5	-18.2	16.5	20.0	88	22	1.179	0.834	20
3 1/2	26	-8	-22.2	10.0	13.0	95	24	1.199	0.817	22
4	30	-17	-27.2	4.5	7.5	104	26	1.219	0.799	24
4 1/2	34	-27	-32.8	0.0	2.0	112	28	1.240	0.778	26
5	37 1/2	-39	-39.4	9"	5.5"	120	34	1.305	.....	32
5 1/2	41	-54	-47.7	17"	14.5"	Max. D.	32	1.283	.....	30

TABLE 71. COLD STORAGE PIPING
Ratio of Cubic Feet of Room Space to One Linear Foot of Various Size Ammonia and Brine Pipe

Cubic Feet of Space to Cool	TEMP. 20° F.			TEMP. 15° F.			TEMP. 10° F.			TEMP. 5° F.			TEMP. 0° 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		
	Cu. Ft. Per Ton	Dl. Ex.	Brine	Cu. Ft. Per Ton	Dl. Ex.	Brine	Cu. Ft. Per Ton	Dl. Ex.	Brine	Cu. Ft. Per Ton	Dl. Ex.	Brine	Cu. Ft. Per Ton	Dl. Ex.	Brine
12	110	1 1/4"	2"	103	1 3/4"	1 1/2"	95	1 1/2"	0.6	1 1/2"	0.6	1 1/2"	830	0.9	0.4
20	140	1 7/8"	2 3/4"	125	1 4/8"	1 1/2"	110	1 1/2"	0.6	1 1/2"	0.6	1 1/2"	1000	0.9	0.4
50	200	1 8/8"	2 4/8"	180	1 5/8"	1 1/2"	160	1 1/2"	0.6	1 1/2"	0.6	1 1/2"	1300	0.9	0.5
100	350	2"	2 6/8"	325	1 6/8"	2"	300	1 1/2"	0.6	1 1/2"	0.6	1 1/2"	2150	0.9	0.5
250	650	2 1/2"	2 8/8"	575	2 1/8"	2 1/2"	500	1 1/2"	0.6	1 1/2"	0.6	1 1/2"	368	1.2	0.6
500	1100	3 1/2"	3 2/8"	900	2 3/8"	2 1/2"	700	1 1/2"	0.6	1 1/2"	0.6	1 1/2"	530	1.4	0.6
1000	1200	3 8/8"	3 5/8"	1000	3 1/8"	2 3/4"	800	2 1/2"	0.6	1 1/2"	0.6	1 1/2"	650	1.8	0.6
3000	2200	4 5/8"	4 5/8"	1800	3 5/8"	3 1/2"	1400	2 5/8"	0.6	1 1/2"	0.6	1 1/2"	1050	2.1	0.6
5000	3200	5 8/8"	5 8/8"	2800	4 6/8"	4 1/2"	2400	3 2/8"	0.6	1 1/2"	0.6	1 1/2"	1890	2.7	0.6
10000	3800	7 10/8"	7 10/8"	3500	5 7/8"	5 1/2"	3200	4 1/2"	0.6	1 1/2"	0.6	1 1/2"	2230	3.4	0.6
20000	4000	8 12/8"	8 12/8"	3700	6 4/8"	6 1/4"	3400	4 3/8"	0.6	1 1/2"	0.6	1 1/2"	2500	4.1	0.6
40000	4500	9 14/8"	9 14/8"	4150	7 3/8"	7 1/4"	3800	5 5/8"	0.6	1 1/2"	0.6	1 1/2"	52900	4.8	0.6
70000	5000	11 17/8"	11 17/8"	4500	8 8/8"	8 1/4"	4000	6 5/10"	0.6	1 1/2"	0.6	1 1/2"	67300	5.7	0.6
100000	6000	14 20/8"	14 20/8"	5250	11 10/8"	11 10/8"	4600	8 12/8"	0.6	1 1/2"	0.6	1 1/2"	3650	7 10/8"	0.6

TABLE 72. COLD STORAGE PIPING
Ratio of Cubic Foot of Room Space to One Linear Foot of Various Size Ammonia and Brine Pipe

Cubic Feet of Space to Per Ton of 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	160	3.4	5.8	2.8	4.6	.....	.....	.....	150	3.	5.	.....	140	2.7	4.3	.....	130	2.3	3.5	.....
20	220	3.5	5.9	2.9	4.7	.....	.....	.....	200	3.1	5.1	.....	180	2.8	4.4	.....	160	2.4	3.6	.....
50	325	3.6	6.	3.	4.8	.....	.....	.....	300	3.2	5.2	.....	275	2.9	4.5	.....	250	2.5	3.7	.....
100	700	3.8	6.3	3.1	5.1	.....	.....	.....	600	3.4	5.5	.....	500	3.1	4.7	.....	400	2.7	3.9	.....
250	1075	.....	7.2	.....	5.5	.....	.....	.....	1000	6.3	.....	.....	850	5.4	.....	.....	750	4.5	.....	.....
500	1550	.....	8.6	.....	6.4	.....	.....	.....	1500	7.5	.....	.....	1400	6.5	.....	.....	1250	5.4	.....	.....
1000	2250	.....	9.8	.....	7.4	11.	.....	.....	2000	8.7	.....	.....	1800	7.6	.....	.....	1600	6.5	.....	.....
3000	3250	.....	11.	.....	8.5	13.	.....	.....	3000	10.	.....	.....	2750	9.8	.....	.....	2500	8.3	1500	.....
5000	4250	.....	14.	.....	11.	17.	.....	.....	4000	12.	18.	.....	3750	11.	15.	.....	3500	9.	12.	.....
10000	5250	.....	17.	26.	13.	19.	.....	.....	5000	15.	22.	.....	4500	13.	19.	.....	4000	11.	16.	.....
20000	6250	.....	21.	31.	14.	21.	.....	.....	6000	18.	26.	.....	5500	16.	22.	.....	5000	13.	17.	.....
40000	7250	.....	23.	35.	16.	25.	.....	.....	7000	20.	30.	.....	6500	18.	25.	.....	6000	15.	20.	.....
70000	8750	.....	29.	44.	20.	29.	.....	.....	8500	25.	37.	.....	7500	22.	31.	.....	7000	18.	24.	.....
100000	10250	.....	33.	54.	23.	35.	.....	.....	10000	30.	45.	.....	9500	25.	37.	.....	9000	20.	28.	.....

TABLE 73. 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
Ham, Ribs, Shoulders (not brained).....	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 74. FREEZING TIME IN HOURS TO FREEZE CAN OF ICE

TEMP. OF BRINE	WIDTH OF CAN							
	4"	5"	6"	7"	8"	9"	10"	11"
10°	5.10	8.00	11.5	15.6	20.4	25.8	31.8	45.8
12°	5.60	8.75	12.6	17.3	22.4	28.4	35.0	50.4
14°	6.22	9.70	14.0	19.0	25.0	31.5	39.0	56.0
16°	7.00	11.00	15.8	21.5	28.0	35.5	43.7	63.0
18°	8.00	12.50	18.0	24.5	32.0	40.5	50.0	72.0
20°	9.30	14.60	21.0	28.5	37.3	47.2	58.3	84.0
22°	11.20	17.50	25.2	34.3	44.8	56.7	70.0	100.0
24°	14.00	21.00	31.5	42.8	56.0	71.0	87.5	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 75. 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	.....	.....

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 currents 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. 86. 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 1 to 3, 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 76. 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 77. 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. 87. 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 hygroscopic 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 78. 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.

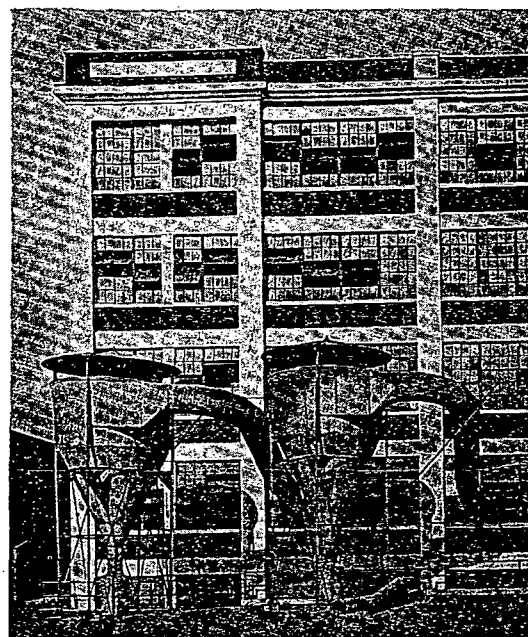


FIG. 88. COLLECTORS ON ROOF OF NEW JERSEY PIANO FACTORY

The orifice coefficient f is dependent upon the shape and construction of the hood and will range from 60 to 90 per cent. An average value is 70 per cent.

Knowing the suction at each hood and the diameter of each connection, the volume of air passing up each branch can be taken from the accompanying Table 80. 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.

TABLE 79. 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

DIAM. 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

Similarly the discharge pipe leading from the fan outlet to collector is frequently made the same diameter as the large end of the main suction pipe. The reason for this increase in size is that a considerable power saving results from the lower air velocity. However, there is no technical reason why mains should be a certain percentage greater area than the sum of the connections, and still lower power consumption can be obtained by using larger branches and mains of equal area. While the rule of thumb method of determining size of mains works very well in many cases, yet it is always desirable to figure the mains and branches of the proper size to give the velocity which has been found best suited to the work to be done.

In certain special cases where explosive or poisonous dusts such as aluminum buffings, grain dust, powdered sugar, or lead dust are handled, increasing the size of the mains unduly would introduce a serious hazard.

An exhaust system to be effective must remove a certain amount of air from each hood or other connection, and in addition must maintain sufficient velocity throughout the piping system to convey the dust or refuse material to the separator. Any system which is mechanically well constructed and handles the requisite air at the connections and maintains sufficiently high velocities, is an effective system from the standpoint of the work done. However, to keep the operating cost low it is advantageous to do the work with as low velocities as the characteristics of the material will permit. The skilled designer will keep both of these requirements in mind and produce a system which is both effective and economical of power.

The maintained resistance of the exhaust system is composed of three factors: (1) Loss through the hoods; (2) Collector drop; and (3) Friction drop in the pipes.

TABLE 80. FRICTIONAL RESISTANCE OF STRAIGHT CONVEYOR PIPE TO FLOW OF AIR PER 100 FEET OF PIPE

VEL. OF AIR IN FEET 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	.962	.770	.640
2200	2.32	1.85	1.55	1.32	1.16	.932	.778
2400	2.77	2.22	1.84	1.58	1.39	1.01	.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	.550	.482	.428	.385	.350	.320	.257
2200	.655	.582	.578	.465	.423	.388	.310
2400	.790	.693	.617	.553	.504	.462	.369
2600	.930	.810	.722	.650	.590	.542	.434
2800	1.07	.932	.838	.754	.685	.628	.503
3000	1.24	1.08	.961	.865	.788	.722	.577
3200	1.41	1.23	1.09	.985	.895	.820	.657
3400	1.59	1.43	1.24	1.11	1.01	.925	.742
3600	1.78	1.56	1.38	1.25	1.13	1.04	.832
3800	1.99	1.74	1.54	1.39	1.26	1.16	.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.

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 —. Total friction loss in the piping system is the friction drop in furthest branch plus the drop in the various sections of the main, plus the drop in the discharge pipe.

The total maintained resistance of the system—or static head required at the fan = $A + B + C$.

SELECTING THE FAN

Having determined the volume of air and static head required, the size of exhaust fan, speed and horsepower 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 fur-



nished 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.

CATALOG DATA SECTION

with

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(Pages 352-358)

and

INDEX TO ADVERTISERS

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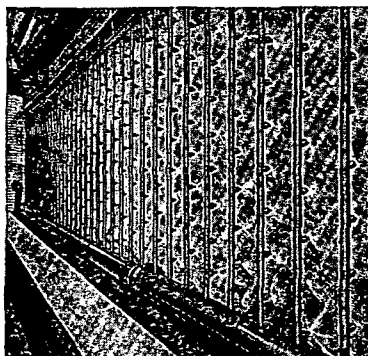
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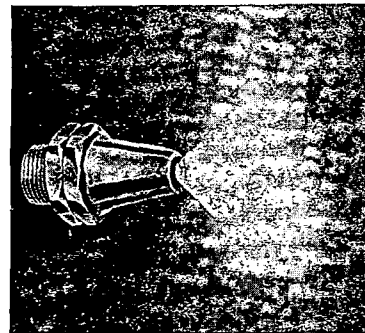
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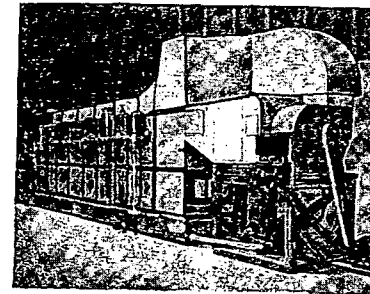
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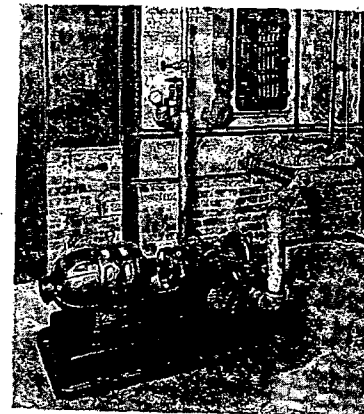
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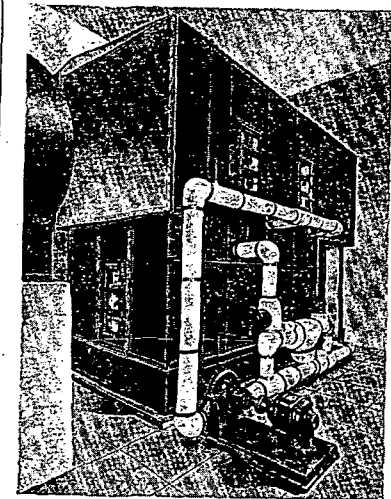
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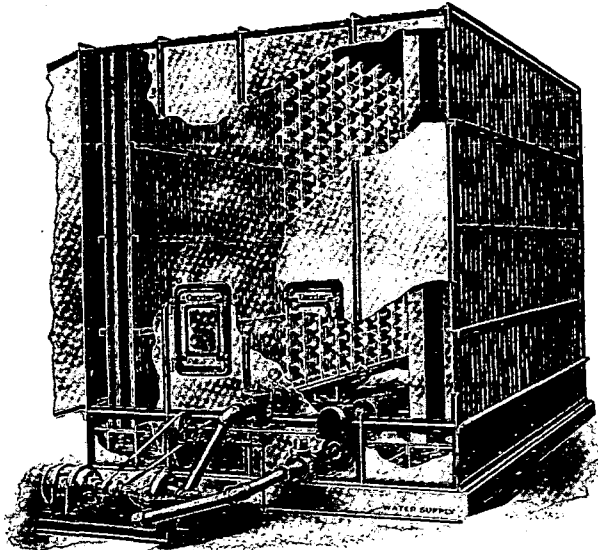
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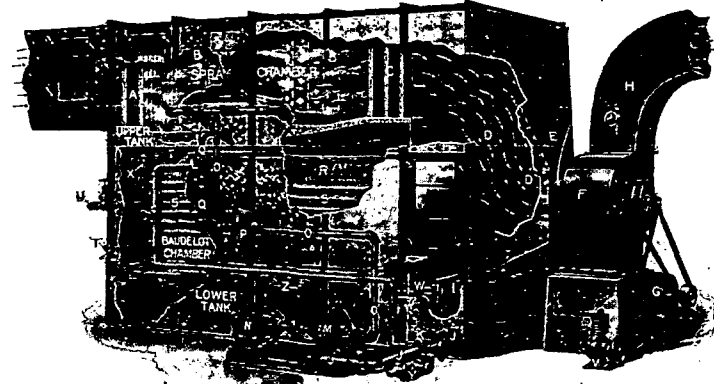
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Typical Carrier Self-Contained Dehumidifier. A—Distributor Plates. B—Sprays. C—Eliminator Plates. D—Outlet. E—Fan Connection. F—Fan. G—Fan Motor. H—Fan Outlet Connection to Duct System. I—Pump Suction Screen. J—Pump Suction Line. K—Three-way Mixing 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 Troughs over Baudelot Coils. S—Baudelot 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.

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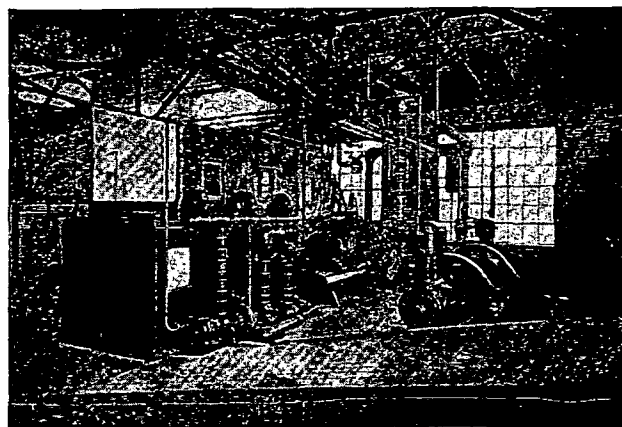
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Representatives in Principal Cities

The air washers tabulated below embody all the good features of the best modern practice and have been designed to meet the specifications of Architects and Engineers for public buildings. Some exclusive features are the special clog-proof nozzles, the duplex spray heads with scale arrester, and automatic humidity control devices.

For information on washers for generators, ask for Bulletin K.

AIR WASHERS FOR PUBLIC BUILDINGS

Length 7' 0". Air Vel. gross area 480' per min. Resistance 0.2" water gage.

Washer Number	Total Width	Total Height	Capacity Cubic Feet per Min.	CIRCULATING PUMP				PIPE CONNECTIONS			
				Size	Capacity G. P. M.	Brake H. P.	R. P. M.	Motor H. P.	Pump Discharge	Pump Suction	Fresh Water Drain
B-5	3'-9"	4'-0 1/2"	4,500	1 1/2"	22	1.1	1,730	2	1 1/2"	2"	3/4" 2"
B-7	3'-9"	5'-0 1/2"	6,000	1 1/2"	30	1.5	1,730	2	1 1/2"	2"	3/4" 2"
B-9	3'-9"	6'-0 1/2"	8,000	1 1/2"	40	1.8	1,730	2	1 1/2"	2"	3/4" 2"
B-11	3'-9"	7'-0 1/2"	10,000	1 1/2"	48	2.1	1,730	3	1 1/2"	2"	3/4" 2"
C-7	5'-6"	5'-0 1/2"	9,200	1 1/2"	46	2.0	1,730	3	2"	2"	3/4" 2"
C-9	5'-6"	6'-0 1/2"	12,000	1 1/2"	60	2.5	1,730	3	2"	2"	3/4" 2"
C-11	5'-6"	7'-0 1/2"	15,000	1 1/2"	73	3.0	1,720	5	2"	2"	3/4" 2"
C-13	5'-6"	8'-0 1/2"	17,200	2"	86	2.7	1,720	5	2"	2 1/2"	3/4" 2"
C-15	5'-6"	9'-0 1/2"	20,000	2"	100	3.2	1,720	5	2"	2 1/2"	3/4" 2"
D-9	7'-3"	6'-0 1/2"	15,800	1 1/2"	79	3.2	1,720	5	2"	2"	3/4" 2"
D-11	7'-3"	7'-0 1/2"	20,000	2"	97	3.1	1,720	5	2"	2 1/2"	3/4" 2"
D-13	7'-3"	8'-0 1/2"	22,800	2"	114	3.6	1,720	5	2 1/2"	2 1/2"	3/4" 2"
D-15	7'-3"	9'-0 1/2"	26,400	2"	132	4.1	1,720	5	2 1/2"	2 1/2"	3/4" 2"
D-17	7'-3"	10'-0 1/2"	30,000	2 1/2"	150	3.8	1,720	5	2 1/2"	3"	3/4" 2"
D-19	7'-3"	11'-0 1/2"	33,400	2 1/2"	167	4.2	1,720	5	3"	3"	3/4" 2"
E-9	9'-0"	6'-0 1/2"	20,000	2"	99	3.2	1,720	5	2"	2 1/2"	3/4" 2"
E-11	9'-0"	7'-0 1/2"	24,200	2"	121	3.8	1,720	5	2 1/2"	2 1/2"	3/4" 2"
E-13	9'-0"	8'-0 1/2"	28,600	2 1/2"	143	3.7	1,720	5	2 1/2"	3"	3/4" 2"
E-15	9'-0"	9'-0 1/2"	33,000	2 1/2"	165	4.2	1,720	5	3"	3"	3/4" 2"
E-17	9'-0"	10'-0 1/2"	37,500	2 1/2"	187	4.7	1,720	5	3"	3"	3/4" 2"
E-19	9'-0"	11'-0 1/2"	42,000	2 1/2"	209	5.3	1,750	7 1/2	3"	3"	3/4" 2"
F-11	10'-9"	7'-0 1/2"	30,000	2 1/2"	145	3.7	1,720	5	2 1/2"	3"	3/4" 2"
F-13	10'-9"	8'-0 1/2"	35,000	2 1/2"	172	4.3	1,720	5	3"	3"	3/4" 2"
F-15	10'-9"	9'-0 1/2"	40,000	2 1/2"	198	5.0	1,750	7 1/2	3"	3"	3/4" 2"
F-17	10'-9"	10'-0 1/2"	45,000	3"	224	5.6	1,750	7 1/2	3"	4"	3/4" 2"
F-19	10'-9"	11'-0 1/2"	50,200	3"	251	6.1	1,750	7 1/2	3"	4"	3/4" 2"
G-11	12'-3"	7'-0 1/2"	35,000	2 1/2"	170	4.3	1,720	5	3"	3"	1" 2 1/2"
G-13	12'-3"	8'-0 1/2"	40,000	2 1/2"	200	5.0	1,750	7 1/2	3"	3"	1" 2 1/2"
G-15	12'-3"	9'-0 1/2"	46,200	3"	231	5.6	1,750	7 1/2	3"	4"	1" 2 1/2"
G-17	12'-3"	10'-0 1/2"	52,400	3"	262	6.3	1,750	7 1/2	4"	4"	1" 2 1/2"
G-19	12'-3"	11'-0 1/2"	60,000	3"	292	7.1	1,750	7 1/2	4"	4"	1" 2 1/2"
H-13	14'-0"	8'-0 1/2"	46,000	3"	229	5.5	1,750	7 1/2	3"	4"	1" 2 1/2"
H-15	14'-0"	9'-0 1/2"	53,000	3"	264	6.4	1,750	7 1/2	4"	4"	1" 2 1/2"
H-17	14'-0"	10'-0 1/2"	60,000	3"	299	7.2	1,740	10	4"	4"	1" 2 1/2"
H-19	14'-0"	11'-0 1/2"	67,000	4"	334	7.0	1,750	7 1/2	4"	4"	1" 2 1/2"
I-15	15'-9"	9'-0 1/2"	60,000	3"	298	7.2	1,740	10	4"	4"	1" 2 1/2"
I-17	15'-9"	10'-0 1/2"	67,200	4"	336	7.0	1,750	7 1/2	4"	4"	1" 2 1/2"
I-19	15'-9"	11'-0 1/2"	75,200	4"	376	7.9	1,740	10	4"	5"	1" 2 1/2"
J-15	17'-6"	9'-0 1/2"	66,000	4"	330	6.9	1,750	7 1/2	4"	4"	1" 2 1/2"
J-17	17'-6"	10'-0 1/2"	75,000	4"	374	7.8	1,740	10	4"	5"	1" 2 1/2"
J-19	17'-6"	11'-0 1/2"	83,600	4"	418	8.8	1,740	10	4"	5"	1" 2 1/2"
K-15	19'-3"	9'-0 1/2"	72,600	4"	303	7.2	1,740	10	4"	5"	1 1/4" 3"
K-17	19'-3"	10'-0 1/2"	82,200	4"	411	8.6	1,740	10	4"	5"	1 1/4" 3"
K-19	19'-3"	11'-0 1/2"	92,000	4"	460	9.7	1,760	15	5"	5"	1 1/4" 3"
L-17	21'-0"	10'-0 1/2"	90,000	4"	448	9.4	1,760	15	5"	5"	1 1/4" 3"
L-19	21'-0"	11'-0 1/2"	100,200	4"	501	10.5	1,760	15	5"	5"	1 1/4" 3"

Midwest Air Filters, Inc.

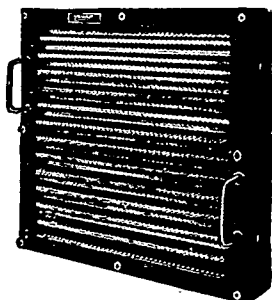
100 East 45th St., NEW YORK, N. Y.

BRANCHES:

New York, N. Y.	Indianapolis, Ind.	Chicago, Ill.	Salt Lake City, Utah
Boston, Mass.	Minneapolis, Minn.	Richmond, Va.	Milwaukee, Wis.
Philadelphia, Pa.	San Francisco, Cal.	St. Louis, Mo.	Seattle, Wash.
Cleveland, O.	Kansas City, Mo.	Denver, Colo.	Dallas, Tex.
Columbus, O.	Pittsburgh, Pa.	Detroit, Mich.	Montreal, Canada

Description of Unit

A Midwest filter unit consists of a frame and a cell. The cells are set on the frames after the frames are put in place. Two or more frames can be bolted together in any shape to obtain the desired capacity filter. See cut on opposite page, for typical installation.



Midwest Unit Air Filter—Type U-2

Dimensions of Units

Each frame measures 20 x 20 x 3 1/2 in.

Each side of the frame has two bolt holes in order that the adjoining frames may be bolted together.

HOW TO DETERMINE THE NECESSARY NUMBER OF FILTER UNITS for a GIVEN QUANTITY OF AIR

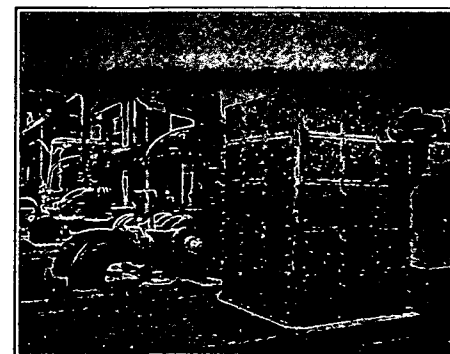
Each filter Unit has a normal capacity of 1000 C.F.M. Therefore divide the total quantity of air to be cleaned per minute by the capacity of an individual Filter Unit. Average Resistance, 3/8" water gage.

The following table gives the number of Filter Units necessary for the various air quantities. However, the proper number of units for any intermediate air quantities can be determined as previously described.

C.F.M.	Number of Filter Units	Square Ft. over Front	Approximate Weight Installed
2,000	2	5.55	130
4,000	4	11.11	240
6,000	6	16.7	340
10,000	10	27.80	540
15,000	15	41.7	780
20,000	20	55.5	1,010
30,000	30	83.3	1,470
40,000	40	111.1	1,950
50,000	50	138.9	2,400
60,000	60	166.7	2,850
70,000	70	194.4	3,560
80,000	80	222.2	4,010
90,000	90	250.0	4,410
100,000	100	277.8	4,720
200,000	200	555.6	9,400
1,000,000	1,000	2,777.8	47,000

Flexibility

Being constructed on the multiple unit principle, this filter can be assembled in any shape or design to conform to local conditions and space allowance. When units are to be assembled in any shape other than in one plane, the Midwest Air Filters, Inc., furnish suitable corner connections, enabling the filters to be installed in the shape which local conditions require.



Typical Installation

The filter can be installed in a room or in an enlarged portion of the duct. The air may be taken from the outside of the building or it may be taken from the inside and recirculated.

If inside space is valuable, the filter can be placed outside the building or on the roof, ducts leading from same to various points of distribution.

Inlet and Outlet Ducts for small installations of about 25 units and under, should be about 3 ft. away from the filter. For large installations, this distance should be increased accordingly. An air velocity of 1,000 ft. to 1,200 ft. per min. in ducts leading to and from the filter is recommended.

The maintenance consists of cleaning the filter cells when they have become sufficiently dirty to materially increase their resistance, and in re-charging them with Midwest Viscosine. The cleaning is done by immersing the cells in the washing tank containing hot water or, if necessary, a solution of hot water and soda. After a cell has been cleaned, it is placed in the drying racks in order that all water may drain off. After the cell is perfectly dry, it is immersed in a bath of Viscosine, and again placed on the racks to enable the surplus Viscosine to drain off. As a cell is taken out of an installation for cleaning and re-charging, a ready reserve cell is inserted in its place.

The time that the cell may be in service between cleanings varies from 12 to 20 weeks under normal conditions.

OTHER TYPES OF FILTER

Filters for Turbo-Generators, Air Compressors, Tractors, for cleaning air and gases with heavy dust content, built to suit various industries and uses.

William Reed Engineering Co.

INCORPORATED

50 Church Street
New York

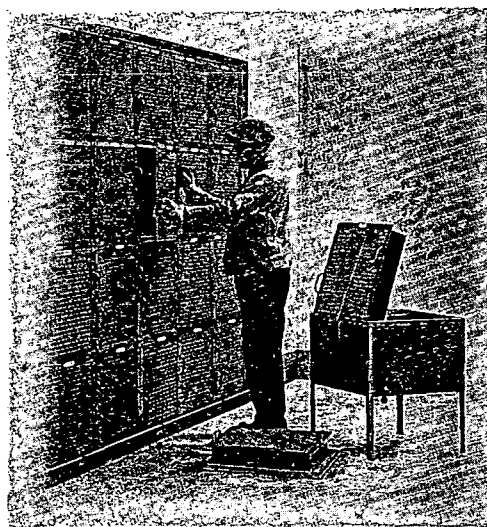
Factory and Engineering Depts.
LOUISVILLE, KY.

Branches in Principal Cities

REED AIR FILTERS

PATENTED MAY 16, 1922—OTHER PATENTS PENDING

The Reed Air Filter—an all metal filter—operates with inexpensive chemicals by an entirely new combination of fundamental principles. It is the result of exhaustive laboratory tests and three years successful operation in various fields and operates on fundamentally the same principle as the human nostril. Air in passing thru the filter impinges on a media saturated with simple chemicals, dirt and dust are leeched out and deposited on the filter body. The cell and its filter media are practically indestructible, both being coated with an enamel which is baked on at high temperature.



Removing Unit for Cleaning

Size.....20"x 20"x 4"
Capacity 800-1000 C.F.M.
Resistance..... 0.12 to 0.15
Efficiency..... 97%
Velocity 300-500 F.P.M.
Weight..... 25 Lbs.

Bulletins

- 106—Description.
- 107—Test, Data, Specifications.
- 108—Gen. Ventilation.
- 109—Vent. Elec. Machinery.
- 110—Compressor Applications.
- 111—Drying-Bacteria Control.

Our Engineering and Research Departments will be glad to discuss special problems.

"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 a Stanley (Automobile) boiler.

"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 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.



"X" Boiler Liquid Sold by all Jobbers

SIZES AND PRICES

Quart Cans..... \$6.00 Each
Half Gallon Cans..... \$10.00 Each

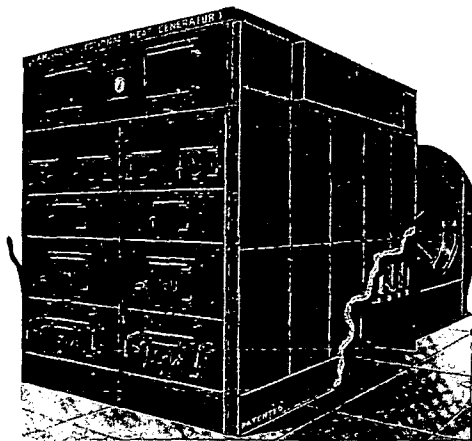
American Foundry & Furnace Company Bloomington, Ill.

SALES REPRESENTATIVES AS FOLLOWS:

LOS ANGELES, CAL. MILWAUKEE, WIS. ST. PAUL, MINN.

AMERICAN WARMING & VENTILATING CO. AMERICAN HEATING & VENTILATING CO.
ATLANTA, GA. ELMIRA, N. Y. PHILADELPHIA, PA. RALEIGH, N. C.
CLEVELAND, O. TOLEDO, O. RICHMOND, VA.

LIGE HEATING & VENTILATING CO., AUBURN, IND.
GILLESPIE-DWYER COMPANY, CHICAGO, ILL.
TEXAS HEATING & VENTILATING COMPANY, FORT WORTH, TEX.
MICHIGAN WARMING & VENTILATING COMPANY, GRAND RAPIDS, MICH.
ATLANTIC HEATING & ENGINEERING COMPANY, HEMPSTEAD, L. I.
W. H. JOHNSON & SON COMPANY, INDIANAPOLIS, IND.
JOHN H. KITCHEN & COMPANY, KANSAS CITY, MO.
SOLAR ENGINEERING CORPORATION, PHILADELPHIA, PA.
CASE FURNACE COMPANY, SEATTLE, WASH.
A. S. JOHNSON, WASHINGTON, D. C.



Two American Solar Heat Generators in Asbestos-Steel Casing

American Solar Heat Generators Insulated With Asbestos-steel Casing

For simple, efficient, and economical Air warming in Blast Systems.

Built entirely of cast iron for single or battery settings.

Capacity from 334,000 to 11,000,000 B.t.u. per hour, depending on size and number of units.

Asbestos-steel Casing assures great efficiency. Made up of two sheets Copper-Bearing Steel with 2" Aircell Asbestos between.

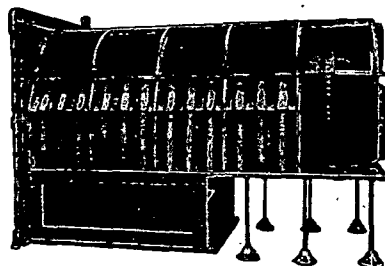
American Heating & Ventilating Steam Boiler

A. S. M. E. Standard Horizontal Tubular Boiler enclosed in cast iron Economizer Jacket. Used as a Warm Air Heater.

Capacity of Single Units from 800,000 to 1,300,000 B.t.u. per hour.

For single or battery setting with brick walls or Asbestos-steel Casings.

Send plans to nearest office above listed for recommendations.



Side View American Heating and Ventilating Steam Boiler

AMERICAN RADIATOR COMPANY

104 West 42nd St.
NEW YORK

816 So. Michigan Ave.
CHICAGO

General Sales Dept., 1807 Elmwood Ave., BUFFALO

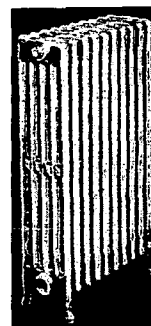
Ideal Boilers, American Radiators, Heating and Vacuum Cleaning Equipments

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)

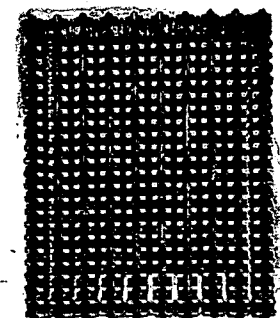
Illustrates (at left) the CORTO Radiator, of classic design. Its heating surface equals, or exceeds, the best; its water content is three-fourths of a pound per square foot of heating surface, or about one-half the contents of the usual form of radiator; and its condensed spacings permit of placing 30% more heating surface in a given area of floor space than with any other type of radiator.

Send for complete CORTO Radiator Catalog.

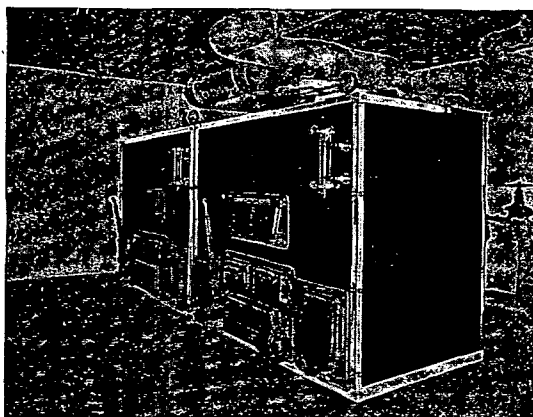
Illustrates (at right) the VENTO Cast-Iron Hot Blast Heaters, now the standard, at home and abroad, for the heating of moving air.

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."



Front View of 10-Section VENTO Stack



IDEAL Type "A" Heat Machines

IDEAL Type "A" Boilers are made in three series, ranging in Steam from 450 to 6,500 sq. ft., and in Water from 750 to 11,000 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.

Steam

Water

Boiler No.	8-Hour Rating Sq. Ft.	No. of Sections	Total Length Inches	Grate Area Sq. Ft.	*Safety Valve Size Inches	Boiler No.	8-Hour Rating Sq. Ft.	No. of Sections	Total Length Inches	Grate Area Sq. Ft.
3-A-5	2600	5	38	8	1-2 1/2	3-A-50	4400	5	38	8
3-A-6	3250	6	46	10	1-3	3-A-60	5500	6	46	10
3-A-7	3900	7	54	12	1-3	3-A-70	6600	7	54	12
3-A-8	4550	8	62	14	2-2 1/2	3-A-80	7700	8	62	14
3-A-9	5200	9	70	16	2-2 1/2	3-A-90	8800	9	70	16
3-A-10	5850	10	78	18	1-3, 1-2 1/2	3-A-100	9900	10	78	18
3-A-11	6500	11	86	20	1-3, 1-2 1/2	3-A-110	11000	11	86	20

Height of Water Line, 49 in. Steam Boilers have one 8-in. Outlet, and one 5-in. Inlet. Water Boilers have one 8-in. outlet and two 8-in. inlets.

For list price, see Current Trade Discount sheet.

*Safety Valve sizes accord with A. S. M. E. boiler code.

Factors determining boiler capacities (derived from actual tests).

Number of Boiler—Steam or Water	5	6	7	8	9	10	11
Fuel available, lb.	578	722	866	1012	1156	1300	1445
Evaporative power, lb.	9.0	9.0	9.0	9.0	9.0	9.0	9.0
Total steam from one fuel charge, lb.	5200	6500	7800	9110	10410	11700	13010
Chimney area (sea level), sq. in.	256	256	320	400	400	400	400
Chimney height*, ft.	40	45	45	50	50	55	60

*For additional chimney flue sizes, see page 36 of "Ideal Fitter."

For Smoke Pipe and other dimensions, see pages 37 of "Ideal Fitter."

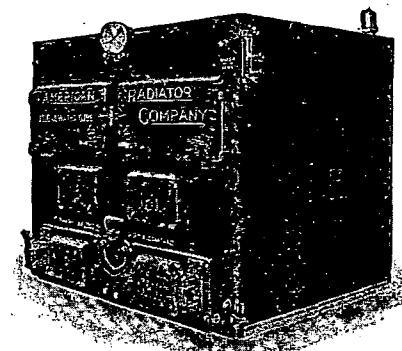
For good chimney construction and its influence on boiler selection, see pages 235 and 236 of "Ideal Fitter."

Height of boiler, 63 inches. Width of boiler, 76 1/4 inches.

For selection of proper size boiler, see pages 240-251 of "Ideal Fitter."

Ratings Developed When Available Fuel Is Burned in 8, 10 or 12 Hours

	Steam Rating					Water Rating				
TIME	5 Sec.	6 Sec.	7 Sec.	8 Sec.	9 Sec.	10 Sec.	11 Sec.	5 Sec.	6 Sec.	7 Sec.
8 Hours	2600	3250	3900	4550	5200	5850	6500	4400	5500	6600
10 Hours	2080	2600	3120	3640	4160	4680	5200	3520	4400	5280
12 Hours	1735	2170	2600	3035	3470	3900	4335	2935	3670	4400



IDEAL Smokeless Water Tube Boilers

(Furnished With or Without Ideal Metallic Jacket)

IDEAL Smokeless Water Tube Boilers are made in series, ranging in Steam from 600 to 20,400 sq. ft., and in Water from 975 to 32,640 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.

Below is given a sample specification page of 79 in. pattern, for Bituminous and for Anthracite Fuels:

The National Boiler and Radiator Manufacturers Association's basis for rating steam and water heating boilers is the number of B.t.u. per hour delivered from the flow pipe—without driving or priming.

The number of B.t.u. delivered per hour divided by *240 is the commercial or catalog rating—in square feet of direct column STEAM radiation.

The number of B.t.u. delivered per hour divided by *150 is the commercial or catalog rating—in square feet of direct column WATER radiation.

The number of B.t.u. delivered per hour divided by **970 is the equivalent of the catalog rating in POUNDS OF STEAM per hour.

FOR BITUMINOUS FUEL

Boiler No. Steam	Rating, Sq. Ft. *Steam Radiation	Boiler No. Water	Rating, Sq. Ft. *Water Radiation	Rating, B.t.u. per hour	Rating, Lbs. Steam per hour	Arrangement of Sections	Grate Dimensions, Ins.	Grate Area, Sq. Ft.	Heating Surface, Sq. Ft.
T-79-12	14400	T-79-120	23040	3456000	3600	A-C-C-C-C-C-C-BW-C-DF-G-BH	79x42	22.96	701.17
13	15600	T-79-130	24960	3744000	3900	A-C-C-C-C-C-C-BW-C-DF-G-BH	79x48	26.24	756.47
14	16800	T-79-140	26880	4032000	4200	A-C-C-C-C-C-C-BW-C-DF-G-BH	79x54	29.52	811.77
15	18000	T-79-150	28800	4320000	4500	A-C-C-C-C-C-C-BW-C-DF-G-BH	79x54	29.52	866.07
16	19200	T-79-160	30720	4608000	4800	A-C-C-C-C-C-C-BW-C-DF-G-BH	79x60	32.80	921.37
17	20400	T-79-170	32640	4896000	5100	A-C-C-C-C-C-C-BW-C-DF-G-BH	79x60	32.80	954.67

SECTIONS—A—Front, C—Center, BW—Bridgwall, DF—Diving Flue, G—Open Center, BH—Back.

FOR ANTHRACITE FUEL

S-79-T-7	8400	W-79-T-7	13440	2018000	2100	A-5C-H	79x42	22.96	379.62
S-79-T-8	9600	W-79-T-8	15360	2310000	2400	A-6C-H	79x48	26.24	434.92
S-79-T-9	10800	W-79-T-9	17280	2590000	2700	A-7C-H	79x54	29.52	490.22
S-79-T-10	12000	W-79-T-10	19200	2880000	3000	A-8C-H	79x60	32.80	545.52
S-79-T-11	13200	W-79-T-11	21120	3168000	3300	A-7C-W-G-H	79x51	27.88	632.74
S-79-T-12	14400	W-79-T-12	23040	3456000	3600	A-8C-W-G-H	79x57	31.16	688.04
S-79-T-13	15600	W-79-T-13	24960	3744000	3900	A-8C-W-C-G-H	79x57	31.16	742.34
S-79-T-14	16800	W-79-T-14	26880	4032000	4200	A-9C-W-C-G-H	79x63	34.44	797.64
S-79-T-15	18000	W-79-T-15	28800	4320000	4500	A-9C-W-C-C-G-H	79x63	34.44	851.94
S-79-T-16	19200	W-79-T-16	30720	4608000	4800	A-10C-W-C-C-G-H	79x69	37.72	907.24
S-79-T-17	20400	W-79-T-17	32640	4896000	5100	A-10C-W-C-C-G-H	79x69	37.72	940.54

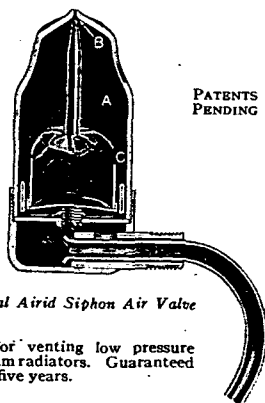
SECTIONS—A—Front Section, C—Center Section, W—Anthracite Bridgwall, G—Open Center Section, H—Anthracite Back Section.

*A. S. M. E. 1922 HEATING BOILER CODE, H-106, H-107.

**Latent Heat of Steam from and at 212° F.

For selection of proper size boiler, see pages 249-251 of "Ideal Fitter" catalog.

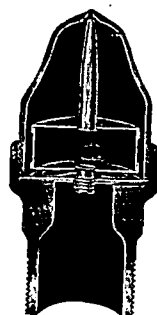
For complete descriptions, ask for Ideal Water Tube, Bituminous and Anthracite Boilers catalogs, also for "The Ideal Fitter" catalog.



PATENTS
PENDING

Ideal Aird Siphon Air Valve

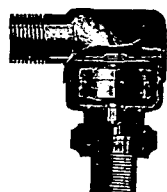
For venting low pressure steam radiators. Guaranteed for five years.



PATENT
PENDING

No. 816 Ideal Quick Vent Valve

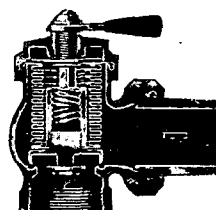
All metal. Very sensitive. For venting mains, long runs of pipe, indirect stacks, drop risers, etc.



PATENT
PENDING

No. 817 Vento Vent

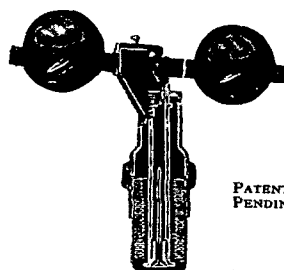
For use on Vento Heaters and Blast Coils.



PATENTS
PENDING

Ideal Packless Radiator Valve
(No. 850)

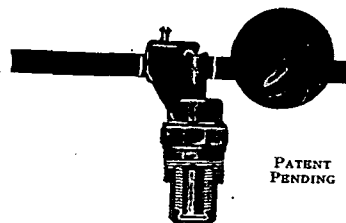
No packing of any kind is used.



PATENTS
PENDING

Arco Water Regulator (No. 800)

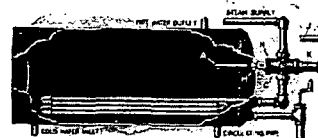
Range 100° to 200° F. Length of Bulb 2½ inches. Connection, 2 inches.



PATENT
PENDING

Arco Junior Water Regulator (No. 801)

For damper control on Hot Water Supply Boilers. Length of bulb, 2 inches. Connection, 1½ inches.



PATENT PENDING

Arco Tank Regulator (No. 880)

Range 140° to 180° F. For use on steam pressures up to 25 lbs.

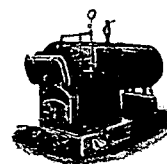
Send for complete catalog of Ideal Heating Specialties.

Ames Iron Works

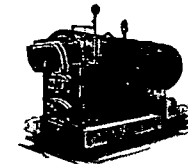
High Pressure Division of the Pierce, Butler & Pierce Mfg. Corp.
Oswego, N. Y.

Boilers for heating and power, Una-flow and heavy duty single valve engines, smokestacks, breechers, tanks.

Sixty-six years of boiler manufacturing experience is behind every Ames Boiler.
A. S. M. E. Requirements.



Plain Furnace Type



Downdraft Furnace Type

Ames Firebox Heating Boiler with Plain Furnace

No. of Size	Diam. Shell In.	Length Furnace In.	Width Furnace In.	Height Furnace Above Grates In.	Sq. Ft. Grate Area	Heating Surface Sq. Ft.	Capacity Steam Rad. Sq. Ft.	Capacity Water Rad. Sq. Ft.	Size Steam Outlet In.	Size Return In.	Diam. Smoke Flue In.	Weight in Lbs. Boiler Complete
805	42	42	36	34	10.5	249	2500	3750	5	3	16	7100
808	48	42	42	37	12.2	403	4000	6000	6	4	20	9370
810	54	48	48	40	16.0	511	5150	7725	6	4	22	10,980
812	54	54	48	40	18.0	613	6500	9750	6	4	22	12,320
813	54	60	48	40	20.0	661	7200	10,800	6	4	22	13,170
814	60	60	54	43	22.5	726	7600	11,400	8	6	26	14,120
815	60	60	54	43	22.5	763	8250	12,375	8	6	26	14,340
816	60	66	54	43	24.7	826	9000	13,500	8	6	26	15,340
818	60	66	54	43	24.7	900	10,000	15,000	8	6	26	16,040
820	66	66	60	46	27.5	1027	11,500	17,250	8	6	30	19,190
823	66	72	60	46	30.0	1158	13,000	19,500	8	6	30	20,750
825	66	72	60	46	30.0	1255	15,000	22,500	8	6	30	21,860
827	72	72	66	49	33.0	1349	16,500	24,750	8	6	32	23,920
830	72	78	66	49	35.7	1501	18,000	27,000	8	6	32	25,340
833	78	72	72	55	36.0	1644	20,000	30,000	10	6	36	27,840
837	78	84	72	55	42.0	1877	22,500	33,750	10	6	36	30,730
840	78	84	72	55	42.0	2017	25,000	37,500	10	6	36	32,640

Ames Firebox Heating Boiler with Downdraft Furnace

No. of Size	Diam. Shell In.	Length Furnace In.	Width Furnace In.	Height Furnace Above Lower Grates In.	Length Grates In.	Grate Area Sq. Ft. A.S.M.E. Rating	Sq. Ft. Heating Surface	Sq. Ft. Cap. Steam Rad.	Sq. Ft. Cap. Water Rad.	Size Steam Outlet In.	Size Return In.	Diam. Smoke Flue In.	Weight in Lbs. Boiler Complete
905	42	66	36	41	42	13.1	258	2625	3938	5	3	16	7880
908	48	66	42	44	42	15.3	408	4100	6150	6	4	20	10,230
910	54	74	48	47	48	20.0	517	5200	7800	6	4	22	12,010
912	54	78	48	47	54	22.5	597	6100	9150	6	4	22	13,170
913	54	84	48	47	60	25.0	622	6500	9750	6	4	22	13,870
914	60	84	54	50	60	28.1	718	7500	11,250	8	6	26	15,480
915	60	85	54	50	60	28.1	831	8200	12,300	8	6	26	15,880
916	60	90	54	50	66	30.9	901	9000	13,500	8	6	26	17,160
918	60	92	54	50	66	30.9	901	10,250	15,375	8	6	26	17,770
920	60	96	54	50	72	33.7	1009	12,000	18,000	8	6	26	19,230
923	66	97	60	53	72	37.5	1154	13,500	20,250	8	6	30	23,040
925	66	104	60	53	78	40.6	1286	15,250	22,875	8	6	30	24,300
927	66	108	60	53	84	43.7	1330	16,000	24,000	8	6	30	25,000
930	72	102	66	56	78	44.6	1500	18,000	27,000	10	6	32	27,300
933	72	104	66	56	78	44.6	1662	20,000	30,000	10	6	32	27,740
937	72	114	66	56	88	50.3	1810	23,500	35,250	10	6	32	30,230

The Brownell Company

Dayton, Ohio

SALES REPRESENTATIVES IN ALL SECTIONS OF THE COUNTRY

Steel Heating and Power Boilers, Feed Water Heaters, Tanks, Breechings, Stacks, Boiler Castings, Steel Plate Construction and Steam Engines.

Since 1855, when The Brownell Co. was established, this company has been manufacturing a complete line of High Grade Boilers and other equipment.

The Brownell Smokeless Firebox Boiler is designed and constructed to burn any kind of fuel economically and without smoke. Brownell Firebox Boilers are mechanically correct and insure long life.

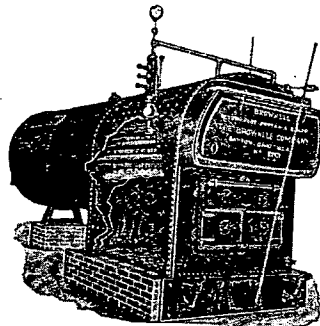


Brownell Heating Boilers have generous and properly designed fireboxes, permitting complete combustion and high efficiency.

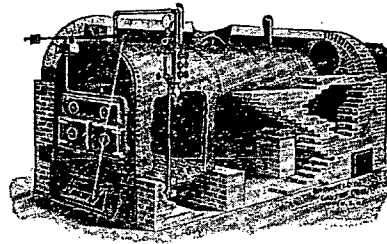
Brownell ratings are very conservative, only the parts of boiler below the normal water level and coming in actual contact with the hot gases being considered as effective heating surface.

Brownell Boilers will carry the number of square feet of direct radiating surface or equivalent given in opposite tables if sufficient radiation is installed to heat the building to the required temperature.

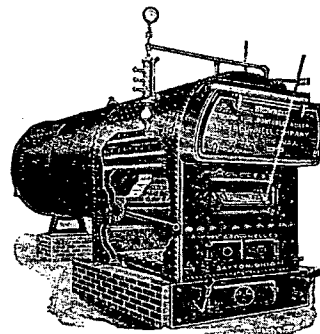
Brownell Firebox Heating Boilers are regularly built according to the A. S. M. E. Code for 15 lb. working pressure but will be furnished for pressures up to 100 lb. at an increased cost.



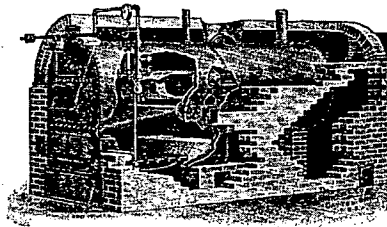
Brownell Return Flue Portable
Direct Draft Type
Bulletin B-6A



Brownell Brick-set Firebox Boiler
Direct Draft Type
Bulletin B-6



Brownell Return Flue Portable
Smokeless Type
Bulletin B-6A



Brownell Brick-set Firebox Boiler
Smokeless Type
Bulletin B-6

BROWNELL DIRECT DRAFT PORTABLE BOILERS

Boiler No.	407	408	409	410	411	412	413	414	415	416	417	418	419	420	421	422	423	424
Capacity—Steam, Sq. Ft.	2500	2900	3500	4000	4500	5000	5500	6000	6500	7000	8000	9500	11000	13000	15000	17500	20000	28000
Capacity—Water, Sq. Ft.	4100	4800	5800	6600	7400	8300	9100	9900	11600	13200	15700	18200	21500	24800	28500	32000	40000	45000
Approximate Weight	6900	7400	8300	9000	9800	10600	11300	12100	13900	15700	18200	21500	24800	28500	32000	40000	45000	45000
Diam. of Boiler, In.	48	48	48	54	54	54	60	60	60	60	66	72	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	16-8	17-8	18-10	19-10	19-10	20-0	22-0	22-0
Heating Surface, Sq. Ft.	293	333	373	427	487	537	614	670	698	781	936	1061	1224	1357	1539	1796	2227	2471
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.	6	6	6	6	6	6	7	7	7	7	8	8	8	8	8	8	10	10
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 of Stack, Ft.	50	50	55	55	55	60	60	60	65	65	70	70	70	70	80	80	90	100
Diam. Breeching, 2 Boilers, In.	30	30	30	34	34	34	38	38	40	44	46	46	50	50	52	52	56	56
Diam. Stack, 2 Boilers, In.	28	28	28	31	31	31	34	34	36	36	40	42	46	46	48	48	54	54
Minimum Height Stack, 2 Boilers, Ft.	60	60	65	65	65	70	70	70	75	75	80	80	80	80	90	100	100	100

BROWNELL SMOKELESS PORTABLE BOILERS

Boiler No.	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324
Capacity—Steam, Sq. Ft.	3000	3500	4000	4500	5000	5500	6000	6500	7500	8500	10000	12000	14000	16000	18000	20000	25000	30000
Capacity—Water, Sq. Ft.	5000	5800	6600	7400	8300	9100	9900	10700	12400	14000	16500	19000	23100	26400	29700	33000	40000	48000
Approximate Weight	7800	8600	9300	10400	11100	11900	14500	16900	17800	20900	22900	25900	28900	32000	35000	37000	43000	48000
Diam. of Boiler, In.	48	48	48	54	54	54	60	60	60	66	72	72	78	78	84	84	90	90
Length Boiler Overall, Ft., In.	8-7	9-10	10-10	10-7	11-7	12-7	12-7	13-7	15-1	16-1	15-9	17-8	17-8	18-6	18-6	20-1	24-1	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.	6	6	6	6	6	6	7	7	7	7	8	8	8	8	8	8	10	10
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	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 of Stack, Ft.	50	55	55	55	60	60	60	65	65	65	70	70	70	70	80	80	90	100
Diam. Breeching, 2 Boilers, In.	30	30	30	34	34	34	38	38	40	44	46	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	80	80	80	80	90	100	100	110

BROWNELL DIRECT DRAFT BRICK-SET BOILERS

Boiler No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Capacity—Steam, Sq. Ft.	900	1050	1200	1400	1700	2000	2000	2600	3000	3500	4000	4500	5500	6500	7500	8700	10000	11000	12000	14000
Capacity—Water, Sq. Ft.	1500	1700	2000	2300	2800	3300	3300	4300	5000	5800	6600	7400	9100	10700	12400	14400	16500	18200	19800	23100
Approx. Shipping Weight	2800	3000	3200	3600	4200	4800	5200	5600	6000	7000	7800	8600	9700	11000	13500	14800	16000	17400	18600	20400
Diam. of Boiler, In.	30	30	30	36	36	42	42	42	48	48	48	54	54	60	60	66	66	72	72	72
Length Boiler, Ft., In.	6-6	7-6	8-6	7-6	9-0	10-6	10-6	10-0	11-6	10-6	12-0	13-6	14-0	16-6	15-6	18-0	16-0	18-0	16-0	18-0
Heating Surface, Sq. Ft.	113	128	143	193	231	268	269	317	364	390	444	499	573	683	755	887	971	1097	1183	1343
Size of Steam, In.	3	3	4	4	4	6	6	6	6	6	6	7	7	7	7	8	8	8	8	8
Size of Return, In.	2 1/2	2 1/2	3	3	3	4	4	4	4	4	4	5	5	5	5	6	6	6	6	6
Size Supply and Return Water Boilers, In.	1-6	1-6	1-6	1-6	1-6	1-6	2-5	2-6	2-6	2-6	2-7	2-7	2-7	2-7	2-8	2-8	2-8	2-10	2-10	2-10
Height of Water Line, In.	53	53	53	59	59	59	61	61	61	65	65	65	67	67	75	75	80	85	85	85
Height Floor to Top of Brick Work, In.	70	70	70	77	77	77	83	83	83	90	90	96	96	108	108	114	114	120	120	120
Diam. Breeching, In.	12	14	16	16	18	18	20	20	22	22	24	24	28	32	32	32	32	36	36	36
Diam. Stack, In.	12	14	16	16	18	18	20	20	22	22	24	26	26	30	30	30	30	34	34	34
Min. Height of Stack, Ft.	40	40	40	40	45	45	45	45	45	50	50	50	55	55	60	60	60	60	60	60
Diam. Breeching, 2 Boilers, In.	26	28	30	30	34	34	38	38	40	44	46	46	50	50	52	52	56	56	56	56
Diam. Stack, 2 Boilers, In.	24	26	28	28	30	32	34	34	36	36	40	42	46	46	48	48	54	54	54	54
Min. Height Stack, 2 Boilers, Ft.	50	50	50	50	55	55	55	55	55	60	60	60	66	66	70	70	70	70	70	70

BROWNELL SMOKELESS BRICK-SET BOILERS

Boiler No.	107	108	109	110	111	112	113	114	115	116	117	118	119	120
Capacity—Steam, Sq. Ft.	2600	3100	3600	4000	4700	5500	6500	7500	8500	10000	11500	13000	14000	16000
Capacity—Water, Sq. Ft.	4300	5100	5900	6600	7800	9100	10700	12400	14000	16500	19000	21500	23100	26400
Approximate Shipping Weight	6100	6700	7200	8400	9100	9800	12300	13600	16000	17400	19400	21000	22400	24300
Diam. of Boiler, In.	42	42	42	48	48	48	54	54	60	60	66	66	72	72
Length Boiler Overall, Ft., In.	9-10	11-4	12-11	12-4	13-10	15-4	15-10	18-4	17-10	20-4	20-4	20-4	20-4	20-4
Heating Surface, Sq. Ft.	309	359	409	448	506	563	643	756	851	987	1074	1204	1303	1468
Size of Steam, In.	6	6	6	6	6	7	7	7	7	8	8	8	8	8
Size of Return, In.	4	4	4	4	4	5	5	5	5	6	6	6	6	6
Size Supply and Return—Water Boilers, In.	2-6	2-6	2-6	2-6	2-7	2-7	2-7	2-7	2-8	2-8	2-10	2-10	2-10	2-10
Height of Water Line, In.	61	61	61	65	65	65	67	67	75	75	80	80	86	86
Height Floor to Top of Brick Work, In.	82	82	82	89	89	89	95	95	107	107	113	113	119	119
Space Required to Open Rear Doors, In.	22	22	22	25	25	25	28	28	30	30	35	35	37	37
Diam. Breeching, In.	22	22	24	24	27	27	30	30	34	34	36	36	38	38
Diam. Stack, In.	20	20	22	22	24	24	28	28	32	32	34	34	36	36
Min. Height of Stack, Ft.	50	50	50	50	55	55	60	60	60	60	70	70	70	70
Diam. Breeching, 2 Boilers, In.	28	30	34	34	36	36	38	40	42	42	44	44	48	48
Diam. Stack, 2 Boilers, In.	26	28	30	30	32	32	34	36	38	38	40	42	44	46

The Bryant Heater & Mfg. Company

Factory, 952 E. 72nd St.



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NEW YORK, N. Y., 212 Livingston St., Brooklyn
CINCINNATI, O., 421 Union Trust Bldg.
DENVER, CO., 1425 Sixteenth St.
CANTON, O., 1607 Shorb Ave., N. W.
PITTSBURGH, PA., East End Trust Bldg., Penn
and Hiland Ave.

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PHILADELPHIA, PA., Bourse Bldg.
BALTIMORE, MD., 1116 Lexington Bldg.
SAN FRANCISCO, CAL., 710 Polk St.

Products—Bryant Gas Boilers for Hot Water, Steam or Vapor Heating; Bryant Hot Water Storage Systems; Bryant Low Pressure Steam Generators.

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 84 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.

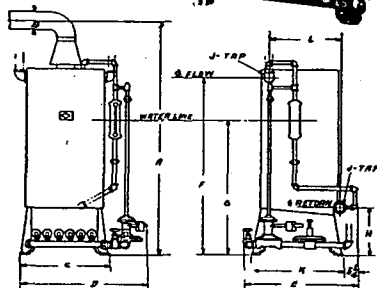
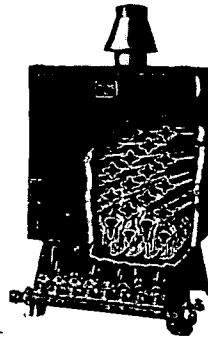
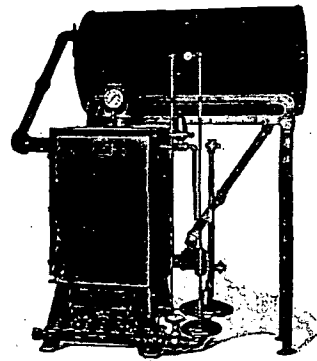
Bryant Boiler,
Showing Interior
Construction

Diagram of Installation, See Dimensions on Next Page



Bryant Hot Water Storage System

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 1/2	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 1/2	31 1/2	29	29 3/4	22	12 1/2	2	18	13 1/2	
5-S-2	335	5-C-2	535	47	5	21 1/2	34 1/2	29	29 3/4	22	12 1/2	2	18	13 1/2	
3-S-3	400	3-C-3	640	65	5	17 1/2	30 1/2	37	46	36	15 1/2	3	26 1/2	21 1/2	
4-S-3	560	4-C-3	895	66	6	20 1/2	33 1/2	37	46	36	15 1/2	3	26 1/2	21 1/2	
5-S-3	720	5-C-3	1150	66	6	23 1/2	37 1/2	37	46	36	15 1/2	3	26 1/2	21 1/2	
6-S-3	880	6-C-3	1410	66	6	26 1/2	41 1/2	37	46	36	15 1/2	3	26 1/2	21 1/2	
7-S-3	1040	7-C-3	1665	67	7	29 1/2	44 1/2	37	46	36	15 1/2	3	26 1/2	21 1/2	
8-S-3	1200	8-C-3	1920	67	7	33	47 1/2	37	46	36	15 1/2	3	26 1/2	21 1/2	
9-S-4	1500	9-C-4	2400	66 1/2	8	40 1/2	54 1/2	37	47 3/4	37	15 1/2	4	26 1/2	21 1/2	
11-S-4	1880	11-C-4	3010	67	8	47 1/2	63 1/2	37 1/2	47 3/4	37	15 1/2	4	26 1/2	21 1/2	
13-S-4	2260	13-C-4	3620	67	8	54 1/2	70 1/2	37 1/2	47 3/4	37	15 1/2	4	26 1/2	21 1/2	
15-S-4	2640	15-C-4	4220	67 1/2	9	61 1/2	77 1/2	37 1/2	47 3/4	37	15 1/2	4	26 1/2	21 1/2	
17-S-4	3020	17-C-4	4830	67 1/2	9	69 1/2	86	37 1/2	47 3/4	37	15 1/2	4	26 1/2	21 1/2	
19-S-4	3400	19-C-4	5440	67 1/2	9	76 1/2	93 1/2	37 1/2	47 3/4	37	15 1/2	4	26 1/2	21 1/2	
21-S-4	3780	21-C-4	6050	67 1/2	9	83 1/2	100 1/2	37 1/2	47 3/4	37	15 1/2	4	26 1/2	21 1/2	
23-S-4	4160	23-C-4	6660	68	10	90 1/2	107 1/2	37 1/2	47 3/4	37	15 1/2	4	26 1/2	21 1/2	
25-S-4	4540	25-C-4	7260	68	10	98 1/2	115	37 1/2	47 3/4	37	15 1/2	4	26 1/2	21 1/2	
27-S-4	4920	27-C-4	7870	68 1/2	11	105 1/2	122 1/2	37 1/2	47 3/4	37	15 1/2	4	26 1/2	21 1/2	
29-S-4	5300	29-C-4	8480	68 1/2	11	112 1/2	129 1/2	37 1/2	47 3/4	37	15 1/2	4	26 1/2	21 1/2	
31-S-4	5680	31-C-4	9090	68 1/2	11	119 1/2	136 1/2	37 1/2	47 3/4	37	15 1/2	4	26 1/2	21 1/2	
33-S-4	6060	33-C-4	9700	68 1/2	11	127 1/2	144	37 1/2	47 3/4	37	15 1/2	4	26 1/2	21 1/2	
35-S-4	6440	35-C-4	10300	68 1/2	11	134 1/2	151 1/2	37 1/2	47 3/4	37	15 1/2	4	26 1/2	21 1/2	
37-S-4	6820	37-C-4	10910	69	12	141 1/2	158 1/2	37 1/2	47 3/4	37	15 1/2	4	26 1/2	21 1/2	
39-S-4	7200	39-C-4	11520	69	12	148 1/2	165 1/2	37 1/2	47 3/4	37	15 1/2	4	26 1/2	21 1/2	
41-S-4	7580	41-C-4	12,330	69	12	156 1/2	173	37 1/2	47 3/4	37	15 1/2	4	26 1/2	21 1/2	

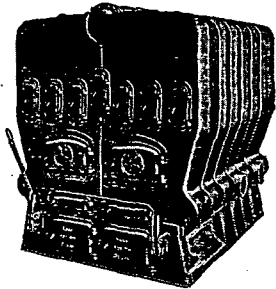
Capacities of Bryant Hot Water Storage Systems

Boiler H. P.	Available B.t.u.	Boiler No.	Capacity, in gallons per hour raised					
			40°	60°	80°	100°	120°	140°
1.3	45,000	3-A-2	135	94	68	54	45	39
1.8	60,500	4-A-2	181	126	91	72	60	52
2.2	75,500	5-A-2	226	157	113	90	75	65
2.7	90,500	3-A-3	275	185	140	110	90	80
3.6	120,500	4-A-3	360	240	180	145	120	105
4.5	151,000	5-A-3	450	300	225	180	150	130
5.4	181,000	6-A-3	545	360	270	215	180	155
6.3	211,000	7-A-3	630	420	315	250	210	180
7.2	241,500	8-A-3	720	480	360	290	240	205
9	305,000	9-A-4	920	610	460	370	305	260
11	372,000	11-A-4	1120	735	560	450	370	320
13	439,000	13-A-4	1320	860	660	530	440	380
15	506,000	15-A-4	1520	1020	760	610	505	435
17	573,000	17-A-4	1720	1150	860	690	575	485
19	640,000	19-A-4	1920	1280	960	770	640	550
21	707,000	21-A-4	2120	1410	1060	850	705	605
23	774,000	23-A-4	2320	1540	1160	930	775	660
25	840,000	25-A-4	2520	1680	1260	1010	840	720
27	908,000	27-A-4	2720	1820	1360	1090	910	775
29	975,000	29-A-4	2920	1950	1460	1170	975	835
31	1,041,000	31-A-4	3130	2080	1565	1250	1040	890
33	1,109,000	33-A-4	3330	2220	1665	1330	1110	950
35	1,176,000	35-A-4	3530	2350	1765	1410	1175	1005
37	1,242,000	37-A-4	3730	2480	1865	1490	1240	1060
39	1,310,000	39-A-4	3930	2620	1965	1570	1310	1120
41	1,377,000	41-A-4	4130	2750	2065	1650	1375	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 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.	List Price
S-50-6	19.27	3-5"	3"	6,250	\$1,425
S-50-7	22.92	3-5"	3 1/2"	7,425	1,660
S-50-8	26.56	4-5"	3 1/2"	8,600	1,885
S-50-9	30.20	4-5"	3 1/2" & 2"	9,775	2,130
S-50-10	33.85	4-5"	3 1/2" & 2"	10,950	2,355
S-50-11	37.5	5-5"	3 1/2" & 3"	12,125	2,590
S-50-12	41.14	5-5"	3 1/2" & 3"	13,300	2,825

Water Boilers

Number	Grate Area Sq. Ft.	Size Supply Tap-pings	Size Return Tap-pings	Rating Sq. Ft.	List Price
W-50-6	19.27	4-5"	2-4"	10,300	\$1,400
W-50-7	22.92	4-5"	2-4"	12,250	1,635
W-50-8	26.56	5-5"	2-4"	14,200	1,870
W-50-9	30.20	5-5"	2-4"	16,150	2,105
W-50-10	33.85	5-5"	2-4"	18,100	2,340
W-50-11	37.5	6-5"	2-4"	20,050	2,575
W-50-12	41.14	6-5"	2-4"	22,000	2,810

SQUARE SECTIONAL Steam Boilers

Number	Grate Area Sq. Ft.	Size Supply Tap-pings	Size Return Tap-pings	Rating Sq. Ft.	List Price
S-18-4	3.00	1-3 1/2"	1-3 1/2"	750	\$260
S-18-5	3.94	2-3 1/2"	2-3 1/2"	950	310
S-18-6	4.88	2-3 1/2"	2-3 1/2"	1,150	360
S-18-7	5.81	3-3 1/2"	2-3 1/2"	1,350	410
S-24-5	5.17	1-4"	2-4"	1,350	405
S-24-6	6.42	2-4"	2-4"	1,700	480
S-24-7	7.67	2-4"	2-4"	2,050	555
S-24-8	8.92	2-4"	2-4"	2,400	630
S-30-5	6.46	2-4"	2-4"	1,750	505
S-30-6	8.02	2-4"	2-4"	2,250	595
S-30-7	9.58	2-4"	2-4"	2,750	685
S-30-8	11.15	3-4"	2-4"	3,250	775
S-30-9	12.71	3-4"	2-4"	3,750	865
S-36-6	9.88	2-4"	2-4"	2,850	700
S-36-7	11.75	3-4"	2-4"	3,500	827
S-36-8	13.63	3-4"	2-4"	4,150	954
S-36-9	15.50	3-4"	2-4"	4,700	1,081
S-36-10	17.38	4-4"	2-4"	5,350	1,208
S-36-11	19.25	4-4"	2-4"	6,000	1,335

Water Boilers

Number	Grate Area Sq. Ft.	Size Supply Tap-pings	Size Return Tap-pings	Rating Sq. Ft.	List Price
W-18-4	3.00	2-3 1/2"	2-3 1/2"	1,250	\$233
W-18-5	3.94	2-3 1/2"	2-3 1/2"	1,575	283
W-18-6	4.88	2-3 1/2"	2-3 1/2"	1,900	324
W-18-7	5.81	3-3 1/2"	3-3 1/2"	2,225	374
W-24-5	5.17	2-4"	2-4"	2,225	374
W-24-6	6.42	2-4"	2-4"	2,800	449
W-24-7	7.67	2-4"	2-4"	3,375	524
W-24-8	8.92	3-4"	3-4"	3,950	599
W-30-5	6.46	2-4"	2-4"	2,900	465
W-30-6	8.02	2-4"	2-4"	3,715	555
W-30-7	9.58	3-4"	3-4"	4,530	645
W-30-8	11.15	3-4"	3-4"	5,345	735
W-30-9	12.71	4-4"	4-4"	6,160	825
W-36-6	9.88	3-4"	3-4"	4,700	655
W-36-7	11.75	3-4"	3-4"	5,775	775
W-36-8	13.63	4-4"	4-4"	6,850	895
W-36-9	15.50	4-4"	4-4"	7,925	1,015
W-36-10	17.38	5-4"	5-4"	9,000	1,135
W-36-11	19.25	5-4"	5-4"	10,075	1,255

Continental Heater Corporation

Dunkirk, N. Y.

MANUFACTURERS OF CAST IRON BOILERS AND RADIATORS

CONTINENTAL LOW WATER LINE BOILER

Has Stood the Test of Many Years' Service

A highly efficient boiler which sends dry steam to the mains and which has the added advantage of a very low water line.

There is good circulation of water in each individual section and throughout entire boiler.

Highly favored for vapor installations because of low, steady water line.

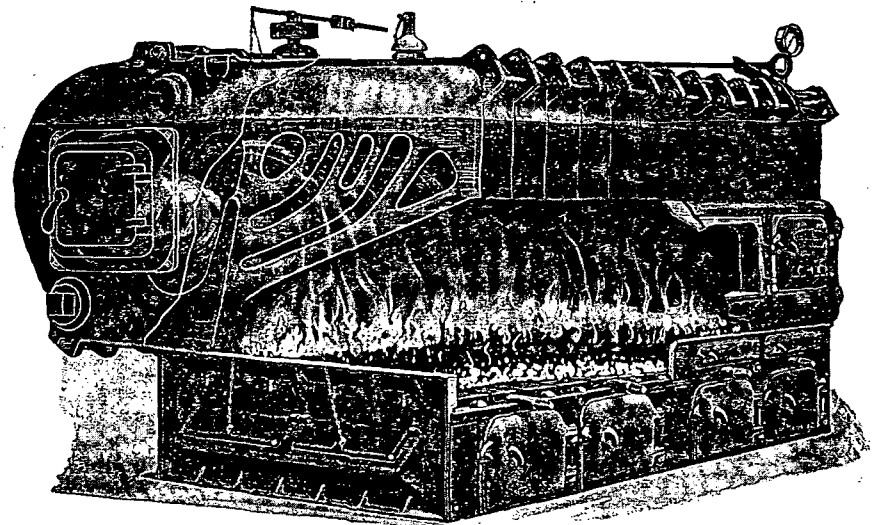
Firing short way of the grate makes possible the easy utilization of entire grate surface.

The fire rises to crown sheet completely enveloping the water tubes, then passing to the first combustion chamber, it travels to one end of boiler, enters rear flue, and travels full length of boiler to smoke exit.

The flue ways because of their design are practically self-cleaning.

Smoke exit may be taken from either end or rear.

Also built in double series with separate fire boxes which may be used independently.



Single Grate Up-Draft Boiler—Smokeless and Regular Type. Any kind of fuel can be satisfactorily used in both types.

Continental Low Water Line Boiler Data

Number	Steam Rating	Water Rating	Grate Area	Flow and Return 2 Each	Front Length of Boiler	Extreme Overall Depth	Chimney Area Inches	Chimney Height Feet
20 SERIES WATER LINE 38"—HEIGHT OF FLOW 43"								
25	700	1150	3.88	3"	35"	39"	8x12	35
26	900	1500	4.85	3"	42"	39"	8x12	35
27	1100	1850	5.82	3"	49"	39"	8x12	40
28	1300	2200	6.80	3"	56"	39"	8x12	40
30 SERIES WATER LINE 43"—HEIGHT OF FLOW 48"								
35	1200	2000	5.83	4"	35"	54"	12x12	40
36	1600	2650	7.29	4"	42"	54"	12x12	40
37	2000	3300	8.75	4"	49"	54"	12x12	40
38	2400	4000	10.21	4"	56"	54"	12x12	40
39	2800	4650	11.67	4"	63"	54"	12x16	40
310	3200	5300	13.13	4"	70"	54"	12x16	45
311	3600	6000	14.59	4"	77"	54"	16x16	45
312	4000	6650	16.05	4"	84"	54"	16x16	45
40 SERIES WATER LINE 47"—HEIGHT OF FLOW 54"								
46	2500	4150	9.72	5"	42"	78"	12x16	50
47	3200	5300	11.66	5"	49"	78"	12x16	50
48	3900	6450	13.60	5"	56"	78"	16x16	50
49	4600	7600	15.54	5"	63"	78"	16x20	55
410	5300	8750	17.48	5"	70"	78"	16x20	55
411	6000	9900	19.43	5"	77"	78"	20x20	55
412	6700	11,100	21.35	5"	84"	78"	20x20	60
413	7400	12,250	23.32	5"	91"	78"	24x24	65
414	8100	13,400	25.27	5"	98"	78"	24x24	65
415	8800	14,550	27.22	5"	105"	78"	24x28	65
416	9500	15,700	29.17	5"	112"	78"	28x28	70
417	10,200	16,850	30.12	5"	119"	78"	28x28	70
418	10,900	18,000	32.07	5"	126"	78"	28x32	70

* Also one additional 5" flow. ** Also two additional 5" flows.
 Cost of these specially designed water tube boilers will compare favorably with cost of the ordinary type.
 Double series boilers 2,600 to 22,300 square feet steam capacity.
 Small square sectional boilers 190 to 825 square feet steam—340 to 1,400 square feet water.

CONTENTO Boiler for Basement or First Floor Installments

Contento Number	Water Rating Sq. Ft.	Steam Rating Sq. Ft.	Radiating Value Sq. Ft.	Fuel Capacity Pounds	Width at Bottom Inches	Outside Length Inches	Extreme Height Inches
4	325	200	50	85	19 1/2	13 1/2	45
5	450	275	60	110	19 1/2	17	45
6	600	350	70	140	19 1/2	20 1/2	45
7	725	425	80	165	19 1/2	24	45

* Radiating value of Contento, piping and expansion tank.

Water boilers have two 2" flow tappings and two 2" return tapping.

Steam boilers have intermediate tapped section with additional 2" top outlet.

All Boilers are equipped with firing tools and ash pan. Shipped assembled, carefully crated.

Being sectional, the boiler may be increased in size and heating capacity at any time the building is enlarged, by simply adding one or more sections.



Contento Boiler

J.F. DAVIS & SONS COMPANY

1122-1123-1124 Harris Trust Bldg.

111 W. Monroe St.

CHICAGO, ILL.

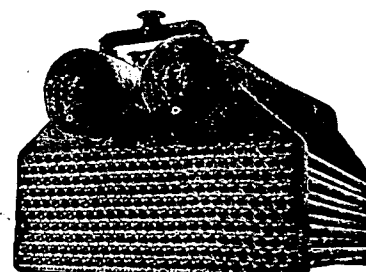
Works at West De Pere, Wis.

LIST OF AGENTS:

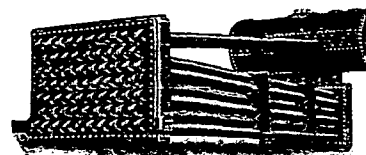
PURCELL-STONE CO.
 3000 Grande River Ave., Detroit, Mich.
 MECHANICAL SERVICE COMPANY,
 Metropolitan Life Bldg., Minneapolis, Minn.

RILEY FREDERICKS CO.
 Security Bldg., Milwaukee, Wis.
 MOUNTAIN STATES MACHINERY CO.,
 U. S. National Bank Bldg., Denver, Colo.

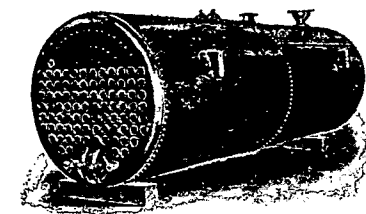
W. E. HYLAND
 728 World-Herald Bldg., Omaha, Neb.



Standard Horizontal Water Tube Boiler



Cross Drum Boiler



Return Tubular Boiler

This Company designs and builds:

Standard Horizontal Drum Water Tube Boilers from 100 to 1,500 hp., and all pressures from 175 lb. to 350 lb.

Standard Cross Drum Water Tube Boilers from 75 to 1,000 hp. and from 175 lb. to 300 lb. pressure.

Medium pressure Cross Drum Water Tube Boilers for heating or power, from 50 to 300 hp. and for 125 lb. pressure.

Return Tubular boilers from 54 inches in diameter to 84 inches in diameter and for 125 lb. and 150 lb. pressure.

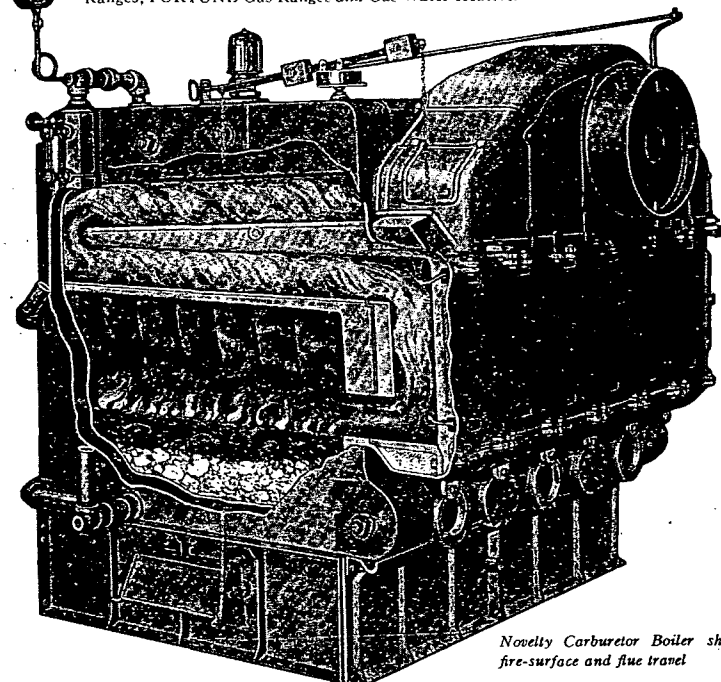
All boilers will be built on a factor of safety of five in accordance with the requirements of the A. S. M. E. Code, and represent the best judgement of years of experience in the design of these types.

The Company is prepared by experience and equipment to design and execute the most intricate and exacting work in steel plate construction, including Stacks, Smoke Flues, Storage Tanks for Oil and Water, Pressure Tanks and Coal Bunkers.

Abram Cox Stove Company

PHILADELPHIA CHICAGO NEW YORK BROOKLYN
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.	Supply Outlets Inches	Return Inlets Inches	Smoke Outlets Inches
3-30	1300	2150	30x 18 1/2	3.85	1-4	1-4	8
4-30	1800	3000	30x 27 3/8	5.76	2-4	2-4	10
5-30	2300	3800	30x 36 3/4	7.65	2-4	2-4	12
6-30	2900	4650	30x 45 7/8	9.56	3-4	3-4	14
7-30	3500	5450	30x 55	11.45	3-4	3-4	16
8-30	4200	6300	30x 64 1/8	13.36	4-4	4-4	18
9-30	4900	7150	40x 27 3/8	7.68	2-4	2-4	12
10-30	5600	8000	40x 36 3/4	10.21	2-4	2-4	14
11-30	6300	8850	40x 45 7/8	12.75	3-4	3-4	16
12-30	7000	9700	40x 55	15.28	3-4	3-4	18
13-30	7700	10550	40x 64 1/8	17.81	4-4	4-4	20
14-30	8400	11400	40x 73 1/4	20.35	4-4	4-4	22
15-30	9100	12250	40x 82 3/8	22.88	5-4	5-4	24
16-30	9800	13100	40x 91 1/2	25.42	5-4	5-4	26
17-30	10500	13950	40x 100 5/8	27.88	5-4	5-4	28
18-30	11200	14800	40x 109 1/4	30.50	6-4	6-4	30
19-30	11900	15650	40x 118 3/8	33.04	6-4	6-4	32
20-30	12600	16500	40x 128	35.58	7-4	7-4	34
21-30	13300	17350	40x 137 1/8	38.12	7-4	7-4	36
22-30	14000	18200	40x 146 1/4	40.66	8-4	8-4	38
23-30	14700	19050	40x 155 1/2	43.20	8-4	8-4	40
24-30	15400	19900	40x 164 1/2	45.74	8-4	8-4	42
25-30	16100	20750	40x 173 3/8	48.28	8-4	8-4	44

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 Boiler Meets All Requirements of Smoke Ordinances.

After the coal gases in the Novelty Carburetor Boiler have come in contact with the extensive overhanging direct heating surface in the firebox of the boiler, they are drawn outside of the firebox into the carburetting chambers located at the rear of the boiler. In these chambers all smoke, gases and carbon (ordinarily wasted), are mixed with oxygen from the air and ignited. This air is admitted through the inlets in such manner that CO₂ is formed.

These gases thus pass from the carburetting chamber into the lower flues in hot red flames at an unusually high temperature to the front of the boiler and there enter the upper flue, still in a red flame, where they 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.

Burns Hard or Soft Coal—Where hard coal is used, cheaper grades and sizes are made to yield as many heat units as a larger and more expensive size.

Where soft coal is used, about 80% of the volatile matter from non-coking or coking coal (which analysis shows to be very high in heat value) is thoroughly consumed.

Over thirty-five years ago, the advantages of feeding a steam or water boiler from the side were recognized by this Company. The boiler they brought out at that time remains unchanged in its fundamental principles; that is, *as a section is added, the grate surface, fire surface, carburetting chamber and flue surface is 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.

The distance from the fire door to back of firebox is only 40 inches in the largest boiler. Low Water line, only 50 inches in all sizes—saves excavating—saves spaces.

INTERNATIONAL HEATER COMPANY

Manufacturers of Heating Apparatus

Utica, N. Y.

CHICAGO 1933-35 Wentworth Ave. NASHUA, N. H. 369 Main St. CLEVELAND, O. 1441 Davenport Ave., N.E.
 NEW YORK Broadway and 57th St.

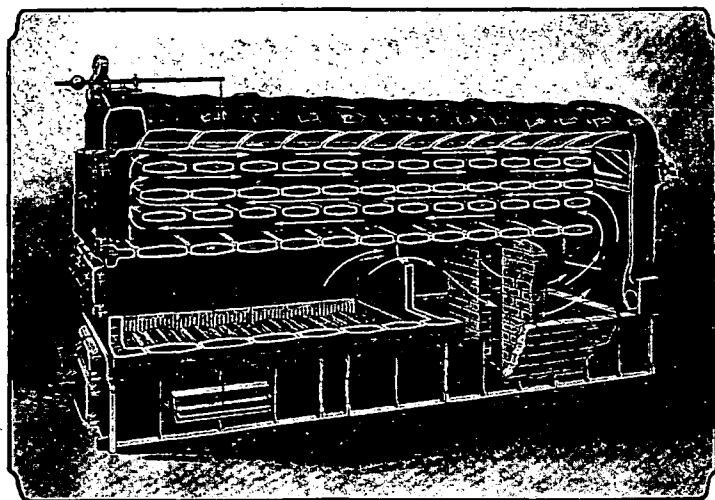
ECONOMY BOILERS

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; 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 two hundred 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. Excess air is always under control—an important feature that promotes fuel economy.



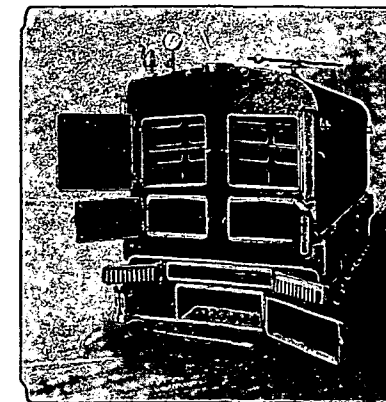
Cut-away View of No. 140-47 Economy Smokeless Boiler

INTERNATIONAL HEATER COMPANY

SECTIONAL MEASUREMENTS Regular and Smokeless Steam Sizes

Series	Height of Water Line	Height to Supply Outlets	Add to Height for Trimmings	Length of Smoke Box	Width of Boiler, Including Trimmings	Height from floor to center of Return Tappings	Height of Fire Box to Crown	Height Grate to Middle of Feed Door	Size of Smoke Flue	Size of Feed Doors
*19	44"	53"	9"	6"	35"	18"	22"	16"	9"	9x14
26	47"	57"	11"	7 1/2"	40"	19"	24"	16"	10"	9x17
31	50"	60 1/2"	11"	7 1/2"	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" Series for hard coal only.

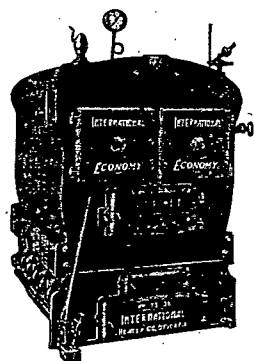
47" Series Economy Smokeless Boiler
Showing Access for Cleaning

Ratings and Dimensions

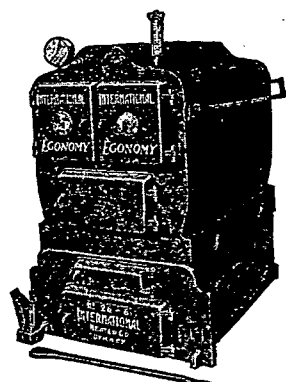
ECONOMY SMOKELESS BOILERS

Number	Rating	Coal Capacity Lbs.	Evap. Power	Dimensions Overall	Tappings		Number	Rating	Coal Capacity Lbs.	Evap. Power	Dimensions Overall	Tappings	
					Supply	Return						Supply	Return
80-26	2200	375	9.3	40x 69"	3-3 1/2"	2-3 1/2"	110-38	5800	1135	9.75	52x 93"	3-5"	2-5"
81-26	2400	425	9.3	40x 74"	3-3 1/2"	2-3 1/2"	111-38	6100	1225	9.75	52x 98"	3-5"	2-5"
90-26	2500	460	9.3	40x 77"	3-3 1/2"	2-3 1/2"	120-38	6350	1285	9.75	52x101"	3-5"	2-5"
91-26	2700	510	9.3	40x 82"	3-3 1/2"	2-3 1/2"	130-38	6900	1285	9.75	52x109"	3-5"	2-5"
100-26	2800	545	9.3	40x 85"	3-3 1/2"	2-3 1/2"	140-38	7450	1285	9.75	52x117"	3-5"	2-5"
110-26	3100	545	9.3	40x 93"	3-3 1/2"	2-3 1/2"	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	45x 69"	3-4"	2-4"							
81-31	3100	545	9.3	45x 74"	3-4"	2-4"							
90-31	3250	590	9.3	45x 77"	3-4"	2-4"							
91-31	3500	655	9.3	45x 82"	3-4"	2-4"							
100-31	3650	700	9.3	45x 85"	3-4"	2-4"							
101-31	3900	765	9.3	45x 90"	3-4"	2-4"							
110-31	4050	810	9.3	45x 93"	3-4"	2-4"							
120-31	4450	810	9.3	45x101"	3-4"	2-4"							
130-31	4850	920	9.3	45x109"	3-4"	2-4"							
140-31	5250	920	9.3	45x117"	3-4"	2-4"							
150-31	5650	920	9.3	45x125"	3-4"	2-4"							
90-38	4700	835	9.75	52x 77"	3-5"	2-5"							
91-38	5000	925	9.75	52x 82"	3-5"	2-5"							
100-38	5250	985	9.75	52x 85"	3-5"	2-5"							
101-38	5550	1075	9.75	52x 90"	3-5"	2-5"							
							90-47	8300	1250	10.	61x 93"	3-6"	2-6"
							100-47	9300	1500	10.	61x103"	3-6"	2-6"
							110-47	10300	1500	10.	61x113"	3-6"	2-6"
							120-47	11300	1500	10.	61x123"	4-6"	4-6"
							130-47	12300	1750	10.	61x133"	4-6"	4-6"
							140-47	13300	1750	10.	61x143"	4-6"	4-6"
							150-47	14300	1750	10.	61x153"	4-6"	4-6"
							160-47	15300	1750	10.	61x163"	4-6"	4-6"
							170-47	16300	1750	10.	61x173"	4-6"	4-6"
							180-47	17300	2000	10.	61x183"	4-6"	4-6"
							190-47	18300	2000	10.	61x193"	4-6"	4-6"
							200-47	19300	2000	10.	61x203"	4-6"	4-6"
							210-47	20300	2000	10.	61x213"	4-6"	4-6"

INTERNATIONAL HEATER COMPANY



No. 76-58 Steam Pattern



No. 26-6 Water Pattern

ECONOMY SECTIONAL BOILERS

Steam

Water

Number	Rating	Coal Capacity Lbs.	Evap. Power	Dimensions Overall	Tappings		Number	Rating	Coal Capacity Lbs.	Dimensions Overall	Tappings	
					Supply	Return					Supply	Return
35-19	700	195	9.6	35x 31"	2-3"	2-3"	19-35	1150	195	33x 31"	1-3"	2-3"
4-19	825	225	9.6	35x 35"	2-3"	2-3"	19-4	1325	225	33x 35"	1-3"	2-3"
45-19	975	265	9.6	35x 40"	2-3"	2-3"	19-45	1600	265	33x 40"	2-3"	2-3"
5-19	1100	295	9.6	35x 43"	2-3"	2-3"	19-5	1825	295	33x 43"	2-3"	2-3"
4-26	1000	290	9.3	40x 37"	2-3 1/2"	2-3 1/2"	26-4	1650	290	36x 37"	2-3 1/2"	2-3 1/2"
45-26	1200	340	9.3	40x 41"	2-3 1/2"	2-3 1/2"	26-45	1975	340	36x 41"	2-3 1/2"	2-3 1/2"
5-26	1300	375	9.3	40x 45"	2-3 1/2"	2-3 1/2"	26-5	2150	375	36x 45"	2-3 1/2"	2-3 1/2"
55-26	1500	425	9.3	40x 49"	2-3 1/2"	2-3 1/2"	26-55	2475	425	36x 49"	2-3 1/2"	2-3 1/2"
6-26	1600	460	9.3	40x 53"	2-3 1/2"	2-3 1/2"	26-6	2650	460	36x 53"	2-3 1/2"	2-3 1/2"
5-31	1650	480	9.3	45x 45"	2-4"	2-4"	31-5	2725	480	42x 45"	2-4"	2-4"
55-31	1900	545	9.3	45x 49"	2-4"	2-4"	31-55	3125	545	42x 49"	2-4"	2-4"
6-31	2050	590	9.3	45x 53"	2-4"	2-4"	31-6	3375	590	42x 53"	2-4"	2-4"
65-31	2300	645	9.3	45x 57"	2-4"	2-4"	31-65	3800	645	42x 57"	2-4"	2-4"
7-31	2450	705	9.3	45x 61"	3-4"	2-4"	31-7	4050	705	42x 61"	3-4"	2-4"
75-31	2700	770	9.3	45x 65"	3-4"	2-4"	31-75	4450	770	42x 65"	3-4"	2-4"
8-31	2850	825	9.3	45x 69"	3-4"	2-4"	31-8	4700	825	42x 69"	3-4"	2-4"
85-31	3100	890	9.3	45x 73"	3-4"	2-4"	31-85	5125	890	42x 73"	3-4"	2-4"
5-38	2500	685	9.75	52x 45"	2-5"	2-5"	38-5	4125	685	48x 45"	2-5"	2-5"
55-38	2800	770	9.75	52x 50"	2-5"	2-5"	38-55	4625	770	48x 50"	2-5"	2-5"
6-38	3050	835	9.75	52x 53"	2-5"	2-5"	38-6	5025	835	48x 53"	2-5"	2-5"
65-38	3350	920	9.75	52x 58"	2-5"	2-5"	38-65	5525	920	48x 58"	2-5"	2-5"
7-38	3600	985	9.75	52x 61"	2-5"	2-5"	38-7	5950	985	48x 61"	2-5"	2-5"
75-38	3900	1070	9.75	52x 66"	2-5"	2-5"	38-75	6450	1070	48x 66"	2-5"	2-5"
8-38	4150	1135	9.75	52x 69"	3-5"	2-5"	38-8	6850	1135	48x 69"	3-5"	2-5"
85-38	4450	1220	9.75	52x 74"	3-5"	2-5"	38-85	7350	1220	48x 74"	3-5"	2-5"
9-38	4700	1285	9.75	52x 77"	3-5"	2-5"	38-9	7750	1285	48x 77"	3-5"	2-5"
95-38	5000	1370	9.75	52x 82"	3-5"	2-5"	38-95	8250	1370	48x 82"	3-5"	2-5"
10-38	5250	1435	9.75	52x 85"	3-5"	2-5"	38-10	8650	1435	48x 85"	3-5"	2-5"
105-38	5550	1520	9.75	52x 90"	3-5"	2-5"	38-105	9150	1520	48x 90"	3-5"	2-5"
11-38	5800	1585	9.75	52x 93"	3-5"	2-5"	38-11	9550	1585	48x 93"	3-5"	2-5"
6-47	5300	1250	9.7	61x 63"	2-6"	2-6"	47-6	8750	1250	59x 63"	2-6"	2-6"
7-47	5600	1500	9.7	61x 73"	2-6"	2-6"	47-7	10400	1500	59x 73"	2-6"	2-6"
8-47	7300	1750	9.7	61x 83"	3-6"	2-6"	47-8	12050	1750	59x 83"	3-6"	2-6"
*B9-47	8300	1750	9.7	61x 93"	3-6"	2-6"	*B47-9	13700	1750	59x 93"	3-6"	2-6"
9-47	8300	2000	9.7	61x 93"	3-6"	2-6"	47-9	13700	2000	59x 93"	3-6"	2-6"
*B10-47	9300	1750	9.7	61x 103"	3-6"	2-6"	*B47-10	15350	1750	59x 103"	3-6"	2-6"
10-47	9300	2250	9.7	61x 103"	3-6"	2-6"	47-10	15350	2250	59x 103"	3-6"	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.

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 Water

Ratings and Dimensions
ECONOMY ROUND BOILERS

Steam

Water

Number	Rating	Coal Capacity Lb.	Evap. Power	Tappings Supply and Return	Height to Flow Out-lets	Number	Rating	Coal Capacity Lb.	Tappings Supply and Return	Height to Flow Out-lets
3E-16	350	114	8.2	1-2 1/2"	45"	16E-3	575	114	1-2 1/2"	40 1/2"
4E-16	375	114	9.0	1-2 1/2"	49"	16E-4	625	114	1-2 1/2"	44 1/2"
5E-16	400	114	9.7	1-2 1/2"	53"	16E-5	650	114	1-2 1/2"	48 1/2"
3E-18	425	142	8.2	1-2 1/2"	45"	18E-3	700	142	1-2 1/2"	40 1/2"
4E-18	475	142	9.0	1-2 1/2"	49"	18E-4	775	142	1-2 1/2"	44 1/2"
5E-18	500	142	9.7	1-2 1/2"	53"	18E-5	825	142	1-2 1/2"	48 1/2"
2E-21	450	170	8.2	2-2 1/2"	46 1/2"	21E-2	750	170	2-2 1/2"	42 1/2"
3E-21	525	170	9.0	2-2 1/2"	50 1/2"	21E-3	875	170	2-2 1/2"	46 1/2"
4E-21	575	170	9.7	2-2 1/2"	54 1/2"	21E-4	950	170	2-2 1/2"	50 1/2"
2E-24	550	220	8.2	2-3"	47 1/4"	24E-2	900	220	2-3"	43 1/4"
3E-24	650	220	9.0	2-3"	52 1/4"	24E-3	1075	220	2-3"	48 1/4"
4E-24	725	220	9.7	2-3"	56 1/4"	24E-4	1200	220	2-3"	52 1/4"
5E-24	775	220	10.3	2-3"	61 1/4"	24E-5	1275	220	2-3"	57 1/4"
2E-27	700	275	8.2	2-3 1/2"	50"	27E-2	1150	275	2-3 1/2"	45 1/4"
3E-27	825	275	9.0	2-3 1/2"	54 1/4"	27E-3	1375	275	2-3 1/2"	50 1/4"
4E-27	925	275	9.7	2-3 1/2"	59 1/4"	27E-4	1550	275	2-3 1/2"	55 1/4"
5E-27	1000	275	10.3	2-3 1/2"	64 1/4"	27E-5	1650	275	2-3 1/2"	59 1/4"
2E-30	1025	385	8.2	2-4"	52 1/4"	30E-2	1675	385	2-4"	48"
3E-30	1200	385	9.0	2-4"	58"	30E-3	2000	385	2-4"	53 1/4"
4E-30	1350	385	9.7	2-4"	63 1/4"	30E-4	2225	385	2-4"	58 1/4"
5E-30	1475	385	10.3	2-4"	68 1/4"	30E-5	2400	385	2-4"	63 1/4"

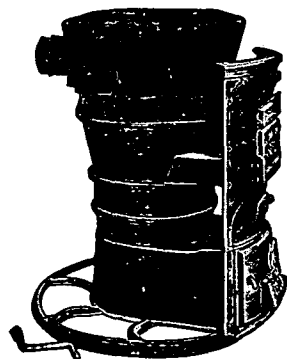
Outside Diameter at Base

Height, Floor to Center, Return Tappings

Size of Smoke Flue

Extreme width of Firepot Section

INTERNATIONAL HEATER COMPANY



Carton Furnace

INTERNATIONAL CARTON FURNACE

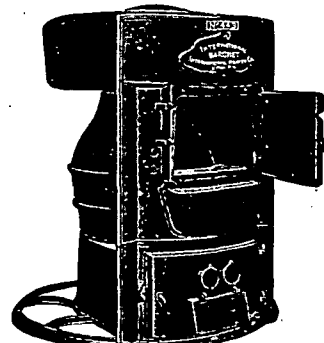
The **International Carton Furnace** is a sturdy, powerful heater made entirely of heavy cast iron with but five principal castings used in its assemblage.

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.

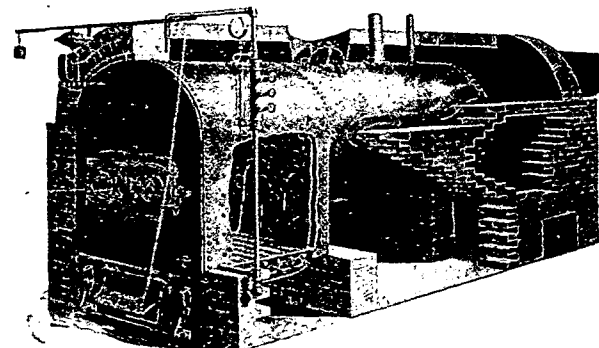
Send for Bulletins 1505 and 4010-G.

KEWANEE BOILER COMPANY

Kewanee, Illinois

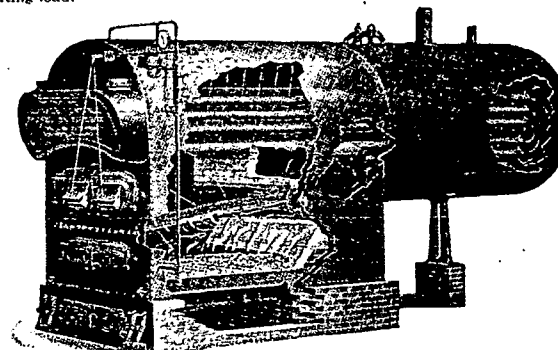
BRANCHES IN ALL PRINCIPAL CITIES

Steel Heating and Power Boilers, Water Heating Garbage Burners, Tabasco Heaters, Tanks and Radiators



KEWANEE SMOKELESS BOILER — Brick-set — for Heating

Kewanee Firebox Boilers represent 35 years of intensive study and effort to obtain 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

viewed 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

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.

square feet of direct radiating surface 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 two pounds pressure at the boiler, and for water on a mean temperature of 180 deg. Fahr. as the water leaves the boiler.

KEWANEE PORTABLE TYKE 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	1600	1900	2450	2950	3300	3800	4300	5200	6200	7100	8200	9500	10400	11400	13300
Heating Surface	sq. ft. 850	sq. ft. 1000	sq. ft. 1150	sq. ft. 1300	sq. ft. 1600	sq. ft. 1900	sq. ft. 2450	sq. ft. 2950	sq. ft. 3300	sq. ft. 3800	sq. ft. 4300	sq. ft. 5200	sq. ft. 6200	sq. ft. 7100	sq. ft. 8200	sq. ft. 9500	sq. ft. 10400	sq. ft. 11400	sq. ft. 13300
Area of Grate	4.4	5.4	6.3	7.4	9.4	11.4	14.4	17.4	20.4	24.4	28.4	34.4	40.4	46.4	54.4	62.4	68.4	74.4	86.4
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	14.10	16.10	18.10	20.10	22.10	24.10	26.10	28.10	30.10	32.10	34.10	36.10	40.10
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 Return	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
Size of Safety Valve	in. 1 1/2	in. 2	in. 2	in. 2	in. 2	in. 2	in. 2	in. 2	in. 2	in. 2	in. 2	in. 2	in. 2	in. 2	in. 2	in. 2	in. 2	in. 2	in. 2
Length of Grate	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32
Length of Ash-pit	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Width of Ash-pit	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
Height 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	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52
Height of Boiler	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59
Location of Steam Supply	4-8	4-8	4-8	4-8	4-8	4-8	4-8	4-8	4-8	4-8	4-8	4-8	4-8	4-8	4-8	4-8	4-8	4-8	4-8
Location of Safety Valve	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
Length of Foundation	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
Width of Foundation	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
Center to Center Bolts in Ash-pit Front	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16
Width of Breaching Connection	61	61	61	61	61	61	61	61	61	61	61	61	61	61	61	61	61	61	61
Length of Breaching Connection	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
Length of Steam Supply	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29
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	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
Height of Return at Rear	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
Height of Return at Front	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
Height of Return at Bottom of Cylinder	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
Height of Return at Draw Tubes	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
Height of Return at Draw Tubes	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
Number of Common Brick	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32
Outside Surface to be Covered	sq. ft. 68	sq. ft. 77	sq. ft. 85	sq. ft. 91	sq. ft. 106	sq. ft. 120	sq. ft. 133	sq. ft. 149	sq. ft. 157	sq. ft. 177	sq. ft. 197	sq. ft. 200	sq. ft. 235	sq. ft. 275	sq. ft. 314	sq. ft. 311	sq. ft. 343	sq. ft. 338	sq. ft. 356

*Foundations not included. If space is available at front, it is not necessary at rear, and vice-versa. Boilers No. 1K to No. 12K are furnished with cast iron base. Full height back stand furnished with all boilers, no pier, see Letter W.

KEWANEE PORTABLE SMOKELESS BOILERS TYPE K

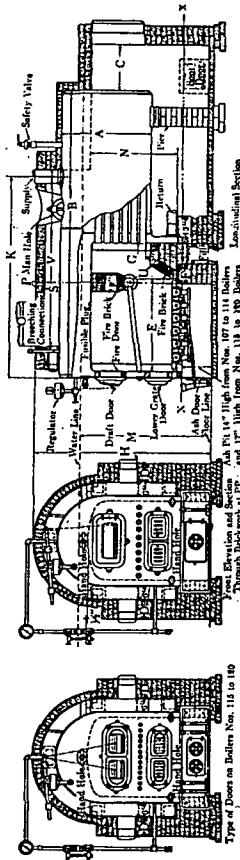
Number of Boiler	104K	105K	106K	107K	108K	109K	110K	111K	112K	113K	114K	115K	116K	117K	118K	119K	120K
Capacity Steam	1500	1800	2200	2500	2900	3400	3800	4400	5200	6200	7100	8100	9500	10900	12300	13300	15200
Heating Surface	sq. ft. 1500	sq. ft. 1800	sq. ft. 2200	sq. ft. 2500	sq. ft. 2900	sq. ft. 3400	sq. ft. 3800	sq. ft. 4400	sq. ft. 5200	sq. ft. 6200	sq. ft. 7100	sq. ft. 8100	sq. ft. 9500	sq. ft. 10900	sq. ft. 12300	sq. ft. 13300	sq. ft. 15200
Area of Grate	5.9	7.2	8.4	9.6	10.8	12.1	13.4	14.7	16.0	17.3	18.6	20.0	21.3	22.6	23.9	25.2	26.5
Diameter of Boiler	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36
Length of Boiler Overall	9.11	10.11	11.11	12.11	13.11	14.11	15.11	16.11	17.11	18.11	19.11	20.11	21.11	22.11	23.11	24.11	25.11
Diameter of Stack	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
Height of Stack	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
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	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Size of Steam Opening	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Size of Return	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Size of Safety Valve	in. 2	in. 2 1/2	in. 2 1/2	in. 2 1/2	in. 2 1/2	in. 2 1/2	in. 2 1/2	in. 2 1/2	in. 2 1/2	in. 2 1/2	in. 2 1/2	in. 2 1/2	in. 2 1/2	in. 2 1/2	in. 2 1/2	in. 2 1/2	in. 2 1/2
Length of Grate	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32
Length of Ash-pit	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31
Width of Ash-pit	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
Height of Ash-pit	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Height of Water-line	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52
Height of Boiler	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59
Location of Steam Supply	4-8	4-8	4-8	4-8	4-8	4-8	4-8	4-8	4-8	4-8	4-8	4-8	4-8	4-8	4-8	4-8	4-8
Location of Safety Valve	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
Length of Foundation	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
Width of Foundation	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
Center to Center Bolts in Ash-pit Front	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16
Width of Breaching Connection	61	61	61	61	61	61	61	61	61	61	61	61	61	61	61	61	61
Length of Breaching Connection	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
Length of Steam Supply	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29
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	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
Height of Return at Rear	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
Height of Return at Front	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
Height of Return at Bottom of Cylinder	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
Height of Return at Draw Tubes	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
Height of Return at Draw Tubes	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
Number of Common Brick	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32
Outside Surface to be Covered	sq. ft. 85	sq. ft. 102	sq. ft. 115	sq. ft. 131	sq. ft. 148	sq. ft. 164	sq. ft. 180	sq. ft. 199	sq. ft. 218	sq. ft. 243	sq. ft. 278	sq. ft. 311	sq. ft. 350	sq. ft. 380	sq. ft. 407	sq. ft. 425	sq. ft. 470

*Foundations not included. If space is available at front, it is not necessary at rear, and vice-versa. Boilers No. 104K to 112K are furnished with cast iron bases. Full height back stand with all boilers, no pier, see Letter X.

**KEWANEE FIREBOX BOILERS—BRICK
SET TYPE**

[illegible]

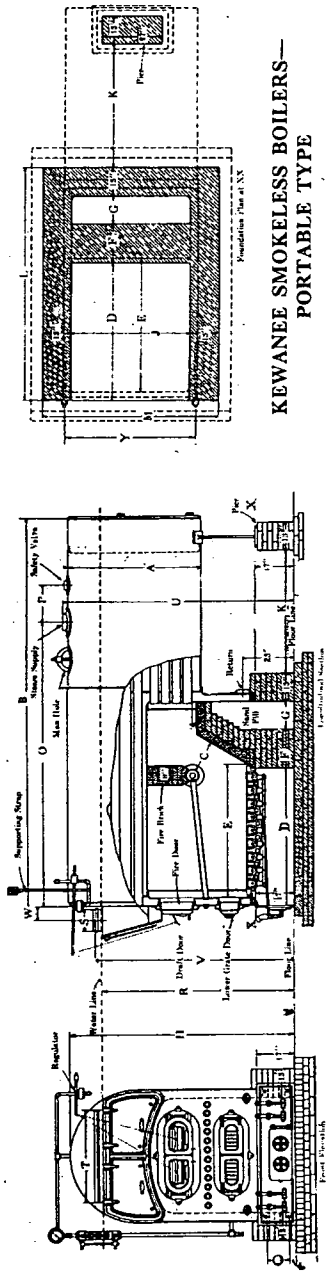
*Foundations not included. NOTE—A Firing Space of about 8'-0" should be maintained at front of Boilers. This provides sufficient space to draw tubes through firedoor.



Number of Boiler...

Capacity, Steam.	sq. ft.	1600	2000	2300	2600	3100	3600	4000	4700	5500	6500	7500	8500	10000	11500	13000	14000	16000
Heating Surface.	sq. ft.	206	243	288	327	345	393	425	480	535	623	741	839	973	1064	1194	1291	1456
Area of Upper Grate.	sq. ft.	5.9	7.2	8.4	9.6	10.1	11.4	11.8	13.2	15.0	17.1	19.1	21.1	23.3	25.9	28.5	31.3	35.3
Diameter of Boiler.	ft. in.	3.6	3.6	3.6	4.2	4.2	4.2	4.8	4.8	4.8	5.4	5.4	6.0	6.0	6.6	6.6	7.2	7.2
Length of Boiler Over-all.	ft. in.	8.7	10.2	11.7	12.0	11.4	12.0	12.4	13.0	15.4	15.9	18.3	17.0	20.4	20.4	20.4	18.4	20.4
Diameter of Stack.	ft.	18	18	20	20	20	22	22	24	24	24	28	32	32	32	34	36	36
Height of Stack.	ft.	45	45	45	50	50	50	50	55	55	55	60	60	60	60	70	70	70
Diameter of Stack, Two Boilers.	ft.	24	24	25	26	28	30	30	32	32	34	36	38	40	42	44	46	46
Height of Stack, Two Boilers.	ft.	55	55	55	60	60	60	60	67	67	71	77	77	77	80	80	80	80
Size of Steam Opening.	in.	3	3	3	3	4	4	4	4	4	4	5	5	5	5	6	6	6
Size of Return.	in.	3	3	3	3	4	4	4	4	4	4	5	5	5	5	6	6	6
Size of Safety Valve.	in.	2	2 1/4	2 1/4	2 1/4	2 1/4	3	3 1/2	3 1/2	3 1/2	4	4 1/2	4 1/2	5	5	6	6	6
C-Rear Space.	in.	17	17	17	17	17	22	22	22	22	24	24	24	24	24	24	28	28
D-Thickness Wall.	in.	9	9	9	9	9	9	9	9	9	9	13	13	13	13	13	13	13
E-Length Grate.	in.	31	37	43	37	43	49	43	49	55	55	61	61	67	67	67	67	73
J-Width Ash-pit.	in.	31	31	31	37	37	37	43	43	43	49	49	54	54	60	60	66	66
F-Thickness Bridge Wall.	in.	9	9	9	9	9	9	13	13	13	18	18	18	18	18	18	18	18
G-Grate to Tube Sheet.	in.	14	14	14	17	17	17	23	23	23	23	29	29	29	29	29	29	29
U-Header to Bridge Wall.	in.	7	7	7	7	7	10	12	10	11	12 1/2	13	14	14	15 1/2	15 1/2	16	17
H-Height Brickwork.	in.	77	77	77	83	83	83	83	90	90	96	108	108	108	114	114	120	120
K-Location Steam Supply	ft. in.	6-0	7-0	7-0	7-6	8-0	8-0	8-0	9-0	9-0	9-6	10-6	11-0	11-0	12-0	12-0	12-0	13-1
L-Length Over-all.	ft. in.	10-9	12-3	13-9	13-9	15-5	15-5	14-1	16-5	17-11	18-0	21-4	20-11	23-5	23-5	23-5	21-9	23-9
M-Height Siderline.	ft. in.	35	35	35	38 1/2	38 1/2	38 1/2	41	41	41	48	58	58	60	60	60	60	60
N-Height of Flue.	ft. in.	26	26	26	27	27	27	27	27	27	27	30	30	31	31	31	31	31
O-Height of Flue.	ft. in.	20	20	20	22	22	22	22	22	22	22	24	24	24	24	24	24	24
P-Flue Siderline.	ft. in.	20	20	20	22	22	22	22	22	22	22	24	24	24	24	24	24	24
S-Tube Sheet Connection.	ft. in.	5-3	6-3	7-3	7-0	7-6	8-0	8-1	8-11	9-9	10-8	10-6	10-10	12-0	12-0	12-0	11-1	12-1
V-Length of Arch.	ft. in.	5-6	5-6	5-6	6-0	6-0	6-6	6-6	6-6	7-0	7-8	8-2	8-2	8-8	8-8	9-2	9-2	9-2
W-Width of Arch.	ft. in.	5-6	5-6	5-6	6-0	6-0	6-6	6-6	6-6	7-0	7-8	8-2	8-2	8-8	8-8	9-2	9-2	9-2
Z-Reg'd at Rear to Draw Tubes.	ft. in.	2-25	3-5	4-5	2-8	3-8	4-8	4-0	5-0	6-0	5-11	6-11	6-11	8-11	7-50	8-300	8-700	9-300
Number Common Brick.	ft. in.	220	2350	2450	2600	2850	3100	3700	4000	4300	6000	7350	7900	7900	7800	8300	8700	9300
Common Fire Brick.	ft. in.	85	85	85	100	100	100	130	130	130	155	155	215	215	250	250	310	310
Common Brick for Two Boilers.	ft. in.	3900	4100	4300	4500	4950	5350	6500	7000	7550	10500	12750	13700	13700	14200	15000	15000	16000

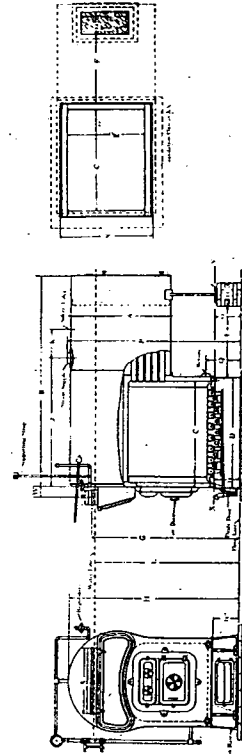
*Foundations not included.



KEWANEE SMOKELESS BOILERS—PORTABLE TYPE

Number of Boiler	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324
Capacity, Steam.....	3000	3500	4000	4500	5000	5500	6000	6500	7000	7500	8000	9000	10000	11000	12000	13000	14000	15000
Heating Surface.....	297	352	391	446	496	546	592	643	693	743	793	843	893	943	993	1043	1093	1143
Area of Upper Grate.....	8.8	10.1	11.4	12.9	14.7	16.5	18.5	20.0	21.4	22.9	24.4	25.9	27.4	28.9	30.4	31.9	33.4	34.9
Diameter of Boiler.....	9.1	10.5	11.5	12.5	13.5	14.5	15.5	16.5	17.5	18.5	19.5	20.5	21.5	22.5	23.5	24.5	25.5	26.5
Length of Boiler Over-all.....	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Diameter of Stack.....	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Height of Stack.....	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Height of Stack, Two Boilers.....	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28
Size of Steam Opening.....	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
Size of Return.....	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Size of Safety Valve.....	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Distance Required to Open Rear Flue Doors.....	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26
E-Length Grate.....	37	43	49	55	61	67	73	79	85	91	97	103	109	115	121	127	133	139
C-Header to Bridge Wall.....	11 1/2	11 1/2	11 1/2	11 1/2	11 1/2	11 1/2	11 1/2	11 1/2	11 1/2	11 1/2	11 1/2	11 1/2	11 1/2	11 1/2	11 1/2	11 1/2	11 1/2	11 1/2
D-Header to Ash-pit.....	38	44	50	56	62	68	74	80	86	92	98	104	110	116	122	128	134	140
K-Rear Wall to Pier.....	29	37	45	53	61	69	77	85	93	101	109	117	125	133	141	149	157	165
J-Width Ash-pit.....	37	43	49	55	61	67	73	79	85	91	97	103	109	115	121	127	133	139
M-Width Foundation.....	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46
L-Height Boiler.....	61	67	73	79	85	91	97	103	109	115	121	127	133	139	145	151	157	163
H-Height Supply.....	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84
N-Height Water-line.....	71	71	71	71	71	71	71	71	71	71	71	71	71	71	71	71	71	71
O-Height of Breaching Connection.....	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70
P-Location Safety Valve.....	5 1/2	6 1/2	7 1/2	8 1/2	9 1/2	10 1/2	11 1/2	12 1/2	13 1/2	14 1/2	15 1/2	16 1/2	17 1/2	18 1/2	19 1/2	20 1/2	21 1/2	22 1/2
W-Center Breaching Connection to Front of Boiler.....	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46
S-Width Breaching Connection.....	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
T-Length Breaching Connection.....	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36
†Reg'd at Front to Draw Tubes.....	7.7	8.1	8.4	8.7	9.0	9.3	9.6	9.9	10.2	10.5	10.8	11.1	11.4	11.7	12.0	12.3	12.6	12.9
*Number Common Brick.....	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
Number Fire-brick.....	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115
Outside Surface to be Covered.....	148	157	173	184	212	221	235	255	285	300	310	320	330	340	350	360	370	380

*Foundations not included. †If space 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	3000	3500	4000	4500	5000	5500	6000	6500	7000	7500	8000	8500	9000	9500	10000	10500	11000
Heating Surface.....	278	310	373	416	465	515	565	626	676	726	776	826	876	926	976	1026	1076	1126
Area of Upper Grate.....	9.6	11.1	12.6	14.1	15.6	17.1	18.6	20.1	21.6	23.1	24.6	26.1	27.6	29.1	30.6	32.1	33.6	35.1
Diameter of Boiler.....	8.7	9.6	10.5	11.4	12.3	13.2	14.1	15.0	15.9	16.8	17.7	18.6	19.5	20.4	21.3	22.2	23.1	24.0
Length of Boiler Over-all.....	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Diameter of Stack.....	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Height of Stack.....	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Height of Stack, Two Boilers.....	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28
Size of Steam Opening.....	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
Size of Return.....	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	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Distance Required to Open Rear Flue Doors.....	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26
E-Length Grate.....	38	44	50	56	62	68	74	80	86	92	98	104	110	116	122	128	134	140
C-Header to Bridge Wall.....	11 1/2	11 1/2	11 1/2	11 1/2	11 1/2	11 1/2	11 1/2	11 1/2	11 1/2	11 1/2	11 1/2	11 1/2	11 1/2	11 1/2	11 1/2	11 1/2	11 1/2	11 1/2
D-Header to Ash-pit.....	36	42	48	54	60	66	72	78	84	90	96	102	108	114	120	126	132	138
K-Rear Wall to Pier.....	33	39	45	51	57	63	69	75	81	87	93	99	105	111	117	123	129	135
J-Width Ash-pit.....	33	39	45	51	57	63	69	75	81	87	93	99	105	111	117	123	129	135
M-Width Foundation.....	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46	46
L-Height Boiler.....	61	67	73	79	85	91	97	103	109	115	121	127	133	139	145	151	157	163
H-Height Supply.....	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84
N-Height Water-line.....	71	71	71	71	71	71	71	71	71	71	71	71	71	71	71	71	71	71
O-Height of Breaching Connection.....	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70
P-Location Safety Valve.....	5 1/2	6 1/2	7 1/2	8 1/2	9 1/2	10 1/2	11 1/2	12 1/2	13 1/2	14 1/2	15 1/2	16 1/2	17 1/2	18 1/2	19 1/2	20 1/2	21 1/2	22 1/2
W-Center Breaching Connection to Front of Boiler.....	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46
S-Width Breaching Connection.....	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
T-Length Breaching Connection.....	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36
†Reg'd at Front to Draw Tubes.....	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1
*Number Common Brick.....	56	65	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70
Number Fire-brick.....	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115	115
Outside Surface to be Covered.....	115	130	150	175	185	190	195	200	205	210	215	220	225	230	235	240	245	250

*Foundations not included. †If space is available at front, it is not necessary at rear, and vice-versa.

Molby Boiler Company

INCORPORATED

41 East 42nd Street

NEW YORK

New Molby Magazine—Feed, Downdraft, Smokeless Boilers with the new adjustable side grate—for steam, vapor and hot water.

USE
No. 1
Buckwheat

with the
NEW MOLBY

The new 'Molby' will heat home—large apartment house—or commercial building—having a good chimney, just as successfully and just as easily with this low-priced small coal as ordinary boilers burning the expensive sizes.

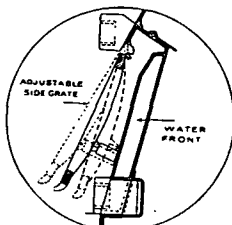
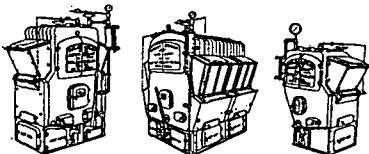
New adjustable side grate permits regulation of fire to suit kind of coal used. Low draft resistance.

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, as well as larger sizes. Also burns sized free-burning bituminous with proper chimney draft. Also coke. Magazines need re-filling only once every 12 hours. 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 new 'Molby' 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 BOILER

STEAM						STEAM AND WATER							WATER				
Number	Steam Cipher	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- 4026	Adageo	43	2-3	500	\$280	54	41	35½	10	2-3	8x12	1890	W- 4026	Domo	2-3	850	\$270
S- 5025	Addio	43	2-3	675	340	54	41	42	10	2-3	8x12	2230	W- 5025	Doseo	2-3	1125	330
S- 6026	Admito	43	2-3	850	400	54	41	48½	10	2-3	8x12	2580	W- 6026	Doffo	2-3	1400	390
S- 7026	Adzo	43	2-3	1025	460	54	41	55	10	2-3	12x12	2950	W- 7025	Doveo	2-3	1700	450
S- 8026	Adelo	43	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	37¾	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	50¾	14	2-4	12x12	4290	W- 6031	Edito	2-4	2850	667
S- 7031	Buno	54	2-3	2050	814	62½	61	56¾	14	2-4	12x16	4690	W- 7031	Edicto	2-4	3425	814
S- 8031	Bulbo	54	2-3	2400	904	62½	61	63⅜	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	Educo	3-4	4575	984
S-10031	Bungo	54	2-4	3100	1064	62½	61	75¾	14	3-4	16x16	5930	W-10031	Eduxo	3-4	5150	1064
47" Series																	
S- 5047	Calzo	61	2-4	2550	960	80	75½	50½	14	2-4	12x16	5990	W- 5047	Fluxo	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	Carpo	61	2-4	4500	1440	80	75½	76	16	3-4	16x20	9500	W- 8047	Flowo	3-4	7500	1440
S- 9047	Casoo	61	2-4	5150	1600	80	75½	84¾	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	Flieigo	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).

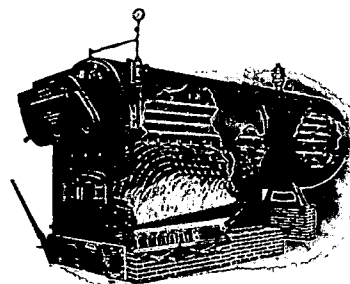
Water boilers are furnished with two water temperature regulators, except 26 in. series which are equipped with one. A complete set of firing and cleaning tools, together with an instruction card for its operation, accompanies each steam and water boiler.

OIL CITY BOILER WORKS Oil City Pa.

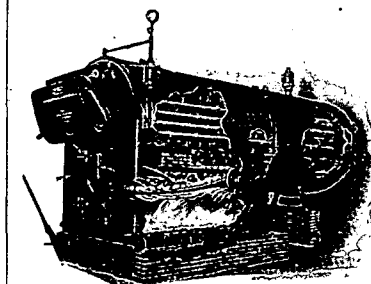
NEW YORK, 501 Fifth Ave.
CHICAGO, 1224 Marquette Bldg.
LOS ANGELES, 404 Union Bank Bldg.
PITTSBURGH, 1116 House Bldg.
BALTIMORE, Dukehart Bldg., McComas and Race Sts.

DETROIT, 242 W. Larned St.
KANSAS CITY, 410 E. 43rd St.
MINNEAPOLIS, Metropolitan Life Bldg.
PHILADELPHIA, Room 1043 Real Estate Trust Bldg.
ATLANTA, 50 S. Forsyth St.
BOSTON, 66 Broadway, Cambridge.

TORONTO, ONT., 45 Jarvis St.



"Oil City" Direct Draft Boiler



"Oil City" Smokeless Boiler

"OIL CITY" low pressure boilers are offered to the trade as the last word in "Heating Economy" comprising in one unit all the elements of a modern plant for steam or hot water heating, especially adapted for Schools, Office Buildings, Hotels, Churches, Club Houses, Hospitals or for any purpose where the service of a universally recognized fire box boiler of high merit is desired.

"OIL CITY" boilers are designed and constructed to meet all requirements of modern engineering as formulated by the American Society of Mechanical Engineers, the boiler laws of the various states and cities, and are backed by thirty-five years of successful practical experience.

Description—"OIL CITY" boilers are built in smokeless and straight draft types for portable and brick settings, self contained with all steel construction thoroughly braced, stayed, inspected, and tested for 15 lb. working pressure.

These boilers have large fire boxes thereby insuring ample combustion space in which heat-giving gases and air freely mix before entering tubes.

The arrangement of tubes in relation to shell allows free circulation of water at all times, together with large steam space, insuring dry steam and steady water level.

All parts of the boiler are made accessible for cleaning by the use of 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.

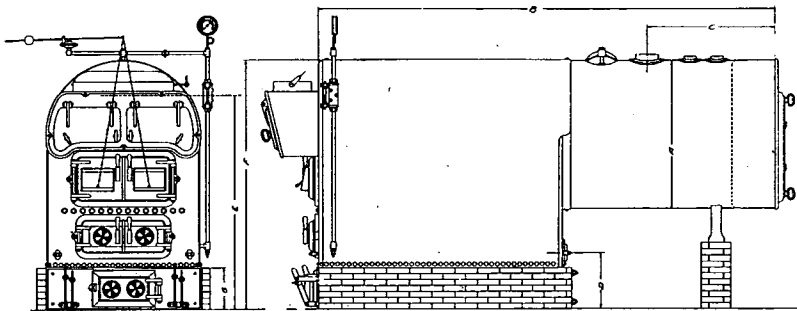
Equipment—Equipment with all boilers includes, in addition to complete set of shaking grates, all the necessary castings, safety valves, steam gauge, water column, etc., required for a complete installation.

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 feature of modern construction and free from the recognized faults.

Every "OIL CITY" boiler bears the official stamp, or symbol of the A. S. M. E. Boiler Code, indicating the pressure at which the boiler may be worked.

At a small increase in cost "OIL CITY" boilers are furnished, braced and stayed, for a safe working pressure of 100 lb. Complete specifications, measurements and weights shown in Catalog H-9.

SPECIFICATIONS AND GENERAL DIMENSIONS ON NEXT PAGE.



Settling Plan and Measurements "Oil City" Heating Boilers

"Oil City" Smokeless

NUMBER OF BOILER	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324
CAPACITY - STEAM	30 FT.	3000	3200	3400	3600	3800	4000	4200	4400	4600	4800	5000	5200	5400	5600	5800	6000	6200
CAPACITY - WATER	30 FT.	3000	3200	3400	3600	3800	4000	4200	4400	4600	4800	5000	5200	5400	5600	5800	6000	6200
BOILER DIAMETER	A	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
BOILER LENGTH	D	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11
DOOR TO OUTLET	C	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11
FLOOR TO RETURN	D	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
FLOOR TO WATER LINE	E	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
HEIGHT OVER DOILER	F	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11
HEIGHT FROM PIT	G	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11
SIZE OUTLET	H	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
SIZE RETURN	H	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
SIZE SMOKE OUTLET	H	10-10	10-10	10-10	10-10	10-10	10-10	10-10	10-10	10-10	10-10	10-10	10-10	10-10	10-10	10-10	10-10	10-10
DOOR BREACHING - ONE DOILER	H	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22
DOOR BREACHING - TWO DOILERS	H	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
DOOR STRACK - ONE DOILER	H	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
DOOR STRACK - TWO DOILERS	H	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
HEIGHT STRACK - ONE DOILER	H	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
HEIGHT STRACK - TWO DOILERS	H	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
DOOR TO OPEN REAR DOORS	H	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20

"Oil City" Direct Draft Type

NUMBER OF BOILER	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324
CAPACITY - STEAM	30 FT.	3000	3200	3400	3600	3800	4000	4200	4400	4600	4800	5000	5200	5400	5600	5800	6000	6200
CAPACITY - WATER	30 FT.	3000	3200	3400	3600	3800	4000	4200	4400	4600	4800	5000	5200	5400	5600	5800	6000	6200
BOILER DIAMETER	A	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
BOILER LENGTH	D	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11
DOOR TO OUTLET	C	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11
FLOOR TO RETURN	D	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
FLOOR TO WATER LINE	E	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
HEIGHT OVER DOILER	F	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11
HEIGHT FROM PIT	G	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11	11-11
SIZE OUTLET	H	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
SIZE RETURN	H	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
SIZE SMOKE OUTLET	H	10-10	10-10	10-10	10-10	10-10	10-10	10-10	10-10	10-10	10-10	10-10	10-10	10-10	10-10	10-10	10-10	10-10
DOOR BREACHING - ONE DOILER	H	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22
DOOR BREACHING - TWO DOILERS	H	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
DOOR STRACK - ONE DOILER	H	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
DOOR STRACK - TWO DOILERS	H	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
HEIGHT STRACK - ONE DOILER	H	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
HEIGHT STRACK - TWO DOILERS	H	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
DOOR TO OPEN REAR DOORS	H	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20

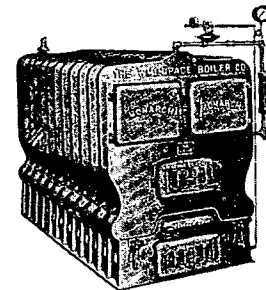
The Wm. H. Page Boiler Co.

GENERAL OFFICES

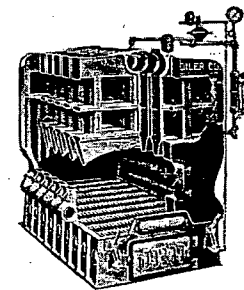
141-145 West 36th Street NEW YORK

Branches: 379 Commercial 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	8 Hr. Rating* Sq. Ft. Steam	8 Hr. Rating* Sq. Ft. Water	Size of Grate, † Inches	Area of Grate, Sq. Ft.	Height Over All, Inches Steam	Width All, Inches Steam	Height Over All, Inches Water	Width All, Inches Water	Total Length, Inches	Water Line, Inches Steam	Outlets and Inlets, Inches	Size of Smoke Pipe, Inches
604	650	1075	22x20	3.35	60 1/2	39 1/4	52	35	34	41	2-3	10
605	850	1400	22x25 1/2	4.03	60 1/2	39 1/4	52	35	40 1/2	41	2-3	10
606	1050	1725	22x32 1/2	5.00	60 1/2	39 1/4	52	35	46 1/2	41	2-3	10
607	1250	2050	22x39 1/2	5.98	60 1/2	39 1/4	52	35	53 1/2	41	2-3	10
608	1450	2400	22x45 1/2	6.95	60 1/2	39 1/4	52	35	59 1/2	41	2-3	10
504	1200	1975	28x24 1/2	4.82	73	45 1/4	64 1/2	41	43 1/2	51	2-5	13
505	1600	2625	28x33 1/2	6.45	73	45 1/4	64 1/2	41	52	51	2-5	13
506	2000	3300	28x41 1/2	8.07	73	45 1/4	64 1/2	41	60 1/2	51	2-5	13
507	2400	3950	28x49 1/2	9.70	73	45 1/4	64 1/2	41	68 1/2	51	2-5	13
508	2800	4600	28x58 1/2	11.32	73	45 1/4	64 1/2	41	77 1/2	51	2-5	13
509	3200	5275	28x66 1/2	12.96	73	45 1/4	64 1/2	41	85 1/2	51	2-5	13
510	3600	5950	28x74 1/2	14.59	73	45 1/4	64 1/2	41	93 1/2	51	2-5	13
511	4000	6625	28x82 1/2	16.22	73	45 1/4	64 1/2	41	101 1/2	51	2-5	13
512	4400	7300	28x90 1/2	17.85	73	45 1/4	64 1/2	41	109 1/2	51	2-5	13
405	2400	3975	40x33 1/2	9.55	81	59 1/4	72 1/2	55	52	58	2-5	21
406	3000	4950	40x41 1/2	11.52	81	59 1/4	72 1/2	55	60 1/2	58	2-5	21
407	3600	5925	40x49 1/2	13.85	81	59 1/4	72 1/2	55	68 1/2	58	2-5	21
408	4200	6925	40x58 1/2	16.18	81	59 1/4	72 1/2	55	77 1/2	58	2-5	21
409	4800	7925	40x66 1/2	18.50	81	59 1/4	72 1/2	55	85 1/2	58	2-5	21
410	5400	8900	40x74 1/2	20.82	81	59 1/4	72 1/2	55	93 1/2	58	2-5	21
411	6000	9900	40x82 1/2	23.13	81	59 1/4	72 1/2	55	101 1/2	58	2-5	21
412	6600	10900	40x90 1/2	25.50	81	59 1/4	72 1/2	55	109 1/2	58	2-5	21
413	7200	11875	40x98 1/2	27.85	81	59 1/4	72 1/2	55	117 1/2	58	2-5	21
414	7800	12875	40x106 1/2	30.20	81	59 1/4	72 1/2	55	125 1/2	58	2-5	21
415	8400	13850	40x114 1/2	32.55	81	59 1/4	72 1/2	55	133 1/2	58	2-5	21
416	9000	14850	40x122 1/2	34.90	81	59 1/4	72 1/2	55	141 1/2	58	2-5	21

† Bridgwall sections are furnished for shortening grates, if desired, and are recommended for boilers above nine sections. They are regularly 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.

* 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, are 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 deg. for hot water.

Pierce, Butler & Pierce Mfg. Corp.

41 E. 42nd St. NEW YORK CITY

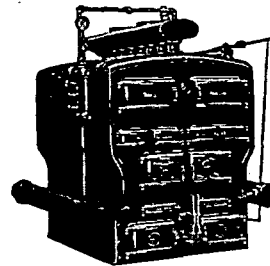
Factories:

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 14,950 sq. ft. capacity. Cast iron steam boilers 325 to 9,000 sq. ft. capacity. Firebox heating boilers, capacity steam radiation 2,500 to 25,000 sq. ft.; capacity water radiation 4,000 to 40,000 sq. ft. Radiators—all types.



The
Pierce-American
Boiler

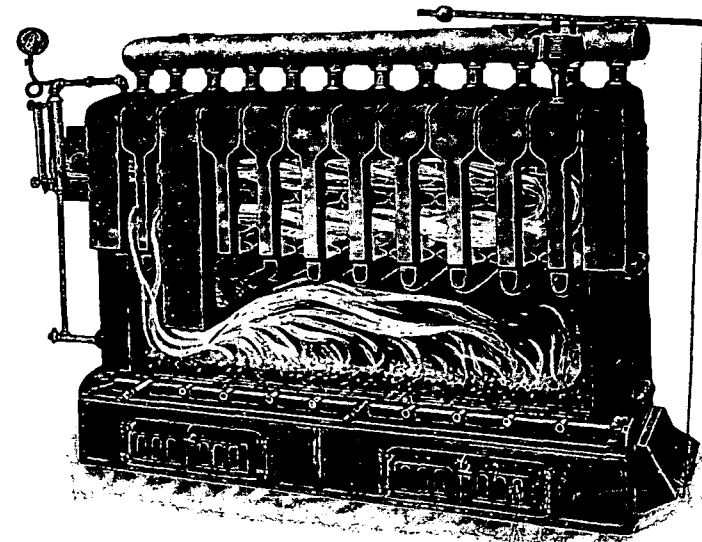
A 30-year record of
proved successful
performance

Sizes and Dimensions

No.*	Sections	Length	BOILER AND HEADERS		Height Water Line on S. B.	No. and Size, Out-lets	No. and Size, Re- turns	Smoke Pipe Dis.	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	8x12	35 ft.	600	1,000
215	5	55	45	56 1/8	40 1/4	2-3	2-3	9 1/2	8x12	35 ft.	800	1,325
216	6	63	45	56 1/8	40 1/4	2-3	2-3	9 1/2	12x12	40 ft.	1,000	1,650
217	7	71	45	58	40 1/4	2-3	2-4	9 1/2	12x12	40 ft.	1,200	2,000
265	5	55	51	64 1/2	47 1/8	2-3	2-3	11 3/4	12x12	40 ft.	1,100	1,825
266	6	63	51	64 1/2	47 1/8	2-4	2-4	11 3/4	12x12	40 ft.	1,400	2,325
267	7	71	51	64 1/2	47 1/8	2-4	2-4	11 3/4	12x16	50 ft.	1,700	2,825
268	8	79	51	64 1/2	47 1/8	2-4	2-4	11 3/4	12x16	50 ft.	2,000	3,325
325	5	55	59 1/4	67	49	2-4	2-4	14	12x16	40 ft.	1,400	2,325
326	6	63	59 1/4	67	49	2-5	2-5	14	12x16	40 ft.	1,750	2,900
327	7	71	59 1/4	67	49	2-5	2-5	14	16x16	40 ft.	2,100	3,475
328	8	79	59 1/4	67	49	2-5	2-5	14	16x16	50 ft.	2,450	4,050
329	9	87	59 1/4	67	49	2-5	2-5	14	16x16	50 ft.	2,800	4,625
405	5	55	66 1/2	69 1/4	51	2-4	2-4	15 3/4	12x16	40 ft.	1,900	3,150
406	6	63	66 1/2	69 1/4	51	2-5	2-5	15 3/4	16x16	40 ft.	2,400	3,975
407	7	71	66 1/2	69 1/4	51	2-5	2-5	15 3/4	16x16	50 ft.	2,900	4,800
408	8	79	66 1/2	69 1/4	51	2-5	2-5	15 3/4	16x20	50 ft.	3,400	5,625
409	9	87	66 1/2	69 1/4	51	2-5	2-5	15 3/4	20x20	50 ft.	3,900	6,450
4010	10	95	66 1/2	69 1/4	51	2-5	2-5	15 3/4	20x20	50 ft.	4,400	7,275
466	6	68	79	82	55 3/4	2-6	2-6	19 1/4	20x20	50 ft.	3,750	6,200
467	7	76	79	82	55 3/4	2-6	2-6	19 1/4	20x20	50 ft.	4,500	7,450
468	8	84	79	82	55 3/4	2-6	2-6	19 1/4	20x20	60 ft.	5,250	8,700
469	9	92	79	82	55 3/4	2-6	2-6	19 1/4	20x20	60 ft.	6,000	9,950
4610	10	100	79	82	55 3/4	2-6	2-6	19 1/4	24x24	60 ft.	6,750	11,200
4611	11	108	79	82	55 3/4	2-6	2-6	19 1/4	24x24	60 ft.	7,500	12,450
4612	12	116	79	82	55 3/4	2-6	2-6	19 1/4	24x24	70 ft.	8,250	13,700
4613	13	124	79	82	55 3/4	2-6	2-6	19 1/4	24x24	70 ft.	9,000	14,950

*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.



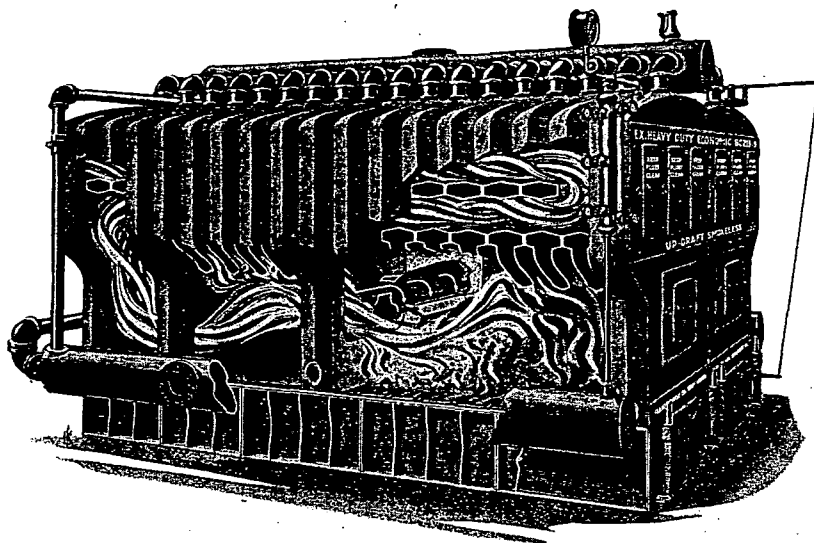
Cutaway View Showing Three Way Fire Travel of Up-Draft Smokeless
Economic Type Boiler. Side Feed

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 Sizes
EC-106	6	67	50	8.19	2-4	2-4	1750	\$630.00	Ecbatic	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.

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	Mesoo	24x65"
AC-211	106	22.2	3-5	4-4	7325	1858.00	Mafo	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	Roew	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	Rollo	32x85"
BC-221	185	31.7	2-10	4-4	18,000	4345.00	Rongo	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	Roebor	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"

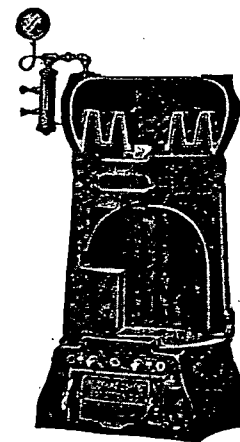
Height to top of header.....	A Series	B Series
Water line.....	72 in.	80 in.
Size of smoke pipe.....	50 in.	55 in.
Height to center of smoke pipe.....	18 in.	24 in.
Total width over headers.....	50 in.	55 in.
Asbestos covering.....	93 in.	93 in.

Richardson & Boynton Company

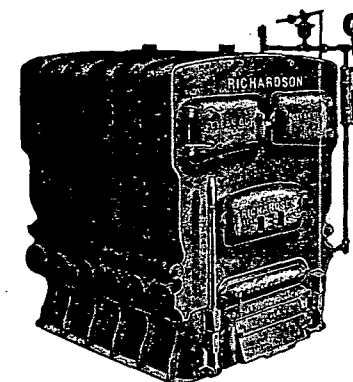
260 Fifth Avenue
New York City

BRANCHES
 Boston
 60 High Street
 Providence
 429 Industrial Trust Building
 Chicago
 171-173 West Lake Street
 Philadelphia
 1308 Arch Street
 Rochester
 Rockwood Street

Richardson Round Boiler



Richardson Sectional Boiler



Round

List Prices and Data

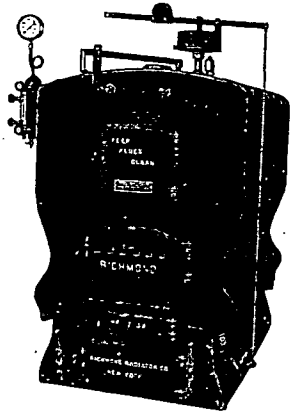
Sectional

Boiler Number	8 Hr. Rating Sq. Ft. Steam	8 Hr. Rating Sq. Ft. Water	Nom. Diam. Grate, Inches	Grate Area, Sq. Ft.	No. Inlets and Outlets and Size, Inches	List Price Com- plete, Steam	List Price Com- plete, Water	Boiler Number	8 Hr. Rating Sq. Ft. Steam	8 Hr. Rating Sq. Ft. Water	Grate Area, Sq. Ft.	Asphalt, Inside, Inches	No. Outlets and Size, inches	List Price Com- plete, Steam	List Price Com- plete, Water
161	250	400	16	1.40	2.2	\$142.00	\$124.00	255	1000	1600	4.57	27 1/2 x 35 1/2	2-3 1/2	\$415.00	\$377.00
162	275	425	16	1.40	2.2	162.00	136.00	256	1250	2000	5.70	27 1/2 x 42 1/2	2-3 1/2	495.00	457.00
190	300	500	19	1.97	2.2 1/2	170.00	139.00	257	1500	2400	6.83	27 1/2 x 50	2-3 1/2	564.00	526.00
191	350	575	19	1.97	2.2 1/2	190.00	160.00	258	1700	2800	7.97	27 1/2 x 57 1/2	2-3 1/2	629.00	591.00
192	375	625	19	1.97	2.2 1/2	210.00	175.00	259	1950	3125	7.85	39 x 53 1/2	2-4	679.00	630.00
221	450	750	22	2.64	2.2 1/2	233.00	192.00	357	2850	4575	11.75	39 x 51 1/2	2-4	805.00	757.00
222	500	825	22	2.64	2.2 1/2	248.00	212.00	358	3300	5300	13.70	39 x 58 1/2	3-4	1,035.00	978.00
223	550	900	22	2.64	2.2 1/2	264.00	230.00	359	3750	6025	15.65	39 x 66 1/2	3-4	1,139.00	1,081.00
251	625	1025	25	3.41	2.3	290.00	242.00	427	3500	5600	13.82	45 x 50	2-5	1,083.00	1,026.00
252	675	1100	25	3.41	2.3	310.00	258.00	428	4050	6500	16.11	45 x 58 1/2	2-5	1,190.00	1,133.00
253	725	1200	25	3.41	2.3	340.00	290.00	429	4600	7400	18.40	45 x 66 1/2	2-5	1,323.00	1,248.00
281	875	1350	28	4.28	2.3 1/2	354.00	300.00	4210	5150	8300	20.69	45 x 74 1/2	3-5	1,432.00	1,357.00
282	950	1550	28	4.28	2.3 1/2	386.00	328.00	4211	5700	9200	22.98	45 x 83	3-5	1,547.00	1,466.00
283	1025	1675	28	4.28	2.3 1/2	426.00	370.00	536	6300	10000	18.94	55 x 55	2-6	1,786.00	1,719.00
								537	7300	11600	22.68	55 x 65 1/2	2-6	2,010.00	1,938.00
								538	8300	13200	26.40	55 x 76 1/2	3-6	2,243.00	2,151.00
								539	9300	14800	30.12	55 x 87 1/2	3-6	2,464.00	2,369.00
								5310	10300	16400	33.88	55 x 98	3-6	2,707.00	2,588.00

Richmond Radiator Company

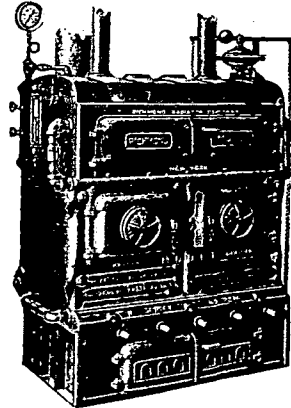
1480 Broadway, New York

217 E. Illinois St., Chicago, Ill.



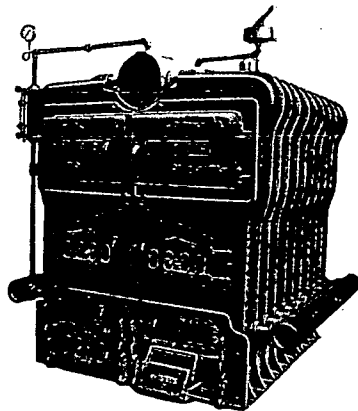
"RICHMOND" Sectional Boiler

Made in sizes: 1200 to 5000 sq. ft. for Steam; 2000 to 8225 sq. ft. for Hot Water.



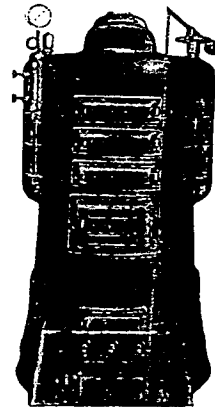
"MODEL" Sectional Boiler

Made in sizes: 350 to 5850 sq. ft. for Steam; 575 to 9850 sq. ft. for Hot Water.



Richmond Heavy Duty Boiler

Made in sizes: 4800 to 12000 sq. ft. for Steam; 7925 to 19000 sq. ft. for Hot Water.



"RICHMOND" Round Boiler

Made in sizes: 330 to 1350 sq. ft. for Steam; 545 to 2275 sq. ft. for Hot Water.

CATALOGS OF BOILERS AND RADIATORS UPON REQUEST

The H. B. Smith Company

Works: Westfield, Mass.

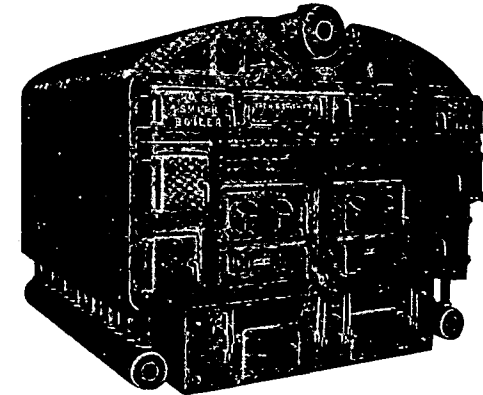
WESTFIELD, MASS. 57 Main Street

NEW YORK: 10 E. 39th Street

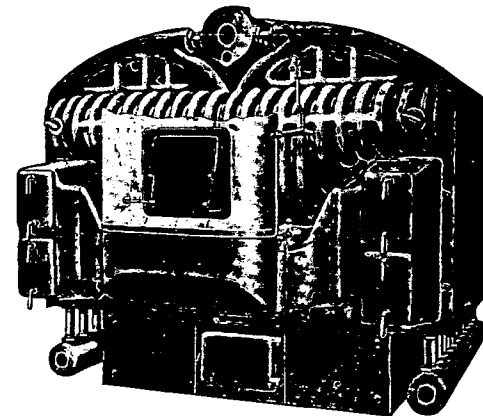
BOSTON: 640 Main Street, Cambridge

PHILADELPHIA: 17th and Arch Streets

Manufacturers of Boilers and Radiators for Steam and Water Heating



No. 60 Smith Boiler—Front



No. 60 Smith Boiler—Back

Smith Boiler With Smokeless Furnace

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	30	77	62	1,500	2,475
11	27	30	83	68	1,650	2,725
11	27	36	83	68	1,800	2,975
12	27	36	89	74	1,950	3,225
12	27	42	89	74	2,100	3,475
13	27	42	95	80	2,250	3,725
13	27	48	95	80	2,400	3,975
14	27	48	101	86	2,550	4,200
15	27	54	107	92	2,725	4,500
16	27	60	113	98	2,900	4,775
No. 36						
11	36	36	87	68	2,750	4,550
12	36	36	93	74	3,000	4,950
12	36	42	93	74	3,250	5,375
13	36	42	99	80	3,500	5,775
13	36	48	99	80	3,750	6,200
14	36	48	105	86	4,000	6,600
14	36	54	105	86	4,250	7,000
15	36	54	111	92	4,500	7,425
16	36	60	117	98	4,800	7,925
17	36	66	123	104	5,100	8,425
18	36	72	129	110	5,400	8,900
No. 60						
12	60	36	110	73	6,600	10,900
13	60	36	116	79	7,200	11,900
13	60	42	116	79	7,800	12,850
14	60	42	122	85	8,400	13,850
14	60	48	122	85	9,000	14,850
15	60	48	128	91	9,600	15,850
15	60	54	128	91	10,200	16,850
16	60	54	134	97	10,800	17,800
17	60	60	140	103	12,000	19,800
18	60	66	146	109	13,200	21,800
19	60	72	152	115	14,400	23,750
20	60	78	158	121	15,600	25,750

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" round	17" round	25" 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		8"
	4"	6"	
8	2	2	2
9	2	2	2
10	2	2	2
11	2	2	2
12	2	2	2
13	2	2	2
14	2	2	3
15	2	2	3
16	2	2	3
17	2	2	3
18	2	2	3
19	2	2	3
20	2	2	3

Smith Boiler Without Smokeless Furnace

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
12	27	66	89	74	3,300	5,450
13	27	66	95	80	3,600	5,950
13	27	72	95	80	3,600	5,950
14	27	66	101	86	3,900	6,425
14	27	78	101	86	3,900	6,425
No. 36						
7	36	36	63	44	2,300	3,800
8	36	42	69	50	2,800	4,625
9	36	48	75	56	3,300	5,450
10	36	54	81	62	3,800	6,275
11	36	60	87	68	4,300	7,100
12	36	66	93	74	4,800	7,925
12	36	66	93	74	4,800	7,925
13	36	66	99	80	5,300	8,750
13	36	72	99	80	5,300	8,750
14	36	66	105	86	5,800	9,575
14	36	78	105	86	5,800	9,575
15	36	72	111	92	6,300	10,400
15	36	84	111	92	6,300	10,400
16	36	72	117	98	6,800	11,225
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
17	60	90	140	103	16,800	27,700
18	60	84	146	109	18,000	29,700
18	60	96	146	109	18,000	29,700

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. 2 1/2 in.
Front ends tapped.....5 in.
Rear ends tapped.....1 1/4 in.
Undersides tapped.....1 1/4 in.

Fire Tools Furnished

Poker, hoe, slice bar, flue brush with handle and ash shovel.

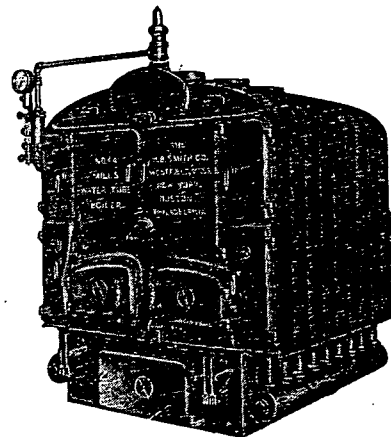
Trimings Furnished with Steam Boilers

Water column, gage cocks, water gage cocks, water gage glass, steam gage (with cock), steam gage siphon. Damper regulator complete with chain.

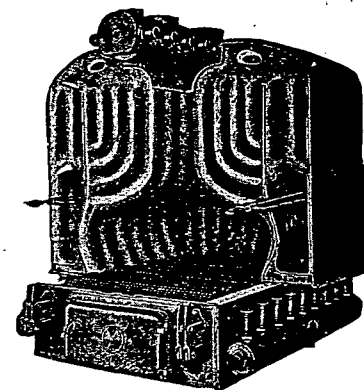
*When boiler is to be used for water warming, specify on order the size of supply and return pipe tappings. Tappings other than those listed are special. Order must specify size.

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

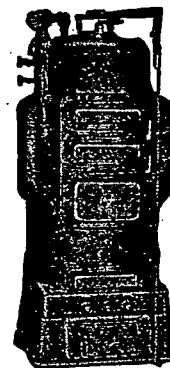


No. 44 Mills Boiler—Interior

Size of Boiler	Nominal Width Fire Pot	Commercial Rating—Capacity in Sq. Ft.		Max. Allowable Working Pressure		
		Steam	Water	Steam	Water (Open Tank)	Water (Closed Tank)
No. 24	24"	900 to 2,025	1,500 to 3,350	15 lbs.	30 lbs.	15 lbs.
No. 34	34"	2,000 to 5,200	3,300 to 8,575	15 lbs.	30 lbs.	15 lbs.
No. 44	44"	3,600 to 9,000	5,950 to 14,850	15 lbs.	30 lbs.	15 lbs.
No. 48	48"	4,800 to 12,000	7,925 to 19,800	15 lbs.	60 lbs.	30 lbs.

H-B Steam and Water Boilers

H-B Boilers have three waterways between sections. They are the only boilers in which ascending and descending currents of water are circulated through separate connections, giving a steady water line and rapid circulation without back pressure.



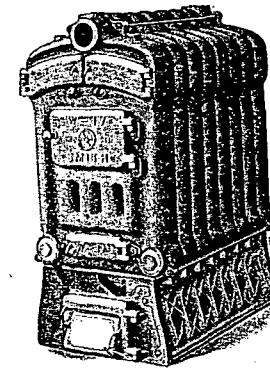
Commercial Ratings

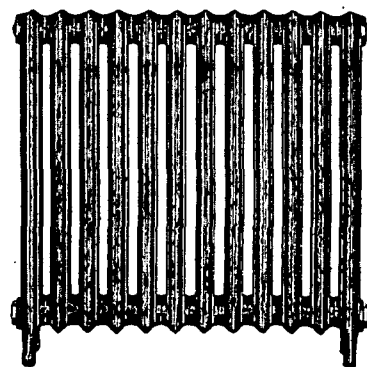
Diam. of Fire Pot Inches	Steam	
	Rating Feet	Rating Feet
15 to 27	250 to 1,000	425 to 1,650

17 Hy-Test Boiler

For Hot Water Supply
A. S. M. E. Standard

Maximum allowable working pressure, 120 lbs. Open Tank; 80 lbs. Closed Tank.





"Princess" Water Radiator

Princess Direct Radiators

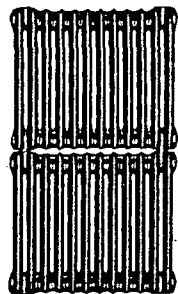
For sanitary reasons, radiators with wide spacing should be demanded.

If ordinary radiators are not sanitary enough for hospitals, they are not sanitary for the home. To meet hospital specifications some manufacturers make special radiators with wide spacing and charge an increased price.

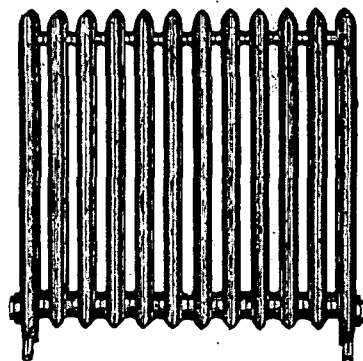
Princess Radiators are the standard radiators of The H. B. Smith Co. and are sold at regular list prices.

Princess Wall Radiators

Suited for all places where direct radiators or pipe coils cannot be used. Especially desirable in locations where floor space is valuable and where wall, column or ceiling space is more available. They possess extreme flexibility of size and arrangement. Made in two heights, 15 and 22 ins. Can be furnished with heating surfaces from 5 sq. ft. up, in multiples of $2\frac{1}{2}$ sq. ft. Corresponding lengths in 22 in. radiator are from 9 in. up, in multiples of 4 in. (1 in. allowed in over all length for plugs and bushings). In the 15 in. radiator, corresponding lengths are from 13 in. up, in multiples of 6 in. By combinations of the two heights, these radiators can be arranged in tiers, either for horizontal runs or for column work. Hung horizontally, they make excellent ceiling radiators.



"Princess" Wall Radiator



"Princess" Steam Radiator

Standard Heater Company

Williamsport, Pa.

NEW YORK PHILADELPHIA BOSTON DENVER BALTIMORE BUFFALO
DETROIT CHICAGO DULUTH
Builders of Spencer Heaters

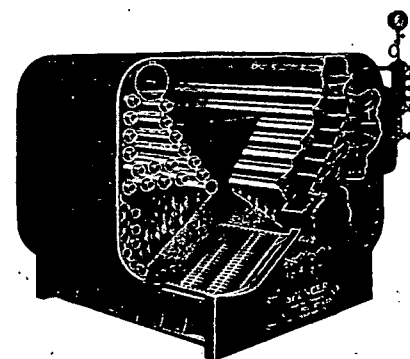
SPENCER HEATERS

Give uniform heat over long periods and use small size hard coal with least attention to the fire.

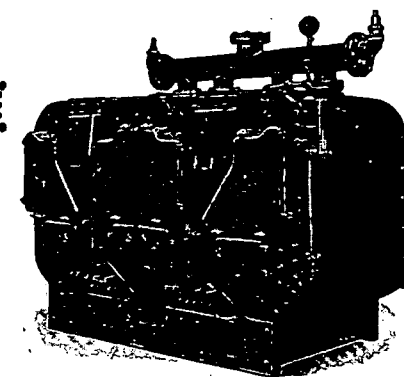
The magazine-feed feature is built into the heater and requires no adjustment. The magazine holds a supply of coal sufficient for 8 to 12 hours in severe weather or for a proportionately longer period in milder weather.

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 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	232	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"
50 Series										
3-45	4,500	18.05	389	2-5"	1-4"	107 3/4	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 1/4	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 1/4	81	59	.28	18"x18"x70"
100 Series										
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 1/4	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 1/4	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 1/4	118 1/2	66	.34	24"x24"x70"

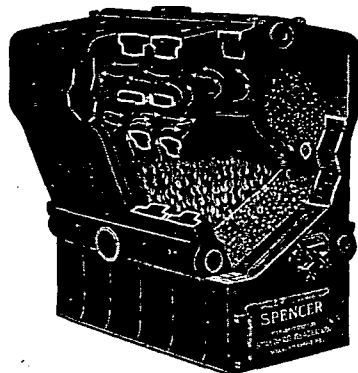
Heaters No. 3-45 to 3-160 are furnished with steel jackets and $1\frac{1}{2}$ in. Rockwool asbestos covering, also pipe header.

Heaters No. 15-21 are furnished with steel jackets only.

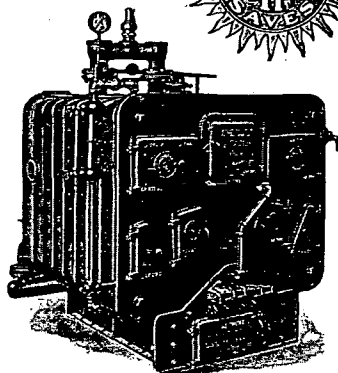
SPENCER HEATERS are adaptable for residences, apartment houses, churches, schools, public and commercial buildings, theatres, green houses, garages and all other types of buildings heated by low pressure steam, vapor, or hot water.

For over 25 years SPENCER HEATERS have been tried and tested under the most severe climatic conditions. There are thousands of successful installations throughout the entire country.

Write for illustrated catalog containing complete information.



15" Series. Spencer Sectional Heater



No. 2 Series. Spencer Sectional Heater

SPENCER SECTIONAL STEAM HEATERS

Heater Number	Rating Sq. Ft. Radiation	Fire Surface Sq. Ft.	Tapping Flow	Tapping Return	Overall Length Ins.	Overall Width Ins.	Water Line Ins.	Draft to Develop Rating Ins. H ₂ O	Size Chimney Flue
154-S	375	2.29	1-4"	2-3"	33	33 1/2	49	.16	8" x 8" x 30"
155-S	500	3.02	1-4"	2-3"	39 1/2	33 1/2	49	.16	8" x 8" x 30"
156-S	625	3.78	1-4"	2-3"	47	33 1/2	49	.17	10" x 10" x 35"
157-S	750	4.54	2-4"	4-3"	54	33 1/2	49	.18	10" x 10" x 35"
158-S	900	5.30	2-4"	4-3"	62	33 1/2	49	.20	10" x 10" x 40"
2-5	1,000	4.51	2-4"	2-4"	63 1/4	57 1/8	50	.15	10" x 10" x 30"
2-6	1,300	5.64	2-4"	2-4"	70	57 1/8	50	.17	10" x 10" x 35"
2-7	1,600	6.77	2-4"	2-4"	76 1/4	57 1/8	50	.18	12" x 12" x 35"
2-8	2,000	7.90	2-4"	2-4"	82 1/2	57 1/8	50	.19	12" x 12" x 35"
2-9	2,400	9.03	2-4"	2-4"	88 3/4	57 1/8	50	.20	12" x 12" x 35"
2-10	2,800	10.16	2-4"	2-4"	95	57 1/8	50	.21	12" x 12" x 40"
2-11	3,200	11.28	2-4"	2-4"	101 1/4	57 1/8	50	.21	12" x 12" x 40"
2-12	3,600	12.40	2-4"	2-4"	107 1/2	57 1/8	50	.22	12" x 12" x 45"

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
154-W	600	2.29	1-4"	2-3"	33	33 1/2	49	.16	8" x 8" x 30"
155-W	800	3.02	1-4"	2-3"	39 1/2	33 1/2	49	.16	8" x 8" x 30"
156-W	1,000	3.78	1-4"	2-3"	47	33 1/2	49	.17	10" x 10" x 35"
157-W	1,200	4.54	2-4"	4-3"	54	33 1/2	49	.18	10" x 10" x 35"
158-W	1,400	5.30	2-4"	4-3"	62	33 1/2	49	.20	10" x 10" x 40"
274-W	1,600	4.38	2-4"	2-4"	41 1/2	55 1/2	49	.19	10" x 10" x 35"
275-W	2,100	5.84	2-4"	2-4"	49 1/2	55 1/2	49	.20	10" x 10" x 40"
276-W	2,600	7.31	2-4"	2-4"	58	55 1/2	49	.20	12" x 12" x 35"
277-W	3,100	8.78	2-4"	2-4"	66	55 1/2	49	.22	12" x 12" x 40"
278-W	3,600	10.29	2-4"	2-4"	74	55 1/2	49	.23	12" x 12" x 40"
306-W	2,750	8.65	2-5"	2-5"	56	64	49	.19	12" x 12" x 35"
307-W	3,300	10.40	2-5"	2-5"	64	64	49	.20	12" x 12" x 35"
308-W	3,850	12.10	2-5"	2-5"	73	64	49	.22	12" x 12" x 40"
309-W	4,400	13.85	2-5"	2-5"	81	64	49	.24	12" x 12" x 40"

Thatcher Furnace Co.

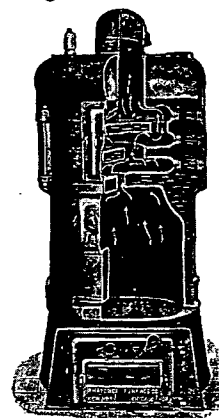
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CHICAGO
341 N. CLARK ST.

New York

NEWARK
39-41 ST. FRANCIS ST.

Boilers, Ranges, Furnaces, Hot Water Supply and Garage Heaters



"Thatcher" Round Boiler

"The 'Thatcher' Round Boiler has water ports on each side which tend greatly to increase the rapidity with which water circulates; the efficient staggered fire travel between each section from the body to the dome and the interior of the body has drop tubes. The fire box is 1 1/4 in. deeper than the accepted standard. Three ports extending into firepot increase heating efficiency. Twenty-foot triangular revolving grates, are very efficient, and most easily operated. The base is high with ample space under grates.

"THATCHER" HOT WATER BOILER

No.	Rating Sq. Ft.	Actual Diameter Grate. In.	Grate Area Sq. Ft.
17-0-W	400	17	1.26
17-1-W	450	17	1.26
19-0-W	500	19	1.76
19-1-W	575	19	1.76
19-2-W	650	19	1.76
22-0-W	750	22	2.40
22-1-W	875	22	2.40
22-2-W	950	22	2.40
25-0-W	1000	25	3.14
25-1-W	1150	25	3.14
25-2-W	1225	25	3.14
28-0-W	1325	28	4.12
28-1-W	1500	28	4.12
28-2-W	1650	28	4.12

"THATCHER" STEAM BOILER

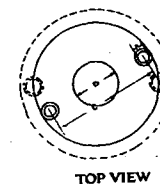
No.	Rating Sq. Ft.	Actual Diameter Grate. In.	Grate Area Sq. Ft.	Height Water Line In.
17-0-S	235	17	1.26	38
17-1-S	275	17	1.26	42 1/2
19-0-S	300	19	1.76	40
19-1-S	350	19	1.76	44 1/2
19-2-S	400	19	1.76	49
22-0-S	450	22	2.40	42 3/4
22-1-S	525	22	2.40	47
22-2-S	575	22	2.40	51 1/4
25-0-S	600	25	3.14	42 1/4
25-1-S	675	25	3.14	47 1/4
25-2-S	750	25	3.14	52 1/4
28-0-S	800	28	4.12	43 1/4
28-1-S	900	28	4.12	48 1/4
28-2-S	1000	28	4.12	54

"THATCHER" ROUND BOILER MEASUREMENTS—STEAM BOILERS

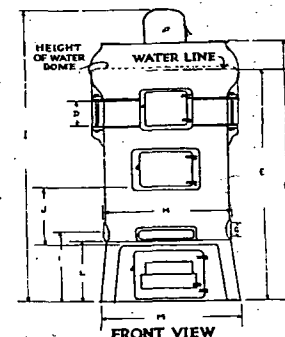
No.	A	B	C	D	E	F	G	H	I	J	K	L	M
17-0-S	2-2 1/2	6	15 1/4	4 1/2	40 1/2	2-2 1/2	21	49 1/2	14 1/2	14 1/2	11 1/2	23	
17-1-S	2-2 1/2	6	15 1/4	4 1/2	40 1/2	2-2 1/2	21	54 1/2	14 1/2	14 1/2	11 1/2	23	
19-0-S	2-3	7	18 1/4	0	46 1/2	2-3	24 1/2	56	14 1/2	14 1/2	11 1/2	27	
19-1-S	2-3	7	18 1/4	4 1/2	44 1/2	2-3	24 1/2	60 1/2	14 1/2	14 1/2	11 1/2	27	
19-2-S	2-3	7	18 1/4	9	49 1/2	2-3	24 1/2	65	14 1/2	14 1/2	11 1/2	27	
22-0-S	2-3	8	21 1/4	0	42 1/2	2-3	28 1/4	60	15	14 1/2	12	30 1/2	
22-1-S	2-3	8	21 1/4	4 1/2	47 1/2	2-3	28 1/4	64 1/2	15	14 1/2	12	30 1/2	
22-2-S	2-3	8	21 1/4	9 1/2	51 1/2	2-3	28 1/4	69 1/2	15	14 1/2	11 1/2	33 1/2	
25-0-S	2-4	9	22 1/2	0	42 1/2	2-4	31	61 1/2	15 1/2	14 1/2	11 1/2	33 1/2	
25-1-S	2-4	9	22 1/2	5	47 1/2	2-4	31	66 1/2	15 1/2	14 1/2	11 1/2	33 1/2	
25-2-S	2-4	9	22 1/2	10	52 1/2	2-4	31	71 1/2	15 1/2	14 1/2	11 1/2	33 1/2	
28-0-S	2-4	9	25	0	43 1/2	2-4	35 1/2	62 1/2	16	15	12	37	
28-1-S	2-4	9	25	5 1/2	48 1/2	2-4	35 1/2	67 1/2	16	15	12	37	
28-2-S	2-4	9	25	10 1/2	53 1/2	2-4	35 1/2	72 1/2	16	15	12	37	

"THATCHER" ROUND BOILER MEASUREMENTS—WATER BOILERS

No.	A	B	C	D	F	G	H	I	J	K	L	M
17-0-W	2-2 1/2	6	15 1/4	0	37 1/2	2-2 1/2	21	44 1/2	14 1/2	14 1/2	11 1/2	23
17-1-W	2-2 1/2	6	15 1/4	4 1/2	42 1/2	2-2 1/2	21	49 1/2	14 1/2	14 1/2	11 1/2	23
19-0-W	2-3	7	18 1/4	0	42 1/2	2-3	24 1/2	51 1/2	14 1/2	14 1/2	11 1/2	27
19-1-W	2-3	7	18 1/4	4 1/2	47 1/2	2-3	24 1/2	56 1/2	14 1/2	14 1/2	11 1/2	27
19-2-W	2-3	7	18 1/4	9	51 1/2	2-3	24 1/2	60 1/2	14 1/2	14 1/2	11 1/2	27
22-0-W	2-3	8	21 1/4	0	44 1/2	2-3	28 1/4	55 1/2	15	14 1/2	12	30 1/2
22-1-W	2-3	8	21 1/4	4 1/2	49 1/2	2-3	28 1/4	59 1/2	15	14 1/2	12	30 1/2
22-2-W	2-3	8	21 1/4	9 1/2	54 1/2	2-3	28 1/4	64 1/2	15	14 1/2	12	30 1/2
25-0-W	2-4	9	22 1/2	0	44 1/2	2-4	31	55 1/2	15 1/2	14 1/2	11 1/2	33 1/2
25-1-W	2-4	9	22 1/2	5	49 1/2	2-4	31	60 1/2	15 1/2	14 1/2	11 1/2	33 1/2
25-2-W	2-4	9	22 1/2	10	54 1/2	2-4	31	65 1/2	15 1/2	14 1/2	11 1/2	33 1/2
28-0-W	2-4	9	25	0	45 1/2	2-4	35 1/2	56 1/2	16	15	12	37
28-1-W	2-4	9	25	5 1/2	50 1/2	2-4	35 1/2	61 1/2	16	15	12	37
28-2-W	2-4	9	25	10 1/2	55 1/2	2-4	35 1/2	66 1/2	16	15	12	37

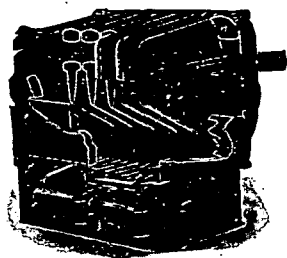


TOP VIEW



FRONT VIEW

For Dimensions—Round Boiler



**"PROGRESS"
BOILER
MEASURE-
MENTS**

40 in. Series: A.
64 in.; B. 64 in.;
C. 42 in.; D. 55 in.;
E. 35 in.; F. 60 in.;
H. 19 1/4 in.; J. 16
in.; K. 11 in.; S.
7 1/4 in.; T. 18 in.;
V. 10 1/4 in.; Z. 16 1/4
in.

"Thatcher" Progress Boiler

No.	640	740	840	940	1040	1140	1240	1340	1440
L.....	65 3/4	73	80 1/4	87 1/2	94 1/4	102 1/4	109 1/4	116 1/2	124 1/4
M.....	37 3/4	45	52 1/4	59 1/2	66 1/4	74	81 1/4	88 1/2	95 1/4
P.....	43 1/4	50 1/4	58	65 1/4	72 1/2	79 1/4	87	94 1/4	101 1/2

28 in. Series: A. 46 in.; B. 55 in.; C. 30 in.; D. 48 in.;
E. 35 in.; F. 42 in.; H. 19 1/4 in.; J. 16 in.; K. 11 in.; S. 7 1/4 in.;
T. 12 in.; V. 10 1/4 in.; Z. 16 1/4 in.

No.	528	628	728	828	928	1028
L..	54 1/4	61 1/4	69	76 1/4	83 1/2	90 1/4
M..	30 1/4	37 1/4	45	52 1/4	59 1/2	66 1/4
P..	36 1/4	43 1/2	50 1/4	58	65 1/4	72 1/2

28 in. AND 40 in. TWIN SERIES

All measurements for 28 in. and 40 in. Twin Boilers are the same as above except height of smoke pipe which is on the back of boiler. The length can be determined by adding 7 1/4 in. for each section added. For example: a No. 2040 T. S. Boiler is twice the length of a 1040 as noted above, plus 7 1/4 in. for dividing wall.

"PROGRESS" BOILER—DIMENSIONS AND CAPACITIES

STEAM BOILER			STEAM AND HOT WATER			HOT WATER BOILER	
No.	Rating	Length Inches Less Trim	Grate Area Sq. Ft.	Flow and Re- turns, 2 Each	No. Feed Doors	No.	Rating
528-S	1150	36 1/4	5.98	4"	1	528-W	1925
628-S	1550	43 1/2	7.32	4"	2	628-W	2600
728-S	2000	50 1/4	8.80	4"	2	728-W	3350
828-S	2450	58	10.22	4"	2	828-W	4100
928-S	2900	65 1/4	11.62	4"	2	928-W	4850
1028-S	3350	72 1/2	13.02	4"	2	1028-W	5650
640-S	2600	43 1/2	10.55	5"	2	640-W	4350
740-S	3200	50 1/4	12.57	5"	2	740-W	5275
840-S	3800	58	14.58	5"	2	840-W	6325
940-S	4500	65 1/4	16.53	5"	2	940-W	7500
1040-S	5200	72 1/2	18.61	5"	2	1040-W	8675
1140-S	5900	79 1/4	20.62	5"	2	1140-W	9850
1240-S	6700	87	22.63	5"	4	1240-W	11175
1340-S	7500	94 1/4	24.03	5"	4	1340-W	12500
1440-S	8300	101 1/2	26.66	5"	4	1440-W	13850
1128 T-S	3100	87	14.02	4"	3	1128 T-W	5125
1228 T-S	3550	94 1/4	15.50	4"	4	1228 T-W	5950
1328 T-S	4000	101 1/2	16.91	4"	4	1328 T-W	6700
1428 T-S	4450	108 1/4	18.32	4"	4	1428 T-W	7450
1528 T-S	4900	116	19.73	4"	4	1528 T-W	8200
1628 T-S	5350	123 1/4	21.14	3"	4	1628 T-W	8950
1728 T-S	5800	130 1/2	22.55	4"	4	1728 T-W	9700
1828 T-S	6400	137 1/4	23.96	4"	4	1828 T-W	10700
1928 T-S	7000	145 1/4	25.37	4"	4	1928 T-W	11700
1540 T-S	7600	116	28.19	4"	4	1540 T-W	12650
1640 T-S	8300	123 1/4	30.21	4"	4	1640 T-W	13800
1740 T-S	9000	130 1/2	32.23	4"	4	1740 T-W	16175
1840 T-S	9700	137 1/4	34.24	4"	4	1840 T-W	17350
1940 T-S	10400	143	36.25	4"	4	1940 T-W	18525
2040 T-S	11100	152 1/4	38.26	4"	5	2040 T-W	19700
2140 T-S	11800	159 1/2	40.27	4"	5	2140 T-W	21025
2240 T-S	12600	166 1/4	42.28	5"	6	2240 T-W	22350
2340 T-S	13400	174	44.30	5"	7	2340 T-W	23675
2440 T-S	14200	181 1/4	46.31	5"	8	2440 T-W	25000
2540 T-S	15000	188 1/2	48.33	5"	8	2540 T-W	26350
2640 T-S	15800	195 1/4	50.35	5"	8	2640 T-W	27700
2740 T-S	16600	203	52.36	5"	8	2740 T-W	29050
2840 T-S	17300	210 1/4	54.37	5"	8	2840 T-W	30400
2940 T-S	18000	217 1/4	56.39	5"	8	2940 T-W	31750

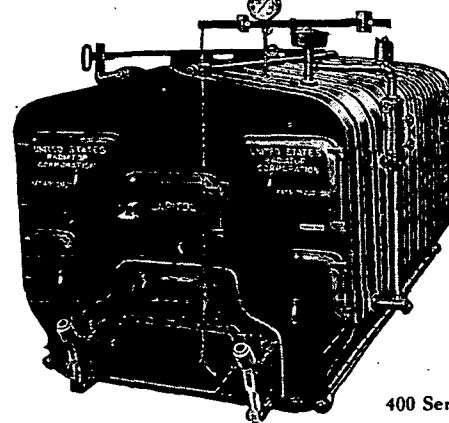
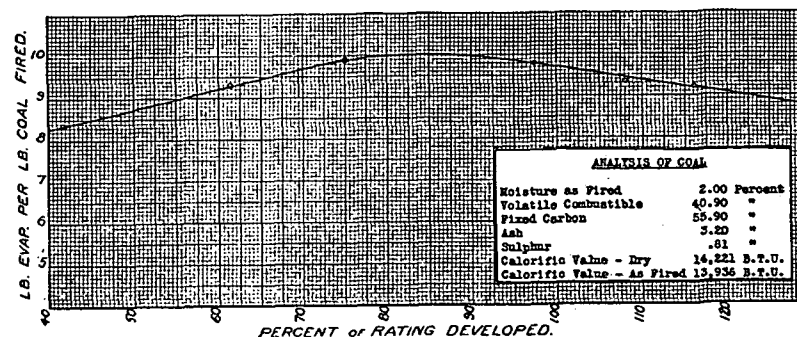
UNITED STATES RADIATOR CORPORATION

GENERAL OFFICES: DETROIT, MICHIGAN

Branch Offices in Principal Cities

Manufacturers of Capitol Boilers and United States Radiators

Performance Curve for No. 411 Capitol Smokeless Boiler

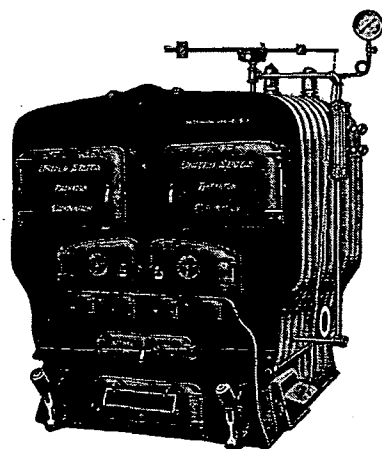
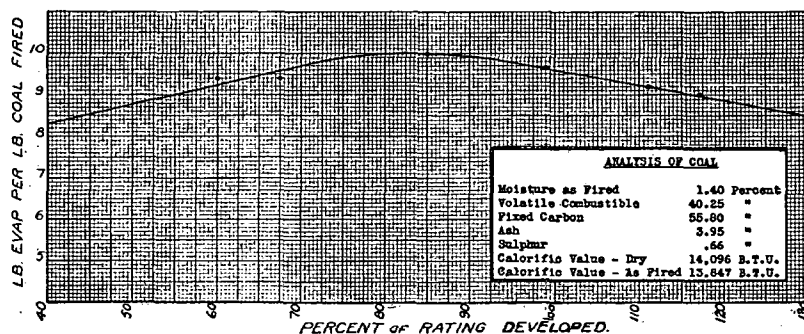


400 Series Ratings and Dimensions

Size	Rating Sq. Ft.		Grate Area Sq. Ft.	Coal Capacity Cu. Ft.	*Outlets	Steam Boiler Dimensions			Minimum Chimney Sizes	
	Steam	Water				Height Water Line Inches	Height Inches Including Trimmings	Width Inches Including Trimmings	Diameter Inches	Height Feet
408	3300	5280	8.15	9.00	2-5"	49	71	75	18x18	50
409	3850	6160	8.15	10.40	2-5"	49	71	75	18x18	50
410	4400	7040	10.31	13.30	3-5"	49	71	75	20x20	55
411	4950	7920	12.47	14.70	3-5"	49	71	75	20x20	55
412	5500	8800	12.47	16.30	3-5"	49	71	75	22x22	55
413	6050	9680	14.63	17.70	3-5"	49	71	75	24x24	60
414	6600	10,560	14.63	19.25	4-5"	49	71	75	24x24	60

*All 400 Series Boilers have two 6" inlets on rear of back section.
For smoke pipe, base dimensions and other measurements see page 236.

Performance Curve for No. 511 Capitol Smokeless Boiler



THE CAPITOL SMOKELESS BOILER 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 of the United States.

500 Series 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
508	6275	10,000	11.58	18.87	3-5"	66	92	82	24x24	60
509	7150	11,400	14.62	23.73	4-5"	66	92	82	24x24	65
510	8025	13,000	17.66	25.80	4-5"	66	92	82	24x28	70
511	8900	14,250	17.66	28.59	4-5"	66	92	82	28x28	80
512	9775	15,650	18.49	29.58	5-5"	66	92	82	28x32	85
513	10,650	17,050	21.53	34.51	5-5"	66	92	82	32x32	85
514	11,525	18,450	21.53	37.80	5-5"	66	92	82	32x32	90
515	12,400	19,850	24.57	41.09	6-5"	66	92	82	32x36	90
516	13,275	21,250	27.61	44.37	6-5"	66	92	82	36x36	90

For smoke pipe, base dimensions and other measurements, see page 236.

CAPITOL SQUARE SECTIONAL BOILERS

Ratings and Dimensions

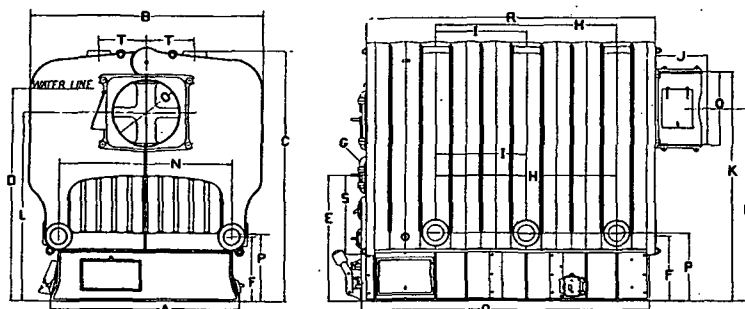
Size	Rating Sq. Ft.		Grate Area Sq. Ft.	Coal Capacity Cu. Ft.	Outlets and Inlets	Steam Boiler Dimensions			Minimum Chimney Sizes	
	Steam	Water				Height Water Line Inches	Height Inches Including Trimmings	Width Inches Including Trimmings	Diameter Inches	Height Feet
184	400	650	1.88	2.33	2-3"	40 1/2	61 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"	46 1/2	66 1/2	45	8x12	35
205	800	1300	3.48	5.85	2-3"	46 1/2	66 1/2	45	8x12	35
206	1000	1650	4.37	7.34	2-3"	46 1/2	66 1/2	45	8x12	35
207	1200	2000	5.26	8.83	3-3"	46 1/2	66 1/2	45	8x12	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	3210	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	49.72	4-5"	66	92	82	28x28	70
WN282	10,100	16,625	30.45	47.21	4-5"	66	92	82	28x28	70
WN283	11,025	18,100	30.45	48.46	5-5"	66	92	82	28x32	75
WN284	11,950	19,600	30.45	49.72	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	49.72	4-5"	66	92	82	28x28	70
SS282	10,100	16,625	30.45	47.21	4-5"	66	92	82	28x28	70
SS283	11,025	18,100	30.45	48.46	5-5"	66	92	82	28x32	75
SS284	11,950	19,600	30.45	49.72	5-5"	66	92	82	32x32	80

For smoke pipe, base dimensions and other measurements, see page 236.

Measurements, All Series Square Boilers, Including Smokeless



	180	200	250	G270	230 SS230	WN270 SS270	400	500
A	25 1/2"	28 1/2"	34 1/4"	36"	41 1/4"	57 1/4"	47"	57 1/4"
B	28 1/2"	32 1/2"	39 3/8"	43 1/2"	48 1/2"	71 1/4"	67"	71 1/4"
C	48"	54"	58 5/8"	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 3/8"	28 3/8"	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 1/4" 279-40 1/2"	.....	.....	410-48 1/2" 413-64 1/2" 411-12-14-56 5/8"	.....
I	184-6 1/4" 185-12 1/2" 186-18 1/2" 187-25"	204-6 1/4" 205-12 1/2" 206-18 1/2" 207-25"	255-16" 256-24" 257-16" 258-24"	276-20 1/4" 277-27" 278-13 1/2" 279-20 1/4"	Figure 8" per section	.....	408-9-13-40 1/2" 410-16 1/4" 411-14-24 1/4" 412-32"	.....
J	12"	11 1/2"	11 1/2"	16"	14"	22 1/2" Top Outlet 15" Back Outlet	19 1/2"	22 1/2" Top Outlet 15" Back Outlet
†K	44 1/2"	50 3/8"	52 3/8"	50"	59"	72"	54 1/4"	72"
†L	37"	43 3/8"	45 3/8"	41 1/2"	52"	58 1/4"	45 1/2"	58 1/4"
§N	.....	.....	.....	.....	.....	53 1/4"	46"	53 1/4"
O	10"	10"	12"	14"	14"	21"	18"	21"
P	14 1/4"	16 1/4"	17 1/4"	16"	19"	20 1/4"	.....	20 1/4"
Q	184-20 1/4" add 6 1/4" for each additional section.	204-23 1/4" add 6 1/4" for each additional section.	255-37 1/4" add 8" for each additional section.	G276-36" add 6 1/4" for each additional section.	235-36" add 8" for each additional section.	WN 276- 49 1/4" add 9 1/4" for each additional section.	408-63 1/2" add 8 1/4" for each additional section.	508-67 1/4" add 9 1/4" for each additional section.
R	184-20 1/4" add 6 1/4" for each additional section.	204-22 1/4" add 6 1/4" for each additional section.	255-36 1/2" add 8" for each additional section.	G276-35 1/2" add 6 1/4" for each additional section.	235-37" add 8" for each additional section.	WN 276- 50 3/4" add 9 1/4" for each additional section.	408-62 1/2" add 8 1/4" for each additional section.	508-68 1/4" add 9 1/4" for each additional section.
*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 3/4" from first tapping.
†Dimensions 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.

Utica Heater Company

UTICA, New York

218-220 West Kinzie St.
CHICAGO, ILL.

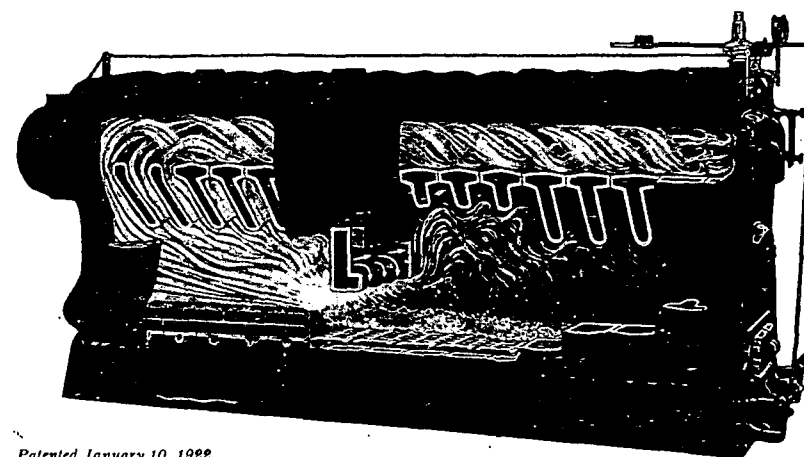
707 Union Building
CLEVELAND, O.

5620 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 - 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

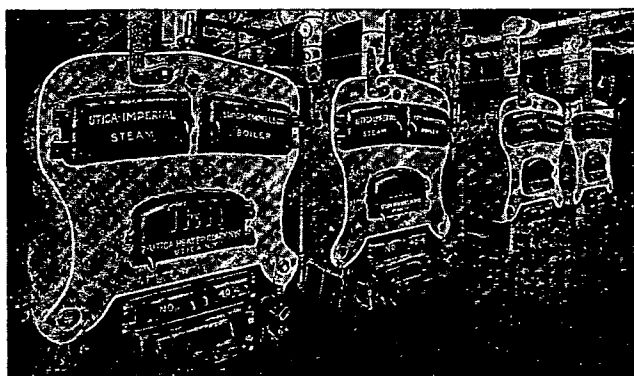
CAPACITIES AND DIMENSIONS OF UTICA-IMPERIAL SUPER-SMOKELESS BOILERS

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)	Height (Feet)
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 3/4	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 3/4	16x16	15	40
S-336	2,500	W-336	4,175	8.68	43 x 33 1/2	47 1/2 x 39	69	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	63 1/2 x 39	83 1/2	18x18	16	50
S-339	4,000	W-339	6,675	13.89	68 x 33 1/2	71 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	4,250	W-407	7,075	13.88	51 x 44 1/2	55 1/2 x 52	81 3/4	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	80
S-4016	11,000	W-4016	18,325	23.13	89 x 44 1/2	132 x 52	154	22x22	22	85
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	85
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	90
S-4020	14,000	W-4020	23,325	23.13	89 x 44 1/2	165 x 52	187	24x24	24	100
S-4021	14,750	W-4021	24,575	23.13	89 x 44 1/2	173 1/2 x 52	195 1/4	26x26	26	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	28x28	28	100

Series.....	24	33	40	Series.....	24	33	40
Height to Top of Steam Trimmings.....	60"	72 1/4"	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"	55"	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 1/4"	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"x15"	10"x18"	12 1/2"x24"

* 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.



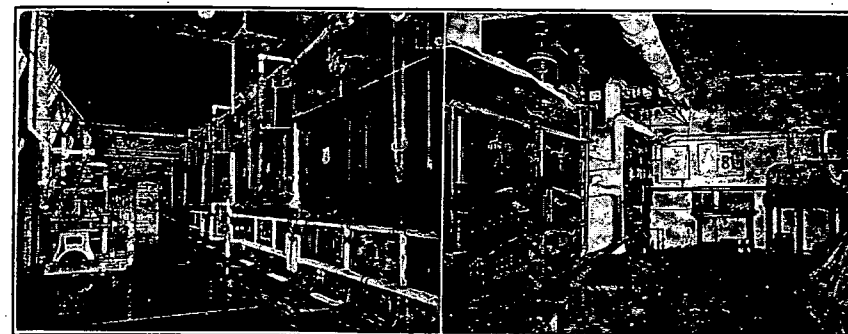
Petroleum Heat and Power Company

Manufacturers — Contractors — Engineers
of FUEL OIL BURNING EQUIPMENT for
Power Plants — Buildings — Residences

NEW YORK

BOSTON

PROVIDENCE

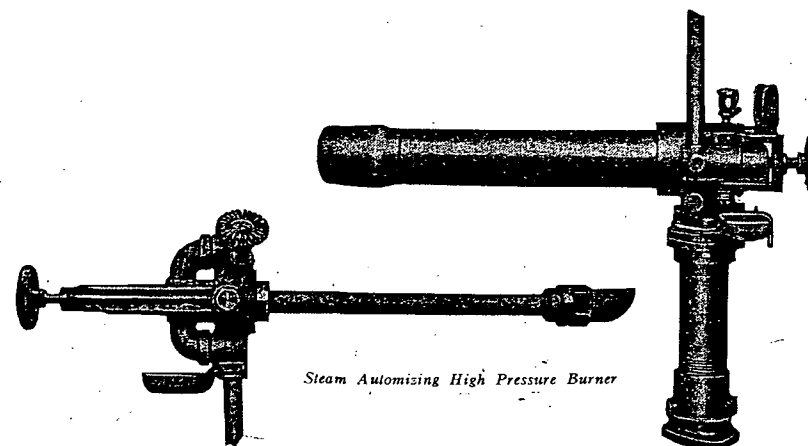


Battery of Four 250 H.P. Oil Fired Boilers in
Saxony Worsted Mills

Two Turbine Burners in Each Boiler in
Western Electric Co. Plant

The Petroleum Heat and Power Co., who were the pioneers in the fuel oil burning industry, have to offer to the heating and ventilating engineers a first class organization, with a complete factory at Stamford, Conn., devoted exclusively to the manufacture of oil burning equipment.

Offices are maintained in New York, Boston and Providence, with agents in all the principal cities, where engineering services are available for heating contractors contemplating the recommendation of fuel oil burning equipment to their clients. In each of these districts there is a fully equipped Service Station for the maintenance of the installations already made; also a delivery system for the supplying of this modern fuel.



Steam Atomizing High Pressure Burner

Turbine Burner

DRYING SYSTEMS INC

11 South Desplaines Street
CHICAGO-U.S.A

Varnish Drying, Air Conditioning and High Temperature Baking Equipment

Drying Systems, Inc., specializes in Drying Problems and 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. We design and install air conditioning apparatus for Finishing Rooms.

The rapid drying of the various siccativ coatings applied to furniture, cabinets, pianos, automobile bodies, chassis, wheels and, in fact, everything that requires a coating, is of great importance to the manufacturer when orders, large or small, must be delivered on a planned schedule without delay.

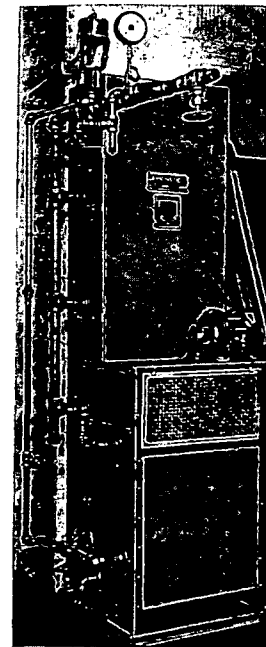
The artificial hastening of the drying must, however, be so effected that the coating will be thoroughly and uniformly dried throughout its entire depth. Heated air, alone, causes surface-drying and certain chemical and physical changes which impair the quality of the finish. Surface-drying impedes the completion of the drying by covering the coating with an almost impervious surface film through which

the volatiles escape with great difficulty, and which retards oxidation, an essential factor in the process of hardening. The vital element in the drying of all siccativ coatings is humidity. Moisture in the air functions to prevent surface-drying and detrimental changes. With adequate circulation of properly humidified and heated air drying becomes a perfected and rapid process, insuring a coating of finest quality, both in appearance and in durability.

And, of even greater importance, conditioned air drying insures a positive and unvarying time schedule, each coat drying in the same time all of the time, regardless of outdoor weather. This permits the establishment of an efficient drying routine, on an exact schedule, greatly increasing production and minimizing costs.

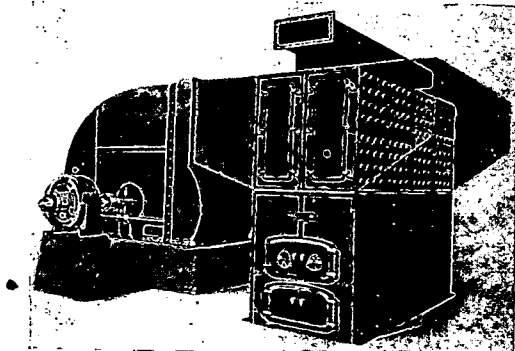
Our broad experience in drying and conditioning, gained through hundreds of successful installations, is at the disposal of our clients and we invite correspondence with reference to such problems.

We manufacture several types of equipment each adapted to specific requirements.



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 any of the old-style dry rooms, without radical changes in construction. With each Drying Unit we furnish a properly designed system of supply and vent ducts. These Units will supply dry rooms up to 1200 sq. ft. of floor-space and are in use in many plants for drying varnish, undercoatings, dimensioned and glued-up stock, etc.



The Harrison Aertube Heater

The Harrison Aertube Heater is a compact plant of the direct-fired indirect type, utilizing any of the ordinary fuels, but preferably 11 deg. Beaumé oil. This Heater is used for heating air in large volumes to temperatures up to 1000 deg. Fahr., avoiding contamination of the air with the products of combustion. The heat is transferred, by convection, from the fuel directly to the air, through tubes of special metal, and this Heater is exceptionally economical and effective, as well as entirely safe, for High Temperature Baking of Enamels, Drying and Processing.

The Greeff System of Drying and Conditioning comprises the Greeff Static Air Washer-Humidifier, Fan, Heater, Automatic Temperature and Humidity Control. The equipment is placed close to the dry room or series of dry rooms and the conditioned air is supplied to the

dry room through carefully designed ducts, insuring uniform circulation throughout the enclosure.

A report of our installation at the plant of Globe-Wernicke Co., Cincinnati, shows that the annual saving in floor-space and interest on capital tied up in unfinished material, is \$16,000.00, or 225 per cent on the investment. (2414).



The Greeff System of Drying

Descriptive Bulletins will be sent upon request

ESTABLISHED 1841

E. B. Badger & Sons Co.

Manufacturers of Expansion Joints for High and Low Pressure

63-75 Pitts Street

BOSTON, MASS.

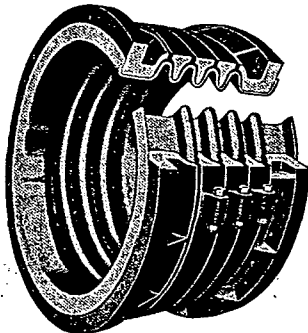
SALES OFFICE: 101 Park Avenue, NEW YORK, N. Y.

Badger Self-equalizing Expansion Joints

The Badger self-equalizing expansion joints are made of seamless copper tubes, of the best quality Lake copper, which is known to be the most ductile metal used in commercial engineering work. They are properly designed and rolled, with deep corrugations; and with the aid of the cast iron or steel equalizing rings, conforming to the shape of the corrugations, they take care of the changes in length in the pipe line, due to temperature changes, in a most efficient and economical manner: (1) because they are a one-piece joint and never require packing, and, (2) because the corrugations are designed and rolled to stand repeated changes of shape and to care for a required amount of expansion on each corrugation.

The external equalizing rings equally distribute the expansion over each corrugation, thus eliminating the possibility of a fracture in the copper, due to the fact that one or two corrugations take care of the total amount of expansion. They also give the added strength to the copper to resist pressure.

Self-equalizing expansion joints are made with: 2 corrugations to care for 1-in. expansion; 4 corrugations to care for 2-in. expansion.



Badger Self-Equalizing Expansion Joint

Face to Face Dimensions in Inches

Size	Two Corrugations	Four Corrugations
6	12 1/2	19
8	12 1/2	19
10	12 1/2	19
12	13	20
14	13 1/2	20
16	13 1/2	20
18	14	21
20	15	21 1/2
22	15	21 1/2
24	15 1/2	22

Special Features of Badger Joints

Badger expansion joints are:

Simple—there are no complicated parts.

Durable—made of best quality copper.

Safe—given a hydraulic test on every joint.

Convenient—installed as easily as any pipe fitting.

Compact—greatest diameter usually less than flange.

Efficient—they require no packing.

When Ordering Badger Joints

State (1) size of pipe; (2) whether steam, water, gas or air line; (3) working pressure; (4) length and material of pipe; (5) face to face dimensions; (6) range of temperature; (7) how often heat is turned on or off; (8) whether subject to superheat; (9) outside diameter of flanges, diameter of bolt circle, number of bolts, diameter of bolt hole.

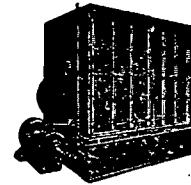
Catalog

Write for Catalog No. 20.

American Blower Company

Detroit, Mich.

Manufacturers of Heating, Ventilating, Cooling, Purifying, Humidifying, Drying, Mechanical Draft and Blast Equipment; Vertical Self-Oiling Steam Engines, Steam Traps; Fans and Blowers for All Purposes.



"Sirocco"
Air Washer

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.

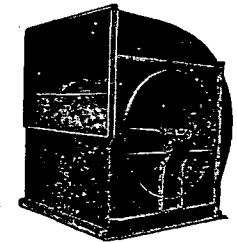
For Dehumidifying and Cooling in Candy Factories, Bakeries, Photo Film Drying Rooms, Blast Furnaces, Electric Generators, etc.

Multiblade Fans and Blowers

For Heating, Ventilating and Cooling in Public, Office, Industrial and Educational Buildings.

For Drying and Mechanical Draft.

Sirocco Multiblade Fans will handle more air, consuming less power than the ordinary steel plate fan having twice the wheel diameter.

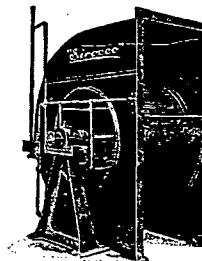


ABC Air Washing and Cooling Fan

The ABC Air Washing and Cooling Fan combined 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 maintenance and attendant costs. It is an automatic, highly efficient 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, and insures good air conditions, bodily comfort and increased working capacity.

It requires a minimum of attention and occupies small floor space. A special bulletin descriptive of this fan will be sent upon request.



"Ventura" Disc Ventilating Fan

For delivering large volumes of air at low pressure or against small resistance.

Low price—small power consumption and inexpensive to install.

For ventilating rooms and buildings—Ventura, motor driven, ventilating fans, 650 C. F. M. to 17,500 C. F. M.

For ventilating small mines or at any mine where a disc fan can be used—engine or motor driven—from 12,000 C. F. M. to 100,000 C. F. M. resistance not to exceed 1" W. G.



Bayley Manufacturing Co.

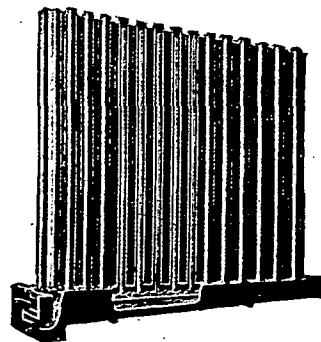
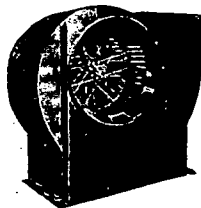
732 Greenbush Street
Milwaukee, Wisconsin

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.

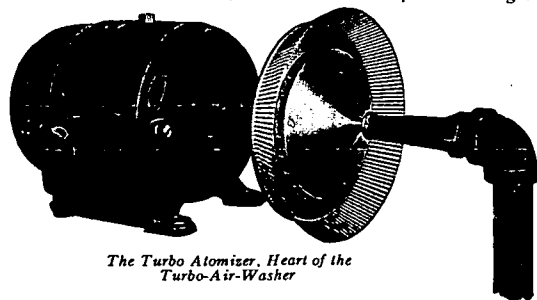


Chinook Heaters

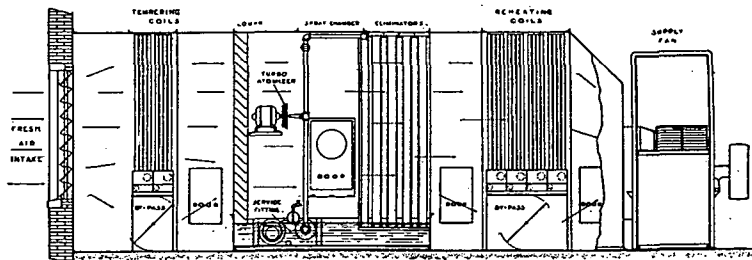
The Bayley Chinook Heater is a tube-within-a-tube radiator without return bends, elbows or nipples. Circulation is established from the steam chamber through the inner tube, and back through the outer tube to the return chamber. Used in connection with the Plexiform fan, also for direct and indirect 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. Atomiser fits any air washer. Washers made in various sizes for washing air or gases and for use in chemical plants.



The Turbo Atomiser, 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., 368 Rockefeller Bldg.
PITTSBURGH, PA., 917 Union Arcade
DETROIT, MICH., 1772 W. Lafayette Blvd.
CHICAGO, ILL., 562 W. Washington Blvd.
ATLANTA, GA., Candler Bldg.

WASHINGTON, Washington Loan & Trust Bldg.
ST. LOUIS, 515 Chemical Bldg.
CINCINNATI, 607 Mercantile Library Bldg.
MINNEAPOLIS, 120 South Ninth St.
DENVER, 1718 California St.
LOS ANGELES, 636 H. W. Hellman Bldg.
INDIANAPOLIS, 1016 Fletcher Trust Bldg.
SAN FRANCISCO, 216 Pine St.

PORTLAND, ORE., Power Equipment Co.

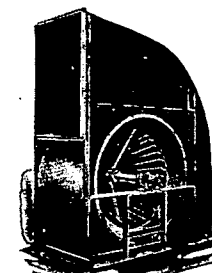
CANADIAN BRANCH

Canadian Blower and Forge Co., KITCHENER, ONTARIO

Carrier
Spray Nozzle in
operation



Conoidal
Multiblade
Fan



Typical Installation of Buffalo Fan and Carrier Air Conditioning Equipment

Buffalo Products

Conoidal Multiblade Fans
Carrier Air Washers
Pipe Coil Heaters
Ventilating Sets
Disc Fans
Humidifiers

Generator Coolers
Gas Scrubbers
Stoker Fans
Induced Draft Fans
Planing Mill Exhaust Fans

Dust Collectors
Pressure Blowers
Drying Apparatus
Spray Nozzles
Forge Shop Equipment

Clarage Fan Company

KALAMAZOO, MICHIGAN

NEW YORK CITY
INDIANAPOLIS
CLEVELAND

CHICAGO
PITTSBURGH
BOSTON

ST. LOUIS

MINNEAPOLIS
LOS ANGELES
ROCHESTER

PHILADELPHIA
DETROIT
MEMPHIS

Complete stocks carried in New York, Pittsburgh and special stocks in Memphis

Multiblade Fans

Clarage-Kalamazoo Multiblade Fans are guaranteed to be equal to any fans built for heating and ventilating work or for the handling of large volumes of air or gases at low pressures.

Since the only points of contact and points of greatest wear are in the bearings, the prime requisite of a good fan is good bearings. The Clarage bearing, shown at the right, below, is self-aligning in every plane and within large limits. Inner sleeves are lined with high grade babbitt and are lubricated by means of two brass oil rings, which carry a copious supply of oil to bearing surfaces from large reservoir below. An exclusive Clarage feature is the felt washers, which fit snugly around shaft at each end of bearing case, keeping oil in and dirt out.

Especially suitable for heating and ventilating schoolhouses, theaters, churches, office buildings and factories. Can be used with equal success for ventilating mines and tunnels. The unusually high efficiency obtained, quietness of operation, small space required and adjustable features of the design are all points in which these fans have been found superior to other types.

For convenience in specifying, fans are numbered according to approximate diameter of wheel: No. 1, 1-ft. wheel; No. 2½, 2½-ft. wheel, etc. Sizes up to and including No. 10. Full-housed fans, up to and including No. 3 size, are built with cast

iron side plates, and are adjustable and reversible for hand and discharge. Built ¾-housed in sizes larger than No. 3. Double width fans have twice the capacity of single width fans of same size.

Pipe coils or cast iron vento heaters, or other accessories for complete heating and ventilating systems, can be supplied.

Air Washers

The efficiency of any air washer depends on the quality of the spray. The Clarage design is simple and compact. Being of the centrifugal type, it does its work thoroughly. Passages are large, a feature which does away with danger of clogging, a trouble which comes often in the center-jet nozzle type.

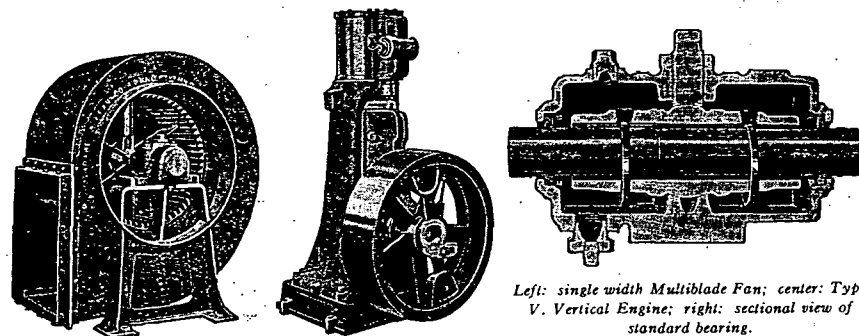
They are designed for a velocity of 500 inches per minute and can be furnished in sizes from 2500 to 100,000 cu. ft. per minute.

Vertical Engines

Clarage Vertical Engines are fully enclosed and self-oiling. Used for direct connection to fans and blowers, pumps, motor generators, etc.; built in four classes and are capable of developing up to 81 hp.

Co-operative Service

The Engineering Department of this company has compiled elaborate data covering capacities, etc., of every Clarage product. This material will be of value in determining requirements. The department will gladly co-operate with architects in every way possible.



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Left: single width Multiblade Fan; center: Type V. Vertical Engine; right: sectional view of standard bearing.

Hersh Brothers Company

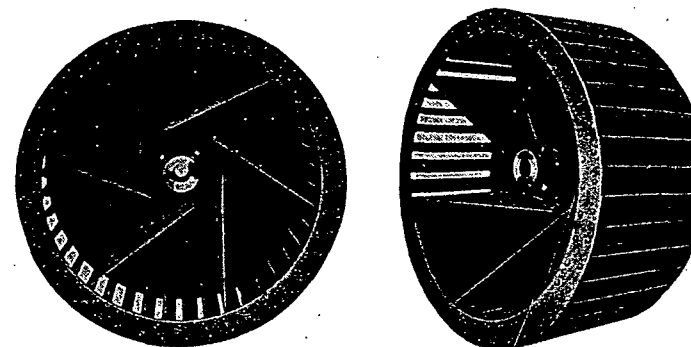
Allentown, Pa.



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 babbitt. They are self-aligning in all directions. This prevents the shaft from becoming bound.

The shaft is constructed of the best grade of DRAWN STEEL containing from 30 to 40% carbon.

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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.			3/8" STATIC PR.			1/2" STATIC PR.			5/8" STATIC PR.			3" 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., .93"	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.
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
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 1/2	21	2.43	3,160	292	.34	3,400	355	.48	3,650	390	.65	3,890	431	.84	4,130	469	1.1
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
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
5	30	4.96	6,450	209	.68	6,950	249	.97	7,450	273	1.3	7,930	303	1.7	8,430	328	2.1
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
6	36	7.25	9,280	171	.96	10,000	207	1.37	10,700	227	1.85	11,400	252	2.4	12,150	273	3.0
7	42	9.72	12,600	146	1.3	13,600	178	1.85	14,600	195	2.5	15,500	216	3.25	16,500	234	4.0
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
9	54	16.1	20,850	114	2.1	22,500	138	3.0	24,100	151	4.0	25,700	168	5.2	27,100	182	6.5
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
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
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
13	78	33.5	43,800	79	4.2	47,000	96	6.1	50,250	105	8.1	53,500	116	10.6	57,000	126	13.2
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
15	90	44.6	58,000	68	5.5	62,500	83	7.9	67,000	91	10.6	71,450	101	13.8	76,000	109	17.2
16	96	50.8	66,000	64	6.2	71,200	78	8.9	76,200	86	11.9	81,200	95	15.5	86,400	103	19.3
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
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
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

Fan No.	Dia. Wheel, In.	Area Outlet, Sq. Ft.	1" STATIC PR.			1 1/4" STATIC PR.			1 1/2" STATIC PR.			1 3/4" STATIC PR.			2" STATIC PR.		
			Total Pres., 1,202"	Outlet Vel., 1800 ft.	Per. Speed, 2950 ft.	Total Pres., 1,500"	Outlet Vel., 2000 ft.	Per. Speed, 3300 ft.	Total Pres., 1,830"	Outlet Vel., 2300 ft.	Per. Speed, 3625 ft.	Total Pres., 2,140"	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.
2 1/2	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	18	1.78	3,210	625	1.1	3,540	698	1.5	4,100	768	2.1	4,460	832	2.6	4,830	895	3.5
3 1/2	21	2.43	4,370	536	1.4	4,850	600	2.0	5,580	659	2.8	6,070	714	3.5	6,550	768	4.6
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
4 1/2	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
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
5 1/2	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
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
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
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
9	54	16.1	28,900	208	8.9	32,100	233	12.3	36,900	256	17.3	40,200	278	22.0	43,300	299	28.8
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	269	35.3
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
12	72	28.6	51,400	157	15.3	57,200	175	21.2	65,700	192	30.0	71,500	208	38.1	77,100	224	50.0
13	78	33.5	60,400	145	17.8	67,000	162	24.7	77,000	178	34.9	83,700	192	44.3	90,500	207	58.0
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
15	90	44.6	80,400	125	23.3	89,400	140	32.3	103,000	154	45.5	111,600	167	58.0	120,600	179	76.0
16	96	50.8	91,400	118	26.2	101,500	131	36.3	116,800	145	51.3	127,000	156	65.2	137,000	168	85.5
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
18	108	64.3	115,700	104	33.0	128,500	117	45.8	147,600	128	64.7	160,500	139	82.2	173,500	149	108.0
20	120	79.3	143,000	94	40.7	159,000	105	56.5	182,500	116	79.8	198,300	125	101.5	214,000	135	133.0

B. F. Sturtevant Co.
Hyde Park, Boston, Mass.

Atlanta, Ga.
Boston, Mass.
Buffalo, N. Y.
Chicago, Ill.
Cincinnati, O.
Cleveland, O.
Dallas, Tex.
Detroit, Mich.
Hartford, Conn.
Kansas City, Mo.
Los Angeles, Cal.

Canadian Offices:—Galt, Ont., Montreal, Que., Toronto, Ont.

Minneapolis, Minn.
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.
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 Climate Doctors.
278 Air Conditioning.
246 Generator Cooling.

Drying

- No. 298 Sturtevant-Brownell Dryer.
299 Drying Systems.
243 Paper Drying.
1052 Vegetable Dryers.
282 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.
1015 Heating and Ventilating Book. Complete. Installations.
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

Power Apparatus

- No. 150 Sturtevant Fuel Economizers.
222 Fuel Economizers in Paper Mills.
255 Gasoline Electric Generating Sets.
239 Steam Engine Generating Sets.
311 Steam Turbines.
256 Steam Turbine Generating Sets.
264 Electrical Apparatus.
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.

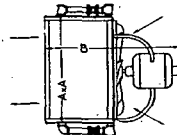
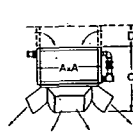
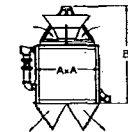
Manufacturers of Wing Featherweight Unit Heaters, Wing Turbine and Motor Driven Blowers, Wing-Scruplex Fans and Exhausters

Wing Featherweight Unit Heaters—The outstanding features of Wing Featherweight Unit Heaters are their extreme light weight (about 1/10 that of the old style) and small dimensions, combined with the fact that the driving motors are direct connected (no belts) and are out of the path of the 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 above make possible the suspending of the units from the ceiling or roof of any building old or new, without necessitating additional strengthening of the structure. It is not necessary to place the units on the ground where they will occupy space valuable for other purposes, and in addition to this, all steam and return lines may be carried overhead, out of the way, eliminating the necessity of pipe trenches.

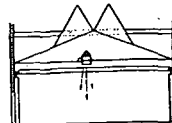
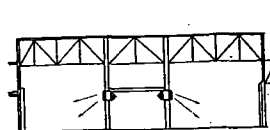
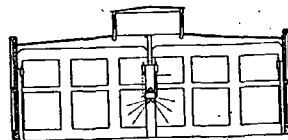
Wing Featherweight Unit Heaters are made in four different designs; Vertical High ceiling—Vertical Low ceiling—Horizontal and Floor type, the latter for use where the roof is very high and there are no convenient columns from which to support the units overhead. Two of these designs are shown also the method of installation.



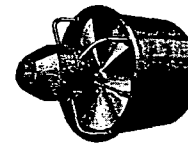
DATA FOR WING FEATHERWEIGHT UNIT HEATERS

Size Unit	A x A	B	C	D	Air C. F. M.	Motor H. P.	Temperature		B.t.u. per hr. Available	Approx. Ship. Wt.
							Room	Leav.		
17-3-12	20x20	34	36	8	1950	1/4	65	113	92,500	265
22-4-12	25x25	34	36	8	2800	3/8	65	125	162,600	350
22-5-12	25x25	34	36	8	2600	3/8	65	135	173,200	360
25-4-12	30x30	39	38	8	4800	1/2	65	125	279,000	400
25-5-12	30x30	39	38	8	4500	1/2	65	135	300,000	415
30-4-85	35x35	47	40	8	6900	1	65	125	401,000	450
30-5-85	35x35	47	40	8	6500	1	65	135	433,000	470
36-4-60	41x41	53	42	8	9600	1 1/4	65	125	558,000	630
36-5-60	41x41	53	42	8	9000	1 1/4	65	135	599,400	660

The above table will afford the Engineer an opportunity to choose the 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, but this data will be gladly furnished on application.



WING FORCED DRAFT BLOWERS



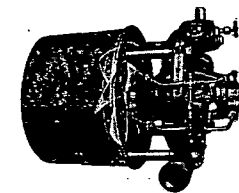
Type E-M Motor Driven

The Wing motor-driven units come in various sizes to fit all kinds and types of boilers. Installation is usually made in side ashpit walls to eliminate ducts and save space. For control purposes hand regulating rheostats are employed on single phase and direct current motors. For polyphase current dampers are used. Automatic control can be supplied if desired. Wing E-M Units in service have proven highly efficient in overcoming deficiencies in draft due to low stacks, poor weather conditions, etc., and they are admirably suited for the burning of the finer grades of coal such as Rice, Barley, Screenings, Cullm and the like.

Write for Bulletin 16 for further details.

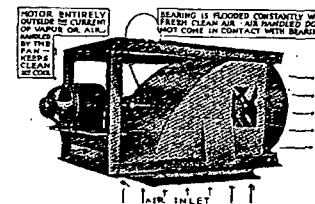
In high pressure plants the Wing Turbine blower has become standard equipment for serving the forced draft to stokered or hand-fired furnaces. The units are compact and easily installed and have air deliveries up to 20,000 cu. ft. per min. with static pressure up to 8 in. The exhaust steam from the turbine is clean and can be used for feed water heating, process work, etc., where the back pressures run as high as 8-10 lb. Hand or automatic control can be effected.

For further details write for Bulletin 57.



Type R E V Turbine Driven

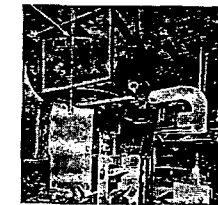
WING-SCRUPLEX EXHAUSTERS



Wing-Scruplex Exhauster

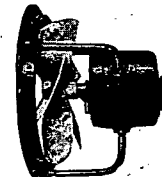
The Wing-Scruplex Exhauster consists of a highly efficient screw-propeller fan, combined with a casing of convenient design with the motor on the outside where it will keep clean and cool, and be easy of access. Because of these features it is used for duct work where the resistance is low instead of propeller fans with motors directly attached, where heretofore to obtain these features it has been necessary to use encased fans of the multivane type.

Being designed in the form of an elbow, it fits very well into any run of duct. Its rectangular frame greatly simplifies installation.



Exhauster Makes Hot Kitchen Comfortable Place to Work

WING-SCRUPLEX FANS



Wing-Scruplex Fan

Sizes including 25" 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", 13", 17", 22", 25", 30", 36", 42", 48", 54", and 60". Capacities from 950 C. F. M. to 33,000 C. F. M.

The Kier Fire Brick Company

OLIVER BUILDING
Pittsburgh, Pa.

GANISTER QUARRIES
BROOKES MILLS, PA.

SILICA BRICK PLANT
CHILDS, PA.

FIRE BRICK PLANT
SALINA, PA.

FIRE CLAY MINES
SALINA, PA.; PHILLIPSBURG, PA.; KITTANNING, PA.



Fire Clay and Silica Brick for Boiler Settings

The Salina brand of fire clay brick has been used in the construction of boiler settings for 78 years. It is capable of meeting any of the furnace conditions that are satisfied by first quality fire clay brick. It gives dependable service as it resists the hottest furnace fire and "soaking heat" by virtue of the uniformly good materials composing it and the expert knowledge of making fire brick gained in over three-quarters of a century in the business.

The Kier Fire Brick Co. is also in a position to supply special brick of higher refractoriness when necessary. Experience has shown that it is often possible to overcome serious furnace trouble by the use of a relatively small percentage of these special refractories. Special conditions in furnace construction and operation demand special attention.

The life of a furnace is an important consideration. Our engineers can aid in solving your problem.

Write us for engineering advice.

The Automatic Furnace Co.

Dayton, Ohio

NEW YORK, N. Y.
PITTSBURGH, PA.

Branch Offices
CHICAGO, ILL.
TOLEDO, O., CLEVELAND, O.

ST. PAUL, MINN.
DETROIT, MICH.

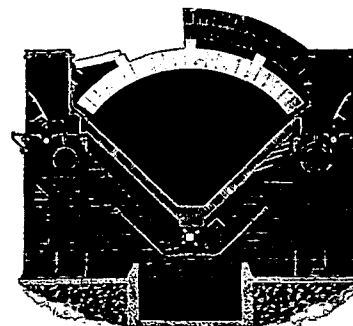
Manufacturers of Smokeless Furnaces, Chain and Shaking Grates

Products

Model Automatic Smokeless Furnaces; Model Chicago Chain Grate; Dayton Coal Feeder; Culver Shaking and Dumping Grate; Model Acme Steam Engine. THE MODEL AUTOMATIC SMOKELESS FURNACE is of the well-known side feed inclined grate type and is suitable for the larger heavy duty units. It is entirely automatic, cleaning the ash and clinker from the fire as well as feeding the fuel to the fire. Heavy overloads can be carried due to the fact that the fire is always clean and ready to respond to sudden large variations in steam requirements.

The design is simple, strong and durable and no parts, except the grate bars, are exposed to the heat of the fire.

Shown below.



THE DAYTON COAL FEEDER automatically feeds the coal onto any grate. It gives an even distribution of fuel over the entire grate surface and the fuel saving seldom amounts to less than 15 per cent.

The saving in fuel will repay the installation cost in a short time. It is simple in design and practically foolproof. It reduces the amount of labor required.

As it is entirely on the front away from the heat of the fire, the maintenance cost is practically nothing.

This Company also manufactures the MODEL CHICAGO CHAIN GRATE. It is of rugged, heavy construction and is designed to stand the trying service of boiler room equipment. Detailed description will gladly be sent on request.



Showing Dayton Coal Feeder Applied to Horizontal Fire Tube Boiler

It is easily and quickly installed without change in the boiler setting and at comparatively small cost.

CULVER SHAKING AND DUMPING GRATE has both a shaking motion, which is sufficient to clean the grate surface of ash and clinker, and a dumping motion in which every other grate raises



Culver Shaking and Dumping Grate

up and the others drop down. When in this position the grates can be rocked, which breaks up the largest and hardest of clinker, and as an 8-in. opening is afforded everything on the grates is dumped into the ash pit.

Sanford Riley Stoker Co.

"RILEY"
Underfeed Stokers"JONES"
Underfeed Stokers
WORCESTER, MASS."MURPHY"
Automatic Furnaces

BOSTON NEW YORK PHILADELPHIA PITTSBURGH BUFFALO CLEVELAND DETROIT
CINCINNATI CHICAGO ST. PAUL KANSAS CITY DENVER CHARLOTTE DALLAS

THE UNDERFEED STOKER COMPANY OF CANADA, LTD., TORONTO

The Murphy
Furnace

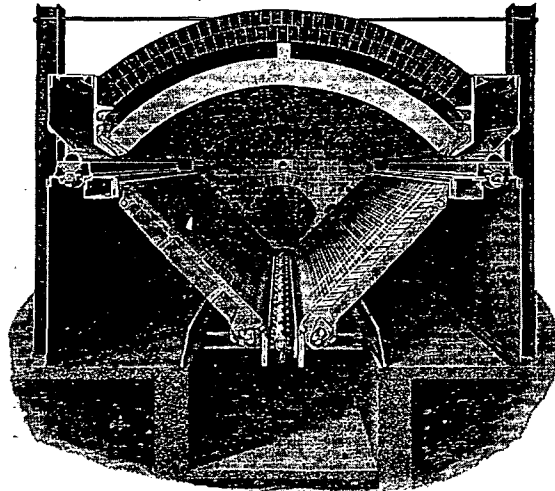
The Murphy Automatic Furnace is particularly adapted for use in office buildings, hotels and schools. It saves 15 to 25% of coal over hand-fired methods—it eliminates the smoke problem. The labor saving depends on the number of men employed. Where only one man is employed there is, of course, no saving, 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., and Buffalo, N. Y.
University of Michigan, Ann Harbor, Mich.
76 School buildings in Detroit.
33 Schools in Cleveland.

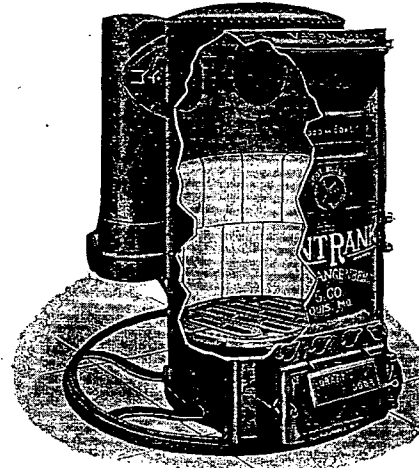
Haynes-Langenberg Mfg. Co.

4549 No. Euclid Ave. :: ST. LOUIS, MO.

FRONTRANK

TRADE NAME REGISTERED

Dealers in all parts of the United States



Front-Rank Steel Furnace

A proven Heater.
Indestructible fire-brick lining.
Separate grates. Burns any fuel.
Long fire travel. No direct draft.
Large direct and indirect surfaces.
• Gas-tight and dust-proof.
Low flue temperatures.
Large casings of known capacity.
Rated for good performance.
30,000 in St. Louis is some proof of the ability of this heater.

Thirty-five years of real service to the Public has put us in the Front-Rank for better heating.

A real Warm Air heating and ventilating system includes, fresh air, humidity, heat control, screened or washed air, and immediate service before breakfast.

It is healthful and sanitary.

Plans furnished and consultation free.

DIMENSIONS OF **FRONTRANK** STEEL FURNACES

No. of Furnace	Diameter of Casing	Diameter of Drum	Diameter of Fire Pot (Inside Tile)	Depth of Fire Pot	Area of Grates	Diameter of Radiators	Height of Radiators	Height of Drum	Height of Furnace over all not less than	Diameter of Smoke Pipe	Size of Feed Door Opening	Capacity in sq. in. of cross area of Hot Air Pipes	Shipping Weight less casing
381, 382	38"	18"	16"	15"	176"	9"	38"	58"	66"	8"	10x12"	350	750 lbs.
42X, 421, 423	42"	22"	20"	15"	233"	10"	34"	58"	68"	9"	12x13 1/2"	450	1,000 "
45X, 451, 453	45"	22"	20"	15"	283"	10"	34"	58"	68"	9"	12x13 1/2"	500	1,000 "
48X, 481, 483	48"	25"	23"	15"	380"	11"	35"	59"	70"	9"	12x13 1/2"	600	1,200 "
51X, 511, 513	51"	25"	23"	15"	380"	11"	35"	59"	70"	9"	12x13 1/2"	650	1,200 "
54X, 541, 543	54"	29"	26"	15"	490"	13"	38"	62"	70"	9"	12x13 1/2"	700	1,450 "
60X, 601, 602	60"	32"	29"	15"	616"	15"	38"	62"	72"	10"	12x13 1/2"	800	1,650 "
160	66"	32"	29"	19"	616"	18"	44"	69"	78"	10"	12x13 1/2"	1,000	1,750 "

xSignifies Single Feed Door.

Capacities as listed are taken from actual proven installations and include a safety factor.

The XXth Century Heating & Ventilating Co.

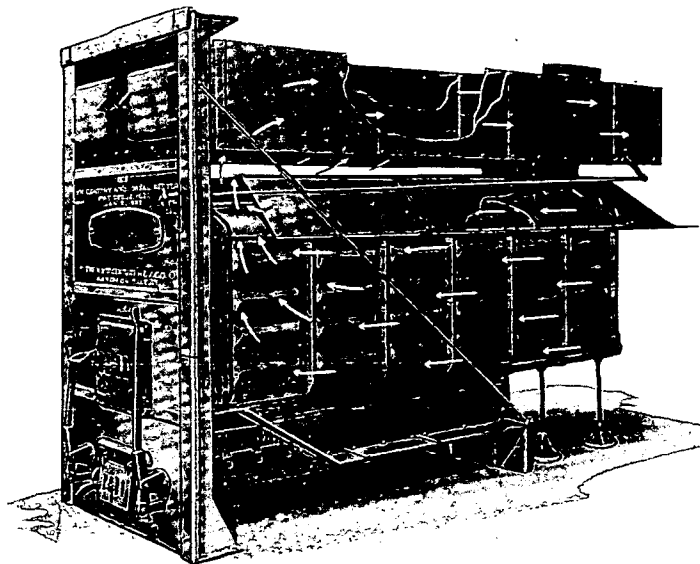
General Office and Factory

Akron, O.

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 systems for heating large buildings

Capacities furnished upon application.



The Horizontal Flow Heater
Pat. Dec. 13, 1921—Jan. 23, 1923

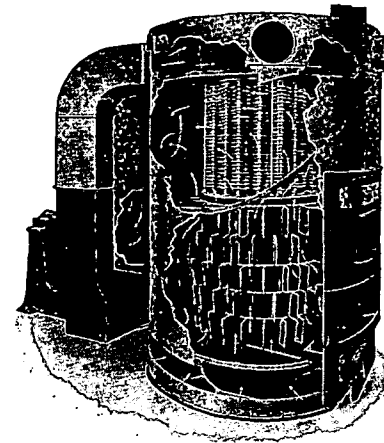
We also manufacture the XXth Century Warm Air Furnace, in eight different sizes, for the heating of residences.

Descriptive matter and prices will be gladly furnished.

Robert Gordon, Inc.

1351 W. Washington Boulevard

Chicago, Ill.



Mechanical Hot-Blast
Heater

For Industrial Purposes

Heating
Ventilating
Drying
Processing

A specially designed direct fired unit using coal, coke, oil, gas, or by products for fuel.

Exceptionally large surface of heavy castings and standard multivane fan delivers 81 per cent of Heat value of fuel used.

HEATING CAPACITIES

Size	0° to 40°	0° to 50°	0° to 60°	0° to 65°	0° to 70°	C. F. M.	Fuel Cons. lbs. per Hr.
3	150,000	135,000	120,000	100,000	75,000	5,500	35 to 40
4	240,000	215,000	190,000	160,000	120,000	8,000	40 to 45
6	480,000	430,000	380,000	320,000	240,000	16,000	80 to 90

Cubic contents above are for standard brick building having not over 30 per cent glass surface Fuel 13,000 B.t.u. per lb.

SPECIFICATIONS

Size	Floor Space	Height	Shipping Weight	Motor H. P.	Smoke Pipe	Fan R. P. M.	Net B.t.u. Production
3	5'x9'	8'-4"	4,400	3	9"	780	288,000
4	5'-6"x10'	9'	5,200	5	10"	705	336,000
6	7'x13'	10'-4"	11,000	7.5	12"	460	672,000

B. F. STURTEVANT CO., Sole Sales Agents

SKINNER BROTHERS

MANUFACTURING COMPANY INC.

HOME OFFICE AND FACTORY
1400-1490 S. VANDERVENTER AVE
ST. LOUIS, MO.

EASTERN OFFICE AND FACTORY
100-160 BAYWAY
ELIZABETH, N. J.

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MINNEAPOLIS KANSAS CITY

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PITTSBURGH—34 WOOD ST.

BALTIMORE—2 E. LEXINGTON ST.
SPOKANE—435 FIRST AVE.
SAN FRANCISCO—MONADNOCK BLOCK



258

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 on 5 lb. steam pressure.

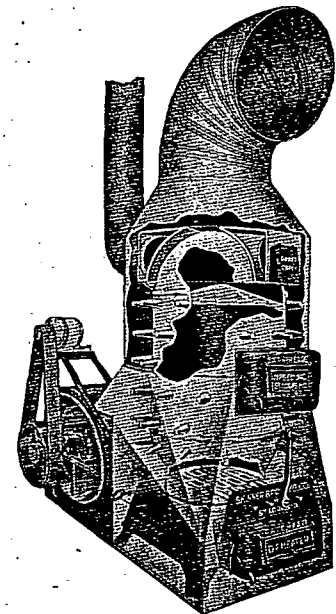
SKINNER BROS. PATENTED DIRECT FIRED HEATERS

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.

Write to us for information on our Up-and-Down Circulation Dryer for soap, veneer, leather, etc.



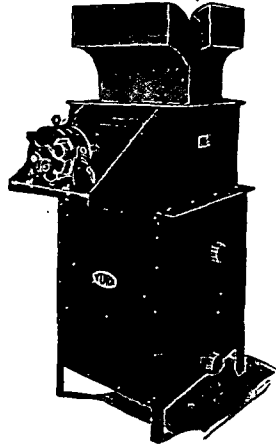
259

York Heating and Ventilating Corp.

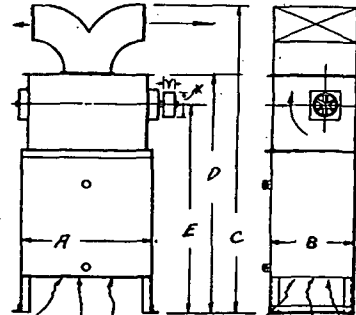
1502 Locust Street :: PHILADELPHIA

Unit Heaters—Unit Fans—Rotary Ventilators—
Stationary Ventilators—Cyclone Dust Collectors—Damper
Quadrants—Blast Gates—Drying Trays—Wool Switches—
Sheet Metal Work and Light Structural Iron Fabrication

YORK "WELDED COIL" UNIT HEATER



York Unit Heater



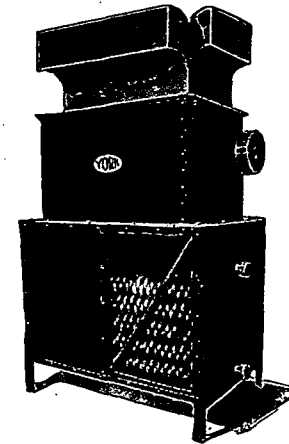
Construction Details of Heater

- 1—Low Power requirements—heater is designed for minimum internal air resistance. There are no baffles, etc., to cause back pressure—path of air is straight through heater.
- 2—Rehandles and reheats air within the room or can be connected to the outside air—thereby supplying air that is both fresh and warm.
- 3—Air passes through the heater with a uniformly increasing velocity, until diffused through the outlets.
- 4—No duct work is required—air is discharged at sufficient height to avoid disturbing floor dust.
- 5—When maximum heating is not required, fan may be stopped; after which a reduced volume of air will circulate through it, generating a considerable quantity of heat with no power costs.
- 6—Maintenance is low—there are no valves and joints to be repaired.

- 1—Welded pipe coils—no joints from inlet to outlet. Coils are tested to over 200 lb. pressure.
- 2—Ball bearing fan—with bearings outside the fan housing and not in contact with hot air.
- 3—Fan may be belted to line shaft or motor or directly coupled to motor.
- 4—Fan pulley is located near top of the heater, 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.
- 5—Base of the heater is open on all four sides. Where connection to outside air is desired, this can easily be made from any side.
- 6—The Unit stands on legs, no special foundation is required.
- 7—It can be furnished for ceiling suspension.

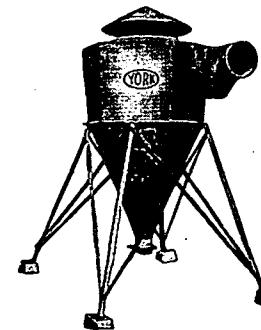
Unit Size	A	B	C	D	E	X	Y
2	3'-7"	2'-0"	8'-6"	6'-4"	5'-8"	8	3
2-A	3'-7"	2'-7"	8'-9"	6'-7"	5'-11"	8	3
3	3'-7"	2'-7"	9'-6"	6'-11"	6'-11/2"	8	3
3-A	4'-0"	3'-7"	9'-6"	6'-11"	6'-11/2"	8	3
3-B	5'-1"	3'-7"	9'-8"	7'-2"	6'-4/2"	8	3
4	5'-1"	3'-7"	9'-10"	7'-10"	6'-9"	12	4
4-A	7'-0"	4'-0"	9'-10"	7'-10"	6'-9"	12	4
4-B	7'-0"	5'-1"	9'-10"	7'-10"	6'-9"	12	4
5	7'-0"	5'-1"	9'-10"	7'-10"	6'-9"	12	5 1/2

Complete Blower Systems for Ventilating or Exhausting, built and installed



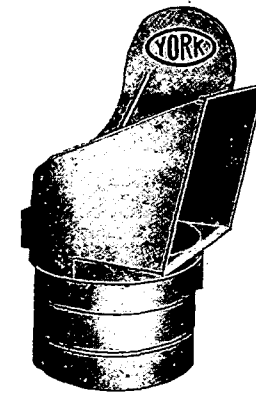
York Unit Heater
York 3A, 3B or 4 Unit Heater.

No. of Unit	Sq. Ft. Heat Surface	NORMAL RATING					Maximum Speed	Weight—Lbs.
		A. P. M.	0° Ent. Air— 5 lb. Steam B.t.u. per Hr.	R. P. M.	H. P.			
2	180	3,870	346,000	1,580	2.2	1,800	1,400	
2-A	260	3,870	395,000	1,580	2.2	1,800	1,700	
3	260	5,530	495,000	1,300	3.1	1,800	1,800	
3-A	360	5,530	560,000	1,300	3.1	1,800	2,200	
3-B	520	5,530	620,000	1,300	3.1	1,800	3,000	
4	520	9,820	925,000	980	5.5	1,200	3,200	
4-A	880	9,820	1,080,000	980	5.5	1,200	5,000	
4-B	1,040	9,820	1,130,000	980	5.5	1,200	5,800	
5	1,040	19,640	1,850,000	980	11.0	1,200	6,200	



York Cyclone Dust Collector

Sizes 6 in. to 60 in. inlet diameter.
Made with or without weather cap and supporting frame.



York Rotary Ventilator

Sizes 10 in. to 60 in. neck diameter.
Made with or without bases.



York Metal Drying Trays

York Metal Drying Trays, with patented nesting corners, may be stacked on a batten as high as desired without liability of toppling. They can then be moved as a unit without rehandling each individual tray.

Patented corners provide uniform space between trays, thus insuring perfect air circulation without use of shelves, special trucks, etc.

York Trays can be furnished with solid or perforated bottoms—made of any special metal.

EverHot Heater Company

Detroit, Mich.

Branches and Distributors in All Large Cities

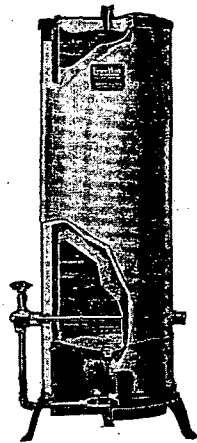
EverHot Gas Fired, Automatic Storage Water Heaters

Product—EverHot Automatic Water Heaters.

EverHot Junior, for homes with one bath room. Storage capacity 20 gal., heating capacity 60 gal. per hr., 60° raise.

Model 32, for large residences, restaurants, etc. Storage capacity 32 gal., heating capacity 120 gal. per hr., 60° raise.

Description—Boiler shells are 10 gage, heads 8 gage copper bearing steel. Boilers are galvanized inside and out. They are riveted and welded and tested at 200 lb. pressure.



The burner is a specially designed, semi-bunsen type which burns with a non-carbonizing flame. Only a limited amount of primary air is admitted through the bunsen tubes, allowing of an unlimited turn down without backfiring. The tubes are placed in pairs which incline toward each other so that the jets of each pair impinge.

A partial vacuum, created at the point of impingement, induces the necessary amount of secondary air for perfect combustion.

The flueway is the cylindrical space between the boiler and the inner shell. It connects with the vent through the flue chamber at the top.

The entire heater is insulated with a thick blanket of rock wool packed between the inner and outer shells. In addition to being a good insulator, this material has a high refractory value.

The thermostat is a simple, graduated type with a copper tube as the expansion member and a carbon rod as the fixed member.

Operation—When the heater is first started, the burner operates at full capacity. As the temperature of the water approaches the set temperature, the thermo valve gradually closes off the gas.

Whenever hot water is drawn the cold water, entering the boiler, causes the thermo valve to open. Gas is admitted to the burner which operates until the water is again heated.

Features—As the water in storage is always hot, the service is immediate. Hot water is delivered at the same pressure as cold.

The heat generated by the pilot, which burns approximately 1 1/2 ft. of gas per hr., keeps the water in storage hot.

The temperature control is so perfect that there is never a difference of more than five degrees in the temperature of the water at the top and at the bottom of the boiler. EverHot Heaters deliver practically all the water in storage without change in temperature.

Stack temperatures average about 100 deg. above the temperature of the water.

Condensation is practically eliminated. As overheating of the water is prevented, precipitation of lime is reduced to the minimum.

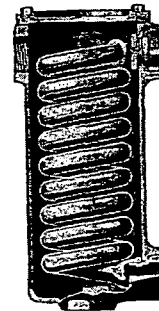
HEATER CAPACITY, DIMENSIONS AND INFORMATION FOR INSTALLATION

EverHot Model	Price	Storage, gal.	Rated heating capacity 60° raise, gal. per hr. (Overload 50%)	Rated gas consumption, cu. ft., 600 B.t.u. gas per hr.	Dimensions, inches		Diameter of cylinder	Water connections, in.	Gas connections, in.	Size of gas meter	Size of flue pipe, in.
					Width	Height					
Junior	99	20	60	22	24	56	16	3/4	1/2	5 Lt.	4
No. 32	160	32	120	42	26	67	19 1/2	1	3/4	10 Lt.	5

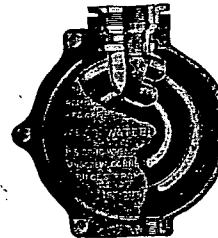
Both models may be connected direct or reheating. Two or more units may be connected in parallel on large installations.

Excelso Specialty Works, Inc.

119 Clinton St., BUFFALO, N. Y.



Sectional View



New Double-Coil Heater

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.

The new heaters take care of installations from 200 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.

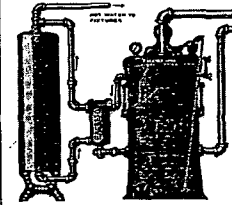
Connected on the outside of steam or vapor boilers the Excelso eliminates the fire pot coil and insures a constant supply of domestic hot water all during the heating season at an even temperature.

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 bigger installations—for apartment houses, buildings and other places where large quantities of hot water are required.

These larger heaters are made in three sizes for tank capacities of 200, 300 and 400 gallons.

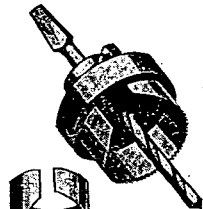
Connecting two or more of these heaters in battery will



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.

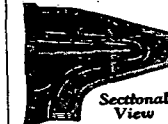
Each tool cuts holes for either 1", 1 1/2" or 2" pipe tap. Price \$7.50 net, including six blades, two of each size.



Hack Saw Tool



Top View



Sectional View

Excelso Fire Pot Generator—This generator fits any type hot water boiler or hot air furnace, and is so designed as 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 gallon capacity. Size No. 2. From 40 to 60 gallon capacity.

PRICE LIST, CAPACITY AND DIMENSIONS OF EXCELSO WATER HEATERS

Size of Heater	11	12	13	14	15	16	17	18
Length in	10 1/2	14	11 1/2	15	19 1/2	15	19	23 1/4
Diameter in	5	5	6 1/2	6 1/2	6 1/2	9	9	9
Shell openings	1	1	1 1/2	1 1/2	1 1/2	2	2	2
Coil openings	3/4	3/4	1	1	1	1 1/2	1 1/2	1 1/2
Weight crates lb.	17	23	31	39	46	68	82	95
List Price	\$30	40	50	60	70	150	180	210

HEATING WATER BELOW WATER LINE OF STEAM OR VAPOR BOILERS

Temperature rise 100 degrees in 3 hours.

Size of Heater	11	12	13	14	15	16	17	18
Tank Capacity in Gallons	30	45	60	90	120	200	300	400

HEATING WATER WITH LIVE STEAM

Temperature rise 100 degrees in 3 hours at 5 lb. pressure.

Size of Heater	11	12	13	14	15	16	17	18
Tank Capacity in Gallons	50	75	100	150	200	300	450	600

INSTRUCTIONS FOR ORDERING HEATERS

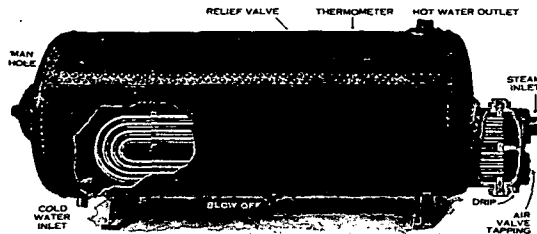
Many tanks are installed too small and heaters should always be ordered to correspond with work required and not size of tank. Also make liberal allowance if circulating system is used.

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	2600
5 S	30 x 60	180	875	25 S	48 x 120	940	2925
6 S	30 x 72	215	1000	26 S	48 x 144	1125	3350
7 S	30 x 84	255	1150	27 S	48 x 168	1300	3840
8 S	30 x 96	285	1300	28 S	48 x 192	1500	4200
9 S	30 x 120	360	1500	29 S	54 x 120	1190	3500
10 S	36 x 72	310	1250	30 S	54 x 144	1425	3900
11 S	36 x 84	365	1400	31 S	54 x 168	1665	4300
12 S	36 x 96	415	1550	32 S	54 x 192	1900	4700
13 S	36 x 108	475	1700	33 S	60 x 120	1400	4300
14 S	36 x 120	500	1850	34 S	60 x 144	1700	4950
15 S	36 x 144	640	2100	35 S	60 x 168	2000	5600
16 S	42 x 72	430	1500	36 S	60 x 192	2240	6200
17 S	42 x 84	500	1650	37 S	72 x 174	3000	7000
18 S	42 x 96	575	1800	38 S	84 x 168	4000	8700
19 S	42 x 108	650	1950	39 S	96 x 168	5200	10000
20 S	42 x 120	720	2200	40 S	96 x 192	6000	11000

HEATING CAPACITIES—40° F. to 180° F.—Steam at Atmospheric Pressure.

No.	Gallons per Hour	Approx. Wt. in Lbs.	No.	Gallons per Hour	Approx. Wt. in Lbs.
1 H	100	200	15 H	2000	700
2 H	150	215	16 H	2500	800
3 H	200	235	17 H	3000	900
4 H	250	255	18 H	3500	1050
5 H	300	285	19 H	4000	1200
6 H	400	315	20 H	4500	1350
7 H	500	350	21 H	5000	1500
8 H	600	370	22 H	6000	1750
9 H	700	400	23 H	7500	2000
10 H	800	425	24 H	10000	3200
11 H	1000	450	25 H	12500	3800
12 H	1250	500	26 H	15000	4500
13 H	1500	550	27 H	20000	5100
14 H	1750	600	28 H	25000	5800

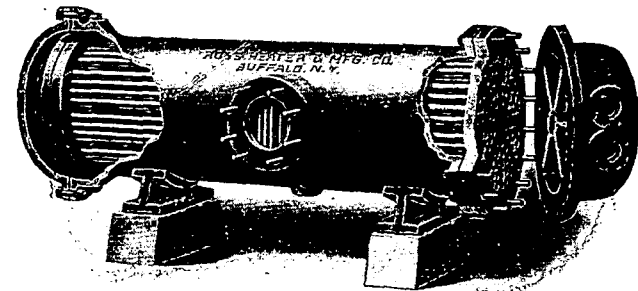
NOTE—To specify Type B. Heaters, combine the numbers of the required storage and heating capacities. For example, "One Patterson Type B. Heater with No. 22 S. and No. 17 H." has 1000 gallons storage with 3000 gallons hourly heating capacity.

Ross Heater & Mfg. Co., Inc.

Buffalo, N. Y.

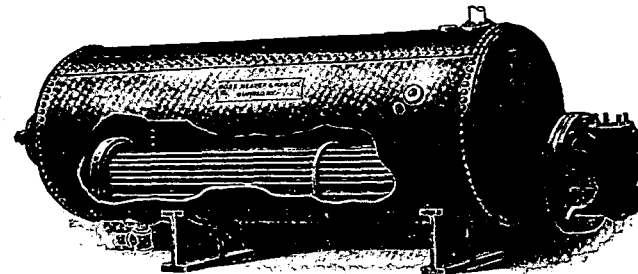
REPRESENTED IN ALL PRINCIPAL CITIES

Heaters, Condensers, Coolers, Water Strainers, Heat Exchangers, Evaporators, Vacuum Pumps and Expansion Joints for all Services.



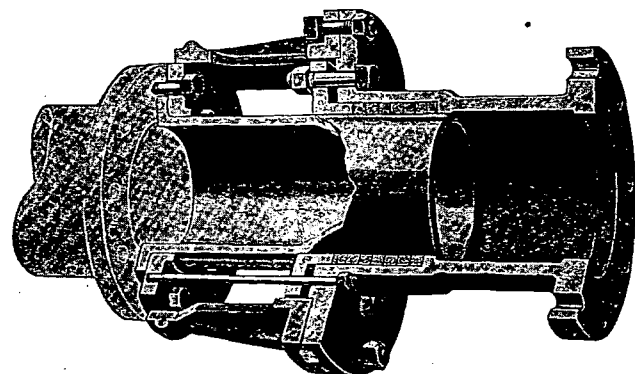
Ross Radial Flow Instantaneous Heater

Instantaneous Heaters cover a very wide field; in fact a large per cent of services can be taken care of with this type even though no attempt is made to carry a supply of the heated liquid in reserve or storage. A few of the services are: Hot water service supply for hotels, factories, hospitals, schools, apartment buildings, etc. Water for hot water heating systems for either forced or gravity circulation. Oil for pipe lines, storage stations, fuel oil burning apparatus, etc. Boiler feed water for high or low pressure. Water for swimming pools. Sugar juice in cane or beet sugar houses. Chemical compounds of all kinds, etc. Straight tubes are used and they are accessible at both ends.



Ross Storage Type Heater

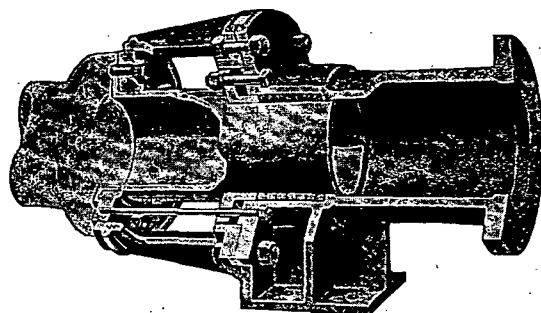
The Ross Storage Heater meets a condition where it is desirable to store up and have in reserve a supply of hot water. This heater is made in various combinations of storage tanks and heating elements so as to meet any condition of service. The heating element is located on the bottom and extends practically the full length of the tank. The entire heating element can be removed for cleaning or repairs. The tubes are straight and expanded into both tube sheets, one of which is of the floating type.



Sectional view Ross Crosshead-Guided single expansion joint, without anchor.

The Ross Crosshead-Guided Expansion Joint is a high grade fitting for taking care of the expansion and contraction in pipe lines due to changes in temperature. These Ross fittings are made for all pipe sizes. The above sectional view shows the construction, the principal feature being the guiding of the slip tube to insure perfect alignment in its travel through the packing box, which is extra deep. The periphery of the slip tube flange is machined to an accurate fit with the machined inner surface of the guide. The flanges are of the well-known Van Stone type. The Ross Crosshead-Guided Expansion Joint is so constructed that it can be easily packed or the packing adjusted without removing it from the pipe line. This is one of the many distinctive features found only in Ross Fittings. It is provided with limit rods to prevent the slip tube pulling out of the packing box. All holes drilled from templates—not cored.

The Ross Crosshead-Guided Expansion Joint is suitable for pipe lines conveying saturated or superheated steam, water, oil, air, or any fluid subjected to changes in temperature. These fittings are built in three general types—Low Pressure Cast Iron for pressures of 125 pounds and lower; High Pressure Cast Iron for pressures from 125 to 250 pounds; High Pressure Cast Steel for extra high pressures and temperatures. All of the above types of joints can be supplied with or without anchor bracket. The length of traverse varies from 4" to 16", depending upon the size and type of fitting.



Sectional view Ross Crosshead-Guided single expansion joint, with anchor.

The Stack Heater Company

39 Sudbury Street

BOSTON

MASSACHUSETTS

MANUFACTURERS OF

Safety Relief Valves—Thermostats—Gas Water Heaters—Indirect Water Heaters—Instantaneous Steam Water Heaters—Non-By-Pass Tees

Every type of Stack Water Heater contains a copper coil of spiraling tubes—The ratio of heating surface of these tubes to volume of water passing through them is 20 to 1.



STACK INDIRECT WATER HEATER— "from kitchenette to hotel"

USERS—

Homes—Hotels—Apartments—Blocks—Y. M. C. A.—Public Buildings—Country and City Clubs—
Saves an extra fire during winter months—
Utilizes heat from house heater—
Attaches to steam boilers—hot water boilers—furnaces.
Maximum amount of hot water required per hour should determine size of heater rather than size of tank which is often too small—
Use at least one size larger Heater than shown in table for circulating systems—

SPECIFICATIONS AND PRICES

Size	Tank Capacity Rated on		Shell Opening	Hot Water Connections	Length	Diameter	Shell Openings on Center	Weight Lbs.	List
	3 Hrs.	1 Hr.							
D-6-13	40	15	1"	3/4"	18"	4"	13"	18	\$18.00
D-12-13	60	24	1 1/4"	3/4"	18"	6"	13"	24	23.50
D-24-15	100	40	1 1/2"	1"	24"	6"	15"	32	40.00
D-37-15	200	80	1 1/2"	1 1/4"	24"	8"	15"	50	70.00
D-50-15	300	120	2"	1 1/2"	24"	10"	15"	60	100.00
D-50-24	400	150	2"	1 1/2"	36"	10"	24"	70	150.00
D-100-24	600	250	2 1/2"	2"	36"	13 1/2"	24"	120	310.00
D-100-36	750	300	2 1/2"	2"	44"	13 1/2"	36"	160	360.00
D-120-24	1000	400	3"	3"	36"	13 1/2"	24"	200	400.00
D-120-36	1200	500	3"	3"	44"	13 1/2"	36"	250	500.00

STACK INSTANTANEOUS STEAM WATER HEATER

a simple, efficient device for supplying clean, hot water.

USERS—

Factories—Institutions—Hotels—Restaurants—Clubs—Turkish Baths—Office Buildings—Steam Laundries—Ocean Liners—Battleships—Bleach and Dye Works—Finishing Plants and other Industrial Requirements.
Works efficiently on exhaust or high pressure steam.
Steam does not mix with the water—it merely transfers its heat to the water in the copper tubes—
Steam is used only while water is being drawn—
No moving parts or expansion joints.
Steam pressure must at all times be less than water pressure and condensation must have a free get away.
Suitable pressure relief valve should be installed.
Full flow of steam must be on heater at all times—
Installation of separate steam trap is recommended.

FOR WATER PRESSURES UP TO 250 LB. AND STEAM PRESSURES UP TO 100 LB. WATER PRESSURE MUST EXCEED STEAM PRESSURE

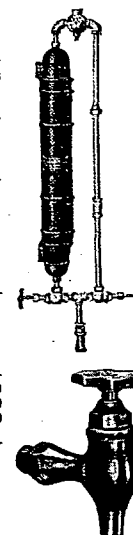
No.	Water Inlet and Outlet	Steam Connections	Gals. Min. 5-10 Lbs. Steam	Gals. Min. 30 Lbs. Steam	Length	Diameter	Weight	List
IS-12-48	1/2	1/4	6	8	6'	4"	60 lb.	\$150.00
IS-37-36	3/4	1/2	12	16	5'	5"	100 lb.	250.00
IS-50-36	3/4	2	15	20	5'	7"	120 lb.	350.00

THE STACK SAFETY RELIEF VALVE—

prevents explosions due to excessive water pressure—
Replaces one hot water faucet.
No separate drain connections.

Price.....\$6.00

TRADE MARK STACK REG. U. S. PAT. OFF.



Thermal Appliance Company

Incorporated

342 Madison Avenue, NEW YORK

SALES OFFICES: 332 S. MICHIGAN AVE., CHICAGO 7 EAST 42nd St., 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 TACO

Domestic TACOS and Apartment TACOS are connected below the water-line of steam, vapor or vacuum heating boilers, capacity 30 to 960 gal.

Receive the heat from the boiler at night as well as during the day and in mild weather, as no steam pressure is required. No benefit is derived from the coal used to bank the fire over night unless a TACO is used.

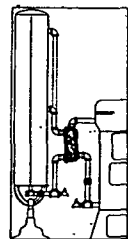
Also recommended for heating hot-water radiators in connection with steam-heating boilers for bath rooms, garages, etc.

Domestic TACO—Capacity 30 to 160 gals.

Coil on cover—1200 tested connection.

Apartment TACO—Capacity 320 to 960 gals.

Copper U tubes expanded into Bronze tube plate. Easily removable for cleaning.



Domestic Taco

No.	Capacity	List Price
30	30	\$15.00
1	40	20.00
2	80	30.00
3	160	50.00

Patents Pending.

*Amount of hot water used in an apartment house varies. Capacity as stated is an average for a 4 or 5 room apartment having one bath and kitchen with usual fixtures, occupied by one family. For intermediate or larger capacities, any number of TACOS may be installed in a battery.



Apartment Taco

No.	*No. of families	Tank Size	Boiler and Water Connections
4	12	320	2"
5	25	640	2 1/2"
6	40	960	3"

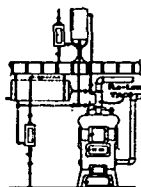


FLO-LINE TACO

Flo-Line TACO Heaters are for connection in the main outlet of steam or vapor heating boilers.

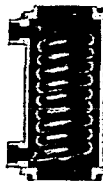
The steam, circulating about the coil which is connected directly with the range boiler or tank, thus heats the domestic water and maintains a full tank of hot water at a uniform temperature. Body of heater is sufficiently large so the pipe area is not restricted.

Water will be successfully heated at night or in mild weather from vapor from boiler when no steam is being generated in boiler.



No.	Capacity	List Price
01	60	\$25.00
02	120	35.00
03	240	55.00

Tank must be connected above Flo-Line heater.



UNIVERSAL TACO

Recommended for use in the fire-pot of hot-water heating boilers for attachment to thirty and sixty-gallon range boilers. The No. 9-30 and 9-60 are furnished with studs for round boilers having coil openings 9" 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 3-60 for use with square boilers of any type. All types and sizes are malleable iron; 6-9-30 and 6-9-60 in Brass also.

9-30; 6-9-30; 3-30	30 gal.
9-60; 6-9-60; 3-60	60 gal.



TACO TOOL

For use when tapping Boiler. Comes in three sizes: 1", 1 1/4" and 1 1/2".



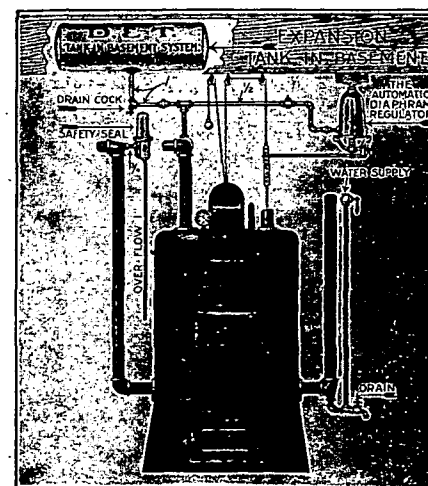
Where stocks are carried: TACO is carried in stock by all leading boiler and radiator manufacturers at their branch showrooms; and by leading jobbing supply houses.

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 80,000 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.

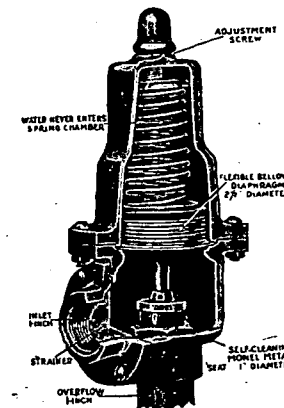
Send for booklet entitled, "Progress in Hot Water Heating."

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 2 1/2 in. in diameter, thereby giving a lifting power 6 1/4 times greater than the area of the disc.



Reading Heater & Supply Co.

Incorporated
GENERAL OFFICES
Woodward and Church Streets
Reading, Pa.

Manufacturers and Distributors of

The Reading Tank-in-the-Basement Systems for Hot Water Heating and The Reading All-Metal Temperature Regulator for Hot Water Heaters, Domestic Heaters and Storage Tanks, Wholesale Dealers in Boilers, Radiators and Heating Specialties.

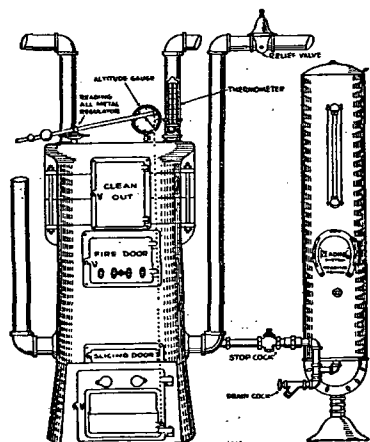
The Reading Tank-in-the-Basement System, for Hot Water Heating, is a long step in advance of the old method of placing the Expansion Tank above the highest radiator, in that it removes



the tank to the basement, obviating many objectionable features and removing the liability of fracture by freezing of the expansion line or overflow.

The Reading Tank is proportioned according to the amount of radiating surface on the job, and provides ample air space to allow for expansion. The gauge glass enables the operator to detect any air leakage and to maintain a sufficient air space.

The Reading Relief Valve permits a slight pressure on the system, even when the water is cold. This means increased



efficiency and prevents the accumulation of air in the upper radiators. The increased pressure will not cause leaks as the air cushion prevents undue strains. We furnish complete instructions for installation.

Capacities and Prices

(Subject to trade discount)

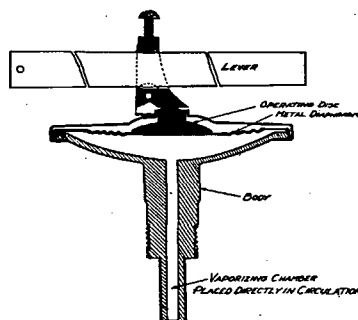
No. 1.	300 to 500 ft. of Radiation	\$38
No. 2.	500 to 800 ft. of Radiation	40
No. 3.	800 to 1,000 ft. of Radiation	41
No. 4.	1,000 to 1,300 ft. of Radiation	45
No. 5.	1,300 to 1,800 ft. of Radiation	50
No. 6.	1,800 to 2,600 ft. of Radiation	56

In ordering Reading Tank-in-the-Basement Systems the following information is required: Amount of radiation on job, square feet; number of stories to be heated.

The Reading All-Metal Regulator can be used to control water temperature in any system, regardless of pressure carried. The Regulator is easily applied and the action is sensitive and reliable.

We will be glad to send a catalog describing our complete line of Specialties, upon request. Our Engineering Department will welcome the opportunity to assist the trade in difficult problems pertaining to our line, and we invite such inquiries.

We carry a large stock of boilers of all capacities, Round or Sectional, and can make prompt shipments.



INTERIOR VIEW
READING ALL-METAL TEMPERATURE REGULATOR

The Bahnson Company

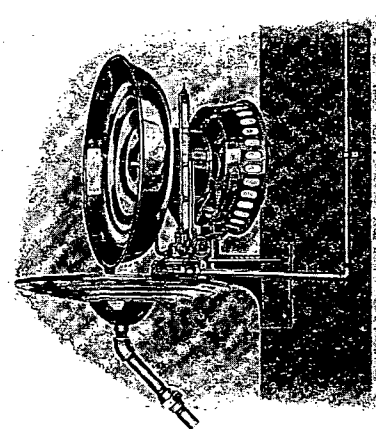
Winston-Salem, N. C.

New York Sales Office: 437 Fifth Avenue

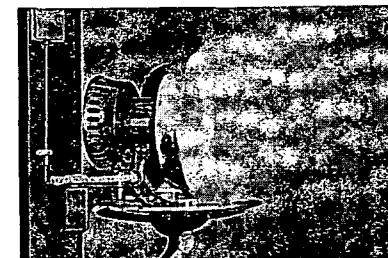
Bahnson Humidifiers

The Bahnson Co. specializes on Bahnson Humidifiers, which are supplied in units of only one size. Varying conditions of use are met by mechanically interchangeable motors for different current supply, and by supporting hangers for mounting the machines on round columns, square columns, walls, or for support from ceiling or floor.

of the disc, and is practically independent of the amount of water fed to the machine. Bahnson Humidifiers possess the unique feature of an adjustable water supply. The percentage of the feed water thrown out in particles is the same regardless of the actual amount of such feed water, so that without sacrificing efficiency the evaporation may be adjusted at any point



Bahnson Humidifier mounted on corner of square column



Reproduction unretouched photograph of Bahnson Humidifier in operation

Each Bahnson Humidifier is a complete, self-contained humidifying unit, operated by its individual motor, with its own accurate, dependable humidity control. On one end of the motor shaft is a conical disc 16 in. in diameter and on the other end a propeller type fan. Water, preferably at pressures below 25 lb. per sq. in., is fed through the controlling mechanism to the center of the revolving disc and is thrown by centrifugal force from the rim to the disc against a series of stationary copper teeth surrounding but not touching the disc. This impact breaks up the water into very fine particles which, in the form of mist or fog, are blown out into the room by the fan. The water is actually evaporated in the room itself.

Since the speed of the water striking the teeth depends on the peripheral speed

from a few drops per minute up to the maximum capacity of the humidifier.

The horizontal movement of air produced by the fan renders it easy to arrange an equipment of Bahnson Humidifiers so as to get a complete circulation all around the room, and the combination of this circulation with the automatic control on each unit insures not only constant humidity, but also remarkably uniform distribution.

The Bahnson Co's. engineers will gladly submit proposals based on architect's drawings or sketch plans. The number of units required in any room depends upon the length, breadth and ceiling height, the process carried on in the room, and the relative humidity required at a specified temperature.

Celite Products Company

NEW YORK, 11 Broadway CHICAGO, 53 W. Jackson Blvd.
SAN FRANCISCO, Monadnock Bldg.

Baltimore, Md., 1120 Munsey Bldg.
Boston, Mass., 79 Milk St.
Buffalo, New York, Lafayette Bldg.
Cincinnati, O., Neave Bldg.
Cleveland, O., Bulkley Bldg.
Denver, Col., Symes Bldg.
Detroit, Mich., Book Bldg.
Houston, Texas, 314 West Bldg.
Los Angeles, Cal., 1135 Van Nuys Bldg.
New Orleans, La., Whitney Central Bank Bldg.
Philadelphia, Pa., Bulletin Bldg.
Pittsburgh, Pa., Keenan Bldg.
St. Louis, Mo., Railway Exchange Bldg.

CELITE PRODUCTS LIMITED
Windsor House,
Victoria Street,
London, England.
417 New Birks Bldg.,
Montreal, Que., Canada.

Description—

Sil-O-Cel is a heat insulation or a heat retardant. It is extremely light in weight, of exceptionally low thermal conductivity and is adapted to the effective and permanent insulation of all heated equipment without change in design. It is produced from the mineral Celite in brick, block, powder, coarse grade, and cement form for all heat insulation requirements.



moistened, the concrete thus formed provides an excellent means for insulating furnace doors, bases and under certain conditions as the walls of dryers, etc.

Sil-O-Cel Insulating Cements—

Adaptable for the insulation of irregular surfaces or in places where other Sil-O-Cel products are not suitable. These cements are prepared in three grades as follows:

- Sil-O-Cel Sticking Cement (First Coat)
- 85% Sil-O-Cel Insulating Cement (Second Coat)
- Sil-O-Cel Hard Finish Cement (Third Coat)

Celite High Temperature Cements—

These cements are mixtures of ceramic materials scientifically compounded for laying and facing fire brick work in boiler settings, furnaces, etc.

Celcote—

Celcote is an elastic adhesive coating material used for covering outer brick surfaces to prevent an infiltration and for waterproofing Sil-O-Cel insulation where exposed to the weather or subjected to the influence of dampness.

Advantages of Insulation—

Sil-O-Cel Insulating Products prevent heat loss and increase the output of the equipment, save fuel, improve working conditions and insure more accurate control of temperature.

Engineering Service—

An engineering department is maintained under the supervision of competent Insulation Engineers, which will supply specific technical or engineering information on Celite Products. Address nearest office.

JOHNS-MANVILLE

Incorporated

New York City

BRANCHES IN 59 CITIES

JOHNS-MANVILLE ASBESTO-SPONGE FELTED

SECTIONAL PIPE INSULATION

An efficient and durable insulation for insulating saturated and superheated steam pipes and surfaces at temperatures up to 750 deg. Fahr.

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 molded type, Johns-Manville Asbesto-Sponge Felted is tough, flexible and practically indestructible in service. Pipe vibration and the general wear and tear to which insulation in factories is subjected will not pulverize Asbesto-Sponge Felted or break it away from the pipe. Even if subjected to excessive moisture or saturated with water it will dry out and regain its initial efficiency. Whenever necessary it can be removed from the pipes and replaced without injury to its insulating value.

JOHNS-MANVILLE IMPROVED ASBESTOCEL

SECTIONAL PIPE INSULATION

For insulating pipes conveying steam at medium or low pressures, or hot water.

Improved Asbestocel is made up of a multitude of small air cells closed upon themselves by corrugations in both directions, so that each chamber contains dead air which cannot escape. In combination with the asbestos material of which it is formed, these dead-air cells make ideal insulation as they prevent the circulation of air, which is the great objection to ordinary longitudinal air-cell coverings. It will not easily crush nor lose its strength, and successfully withstands vibration and hard usage. There is the minimum loss by breakage in transportation and application.

JOHNS-MANVILLE 85% MAGNESIA

SECTIONAL PIPE 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 surfaces.

The Johns-Manville 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.

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" inlet and outlet pipe connections.

Radiator Traps are made to operate at any pressure up to 10 lb. and are equally effective whether used on a vacuum or gravity system. To be used on cast iron radiators only, unless specially ordered for special cases.

Robert A. Keasbey Company

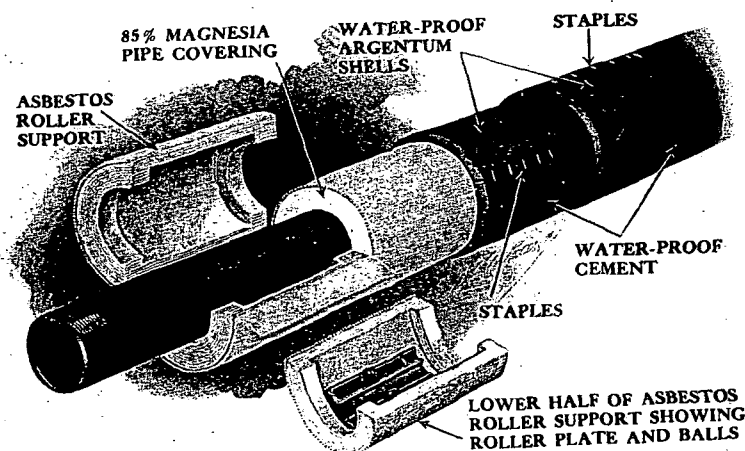
ASBESTOS

Bank and West Streets NEW YORK CITY

Branches:
100 Catherine St., Syracuse, N. Y.
Pipe and Boiler Coverings, Heat and Cold Insulation
Contracts Executed

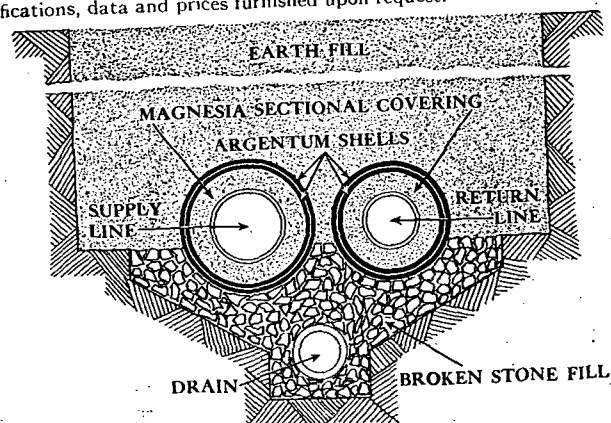
54 Church St., Hartford, Conn.

Argentum Insulation For Underground Piping



This System provides a simple and logical method of insulating underground steam or hot water pipes in connection with Central Heating Plants, large Institutions, Schools, Universities, Hospitals, Garages, etc.

This type of insulation in a modified form is excellent for piping running in uncavated portions or buried in ground subject to dampness under buildings. Specifications, data and prices furnished upon request.



Keasbey & Mattison Company

Ambler, Penna.

K & M FEATHERWEIGHT 85% MAGNESIA PIPE AND BOILER COVERING AND AMBLER ASBESTOS PRODUCTS

"If it's made of Asbestos, we've got it"

BRANCH OFFICES:

Boston, Mass.
Baltimore, Md.
Buffalo, N. Y.
Chicago, Ill.
Cincinnati, Ohio

Cleveland, Ohio
Detroit, Mich.
Minneapolis, Minn.
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Syracuse, N. Y.
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Wilkes-Barre, Penna.
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Pacific Coast Offices

Sharon Bldg., San Francisco

201 Douglas Bldg., Los Angeles

Alaska Bldg., Seattle

Southwestern Distributor: R. V. Aycock Company, Kansas City, St. Louis, Tulsa, Houston

PRODUCTS

Asbestos Fiber, Crude and Carded
Ambler Asbestos Thread and Yarn
Ambler Asbestos Cloth, Metallic and Plain
Ambler Asbestos Selvedge Edge Tape

Ambler Asbestos Wick and Rope Packing
Ambler Asbestos Braided Tubing
Ambler Asbestos Gaskets, Woven and Compressed
Ambler Asbestos Sheet Packing, Plain and Metallic

Ambler Asbestos Compressed Packing
Ambler Asbestos Felt
Ambler Asbestos Paper
Ambler Asbestos Millboard
K. & M. Featherweight 85% Magnesia Pipe and Boiler Coverings

Ambler Asbestos Products

This trade name covers an extensive list of asbestos manufactures, both textile and felted, meeting every imaginable need of the heating engineer. These products are made of asbestos from the famous Bell Asbestos Mines, Thetford, Canada, owned and operated by us, and represent a manufacturing experience of more than 40 years. This experience and the service of a corps of chemical and engineering experts are at your disposal.



K & M 85% Magnesia Coverings in standard thickness can be depended on to save from 75 to 97 per cent of the total heat wasted by bare pipes.

TABLE SHOWING THE WEIGHTS ESTABLISHED BY K & M MANUFACTURING METHODS FOR 85 PER CENT MAGNESIA SECTIONAL AND BLOCK COVERINGS

85% Magnesia Sectional Covering 3 feet long			85% Magnesia Sectional Blocks, 1 Square Foot		
Size	K. & M. warranted weight for Sec.		Size	K. & M. warranted weight for Sec.	Thick-ness K. & M. warranted weight per Sq. Ft.
1/2"	1.41	4"	5.5	1/2"	.763
3/4"	1.5	4 1/2"	6	3/4"	none milled 1921
1"	1.8	5"	7	1"	1.256
1 1/4"	2.125	6"	8	1 1/4"	1.59
1 1/2"	2.25	7"	10	1 1/2"	1.938
2"	3	8"	12	2"	2.596
2 1/2"	3.5	9"	13	2 1/2"	3.25
3"	4	10"	14	3"	6.11
3 1/2"	5			4"	

K & M Featherweight 85% Magnesia Coverings—The efficiency of an insulating covering depends primarily on the number of dead-air cells. Through the use of carded asbestos fiber of selected grade, we are enabled to get the necessary structural strength in our Magnesia Coverings with a minimum amount of asbestos fiber and a maximum amount of carbonate of magnesia. Chemical tests show the magnesia content of K & M Featherweight Magnesia Coverings to be always well in excess of 85 per cent and running as high as 90 to 91 per cent. Some magnesia coverings offered run as low as 70 to 75 per cent in carbonate of magnesia. Tests show that the purchaser is warranted in paying ten per cent more for the lighter and more efficient covering. Don't pay for inert weight in your coverings. "The lighter they weigh, the better they pay."

K & M Featherweight 85% Magnesia covering is available in half sections for standard sizes of pipe to 10 in. in diameter; in segments for larger pipe and for other curved surfaces; in blocks for flat surfaces and flat boilers; and in the form of plastic or fibrous powder for application to joints and other irregular surfaces.

Requests for descriptive literature and advice on specific needs cordially invited.

THE RIC-WIL COMPANY

GUARDIAN BUILDING, CLEVELAND, OHIO

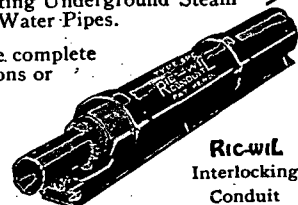
Agents in Principal Cities—Refer to local telephone directory.

A Complete Covering System
For Saving Heat-Loss From Underground Pipes

Products

Manufacturers of Ric-wil Interlocking Conduit, Ric-wil Interlocking Base Drain, Ric-wil Underground Pipe Covering and Ric-wil Interlocking Pipe Supports used in the Ric-wil Method of Insulating Underground Steam and Hot Water Pipes.

We make complete installations or furnish materials only.



is No. 1 quality, standard weight, vitrified salt glazed pipe, of the bell and spigot type. It is shipped on the job in full round sections and split into top and bottom halves when used. The top half has an overhang that interlocks with the bottom half to prevent shifting, to make a wide cement joint and to prevent water from getting in. Every sixth section of conduit has an opening in the bottom for the pipe support.

Ric-wil Interlocking Base Drain is No. 1 quality vitrified salt glazed tile, of such a design that is both a base for supporting and aligning the conduit and a drain for the ground water. Two points of support



for the conduit add 35% to the ground load, which the conduit will carry safely, as compared to a rock bed. The top of the base drain has a slot in it into which the bell of the conduit fits, so the sections of conduit and base drain stagger, and a strong interlocking construction results. The base drain has liberal drainage area and it makes a splendid foundation to build upon.

Ric-wil Pipe Covering

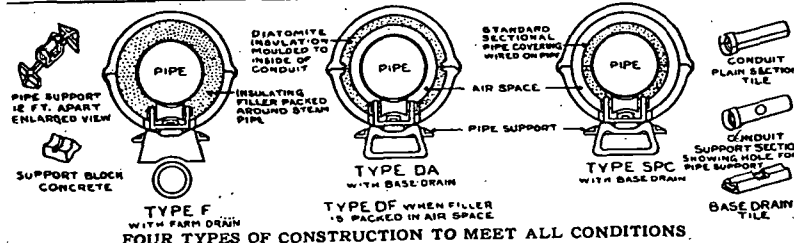
The insulating materials used for Types DA and DF, which is moulded to the inside of the tile pipe, is a mixture of diatomaceous earth, which is an excellent natural barrier to the passage of heat. It is not damageable by water, and it will not deteriorate. With Types DF and F the insulating material which is packed around the steam pipe or pipes is Ric-wil Conduit Filler. It is highly efficient, reasonable in cost and easily applied. For Type SPC we furnish any desired standard make of sectional pipe covering of any thickness.

Ric-wil Pipe Supports

The simplicity and practical features of our pipe support appeal to the engineer because it is mechanically correct, it appeals to the contractor because it is easily installed, and it appeals to the owner because the price is right.

Maximum Capacity of Conduits With Standard Equipment—Approximate

In. Diameter	4	6	8	10	12	15	18	20	22	24
1 Pipe	1½	3	4½	6	8	10	12	14	16	18
2 Pipes	¾-¾	¾-¾	1½-1½	2-2	3-3	4-4	5-5	6-6	7-7	8-8
3 Pipes	None	None	1½-1½	2-2½	3-3½	4-4½	5-5½	6-6½	7-7½	8-8½



FOUR TYPES OF CONSTRUCTION TO MEET ALL CONDITIONS.

Monarch Metal Products Company

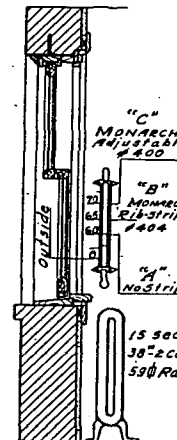
5020 Penrose St.

St. Louis, Mo.

DIRECT SALES OFFICES IN EIGHTY CITIES



Monarch Metal Weather Strips and Elastic Calking Compound when applied to and around windows and doors, establishes the maximum infiltration or air change on which the necessary amount of radiation is based. Engineering science, therefore, must determine on air INFILTRATION VERSUS SINGLE AIR CHANGE, OR PROVEN FACTS VERSUS THEORETICAL ESTIMATES.



60° No. Strip A	Room, Wall, Crack Aperture, Glass, Ceiling, Two windows, 3 x 6, crack aperture, 2 x 21' x 1/8" Wind velocity,	15 x 15 x 10 = 2250 cu. ft. 300 net 264 42 ft. 36 36 225 20 miles per hr.		
65° Monarch Rib Strip No. 404 B	No. Strip Infiltration per hr. per ft. of crack 114 cu. ft.	Rib Strip 55.8 cu. ft.	Monarch Strip 24 cu. ft.	
70° Monarch Adjustable Strip No. 400 C 15 sec. 38", 2 col. 59 rad.	Wall, Glass, Crack In- filtration, Ceiling, Total,	5540 B.t.u. 2520 " 6900 " 4725 " 19,685 B.t.u.	5540 B.t.u. 2520 " 3375 " 4725 " 16,160 B.t.u.	5540 B.t.u. 2520 " 1450 " 4725 " 14,135 B.t.u.

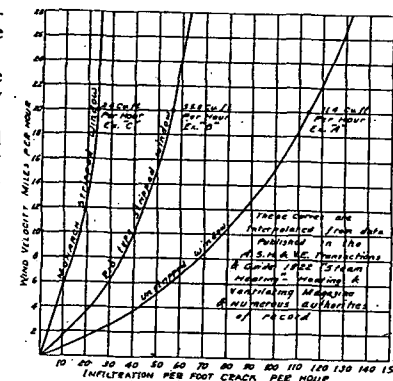
Equipment—Double-hung windows, Casements and Doors are equipped with Standard Monarch Equipment to prevent the in-leakage of air, dust, soot and rain.

Distribution—There are 80 licensees in the principal cities of the country. All carry complete stocks.

Service—A contract with an authorized licensee places the responsibility entirely with the Company to deliver a practical and successful job.

Installation—The greatest care is exercised in the selection of men to be Monarch mechanics. Every mechanic is trained under an instructor in the installation of Monarch Metal Weather Strips before he is permitted to do work on his own responsibility.

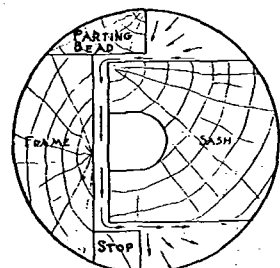
Cost—The first cost of Monarch Metal Weather Strips is the final cost. This is done by strict adherence to our four fundamentals: (1) MACHINE MADE FIT of co-operating members; (2) Self Adjustment to varying window conditions; (3) Co-operation of treatments; (4) Careful analysis of non-rusting metals. Monarch equipments when considered as to function and utility, are, as all good things, extraordinarily low in cost over a period of years.



Comparison of fuel quantities and costs to heat air entering various sliding sash windows, as air infiltration or in-leakage. Assuming 65% overall efficiency of heating plant.

Window,	3' x 7' Crack 23 lin. feet
Wind,	20 miles per hour
B.t.u. to raise 1 cu. ft. air from zero to 70°,	1,439
B.t.u. per lb. best coal,	13,080
Duration Heating Season (24 hr. per day),	130 days
Cost Coal,	\$6.00 per ton
Overall efficiency of heating plant,	65% (high)
Net B.t.u. — 13,080 x .65 = 8500 B.t.u. effective.	

Leakage—	114 cu. ft. per hr. per ft. crack
Unstripped window,	55.8 " " " " " "
Monarch Rib Strip, No. 404,	24 " " " " " "
Monarch Adjustable Strip, No. 400,	

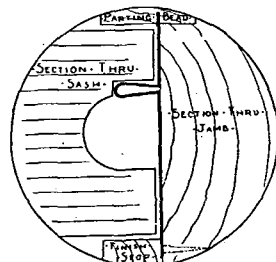


Unstripped Window "A"

$$\frac{23 \times 114 \times 1,439}{8500} = 0.445 \text{ sq. ft. coal per hour}$$

$$\frac{0.445 \times 24 \times 130}{2000} = \frac{1385}{2000} = .694 \text{ tons per season}$$

$$\$6.00 \times .694 = \$4.16 \text{ per season}$$

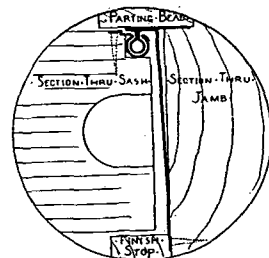


Monarch Rib Strip No. 404 "B"

$$\frac{23 \times 24 \times 1,439}{8500} = 0.0935 \text{ sq. ft. coal per hour}$$

$$\frac{0.0935 \times 24 \times 130}{2000} = \frac{0.292}{2000} = 0.146 \text{ tons per season}$$

$$\$6.00 \times 0.146 = \$0.875 \text{ per season}$$



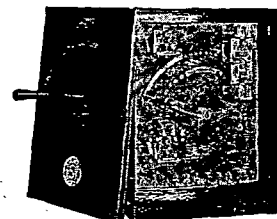
Monarch Adjustable Strip No. 400 "C"

Using the figures above, comparisons may be drawn between the old method of using air change and the new method of infiltration, that the air changes are dependent directly on the lineal footage of window cracks. For instance, a room having four windows would require four times as much radiation for air change as another room with a single window of the same size, irrespective of the cubical contents of the room. Heating specifications should provide, that the owner or architect guarantee the efficiency of the window to insure the satisfactory operation and low cost of a heating plant.

GENERAL ELECTRIC COMPANY

Schenectady New York

Sprague Ventilating Equipments

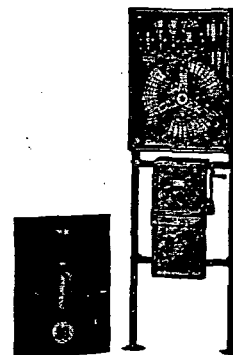
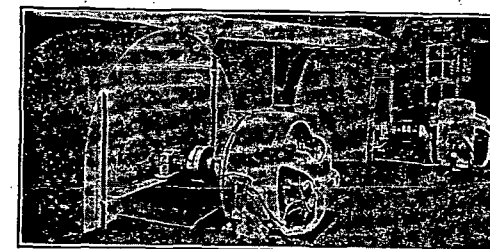


From the early efforts at ventilating large buildings twenty years ago to the present day, the Sprague Engineers have been co-operating with architects and engineers in the making of practical ventilating equipment. Resulting installations are now found in many well known hotels, office buildings and department stores, where they have distinguished themselves for exceptional reliability and economical operation.

Three typical pieces of modern Sprague equipment are illustrated below:

Sprague Electric controllers for varying speed A. C. fan motors with magnetic main line contractor, under-voltage and overload protection, large number of speed steps, and complete enclosure of live parts are the ideal equipment for architects and engineers to specify when the circuit is alternating current.

The Sprague type LC D. C. slow speed motor is especially adapted for driving ventilating fans. The steel field, laminated poles, commutating poles, substantial end-brackets, correct oiling systems, ideal electrical design, well built commutators, rigidly supported brush holders—these insure a long life, lowest possible current consumption and the smallest maintenance charges.



Sprague Electric remote controlled push button operated, automatic self-starting speed regulators (D. C. here illustrated) for either A. C. or D. C. motors are being used to an increasing extent. These controllers are simple in operation, with negligible up-keep expense, and control the motor, at any desired predetermined speed, from a remote point. They are destined to be adopted generally for all classes of work to supplement manually operated controllers as the standard for the future.

We shall be glad to co-operate with Architects and Engineers in laying out their Ventilating Equipments.

The Westinghouse Electric & Manufacturing Company

EAST PITTSBURGH, PA.

WESTINGHOUSE SALES OFFICES

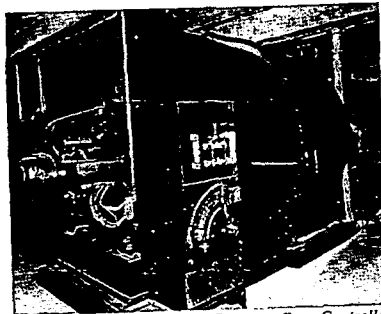
Albany, N. Y.
Atlanta, Ga.
Bakersfield, Cal.
Baltimore, Md.
Birmingham, Ala.
Bluefield, W. Va.
Boston, Mass.
Bridgeport, Conn.
Buffalo, N. Y.
Burlington, Ia.
Butte, Mont.
Canton, O.
Cedar Rapids, Ia.
Charleston, W. Va.
Charlotte, N. C.
Chattanooga, Tenn.
Chicago, Ill.
Cincinnati, O.
Cleveland, O.
Columbus, O.

Dallas, Tex.
Dayton, O.
Denver, Colo.
Des Moines, Ia.
Detroit, Mich.
Duluth, Minn.
Elmira, N. Y.
Fort Wayne, Ind.
Fresno, Cal.
Hammond, Ind.
Hartford, Conn.
Houston, Tex.
Huntington, W. Va.
Indianapolis, Ind.
Jackson, Mich.
Jacksonville, Fla.
Kansas City, Mo.
Little Rock, Ark.
Louisville, Ky.

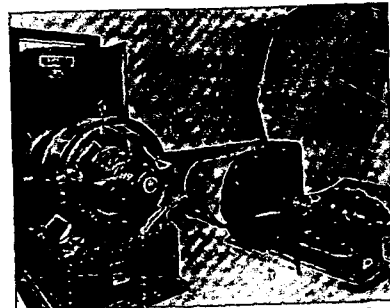
Los Angeles, Cal.
Memphis, Tenn.
Middlesboro, Ky.
Milwaukee, Wis.
Minneapolis, Minn.
Newark, N. J.
New Haven, Conn.
New Orleans, La.
New York, N. Y.
Niagara Falls, N. Y.
Omaha, Neb.
Philadelphia, Pa.
Pittsburgh, Pa.
Portland, Ore.
Raleigh, N. C.
Richmond, Va.
Rochester, N. Y.
Rock Island, Ill.
St. Louis, Mo.
Salt Lake City, Utah

San Antonio, Tex.
Seattle, Wash.
Spokane, Wash.
Springfield, Ill.
Springfield, Mass.
Syracuse, N. Y.
Tacoma, Wash.
Toledo, O.
Tucson, Ariz.
Tulsa, Okla.
Utica, N. Y.
Washington, D. C.
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.

Size	STANDARD PIPE										EXTRA STRONG PIPE				
	1	3	5	10	15	25	35	50	75	100	125	150	175	200	200 Sizes
1/4" Flow	255	286	315	388	461	604	745	953	1,295	1,632	1,965	2,304	2,636	2,962	1,772 2,028 2,278 1/2
Drop	1,337	1,746	2,093	2,552	2,790	3,656	4,515	5,775	7,545	9,88	11,87	13,96	15,96	17,92	17,72 20,28 22,78 3/4
3/4" Flow	448	501	553	681	808	1,058	1,305	1,669	2,271	2,860	3,445	4,038	4,621	5,190	3,282 3,753 4,216 1
Drop	906	1,014	1,118	1,380	1,636	2,140	2,640	3,377	4,600	5,780	6,962	8,180	9,375	10,50	10,11 11,54 12,99 1 1/4
1" Flow	726	812	896	1,103	1,310	1,715	2,115	2,705	3,681	4,636	5,588	6,548	7,490	8,419	5,450 6,236 7,050 1 1/2
Drop	597	668	736	910	1,079	1,410	1,740	2,222	3,028	3,803	4,595	5,400	6,172	6,940	6,355 7,273 8,268 2
1 1/4" Flow	1,256	1,406	1,552	1,912	2,270	2,968	3,662	4,683	6,372	8,030	9,570	11,32	12,97	14,56	9,720 11,25 12,48 2 1/2
Drop	369	414	457	564	668	875	1,076	1,379	1,873	2,363	2,842	3,333	3,825	4,279	3,826 4,470 4,900 3
1 1/2" Flow	1,711	1,914	2,111	2,604	3,086	4,042	4,986	6,380	8,270	10,93	13,17	15,42	17,65	19,83	13,38 15,31 17,21 3 1/2
Drop	284	318	351	434	512	671	828	1,081	1,440	1,817	2,187	2,567	2,958	3,295	2,895 3,322 3,715 4
2" Flow	2,818	3,152	3,480	4,290	5,085	6,660	8,215	10,51	14,29	18,01	21,68	25,42	29,08	32,67	22,38 25,60 28,77 5
Drop	187	211	232	286	338	444	548	697	950	1,198	1,442	1,694	1,938	2,173	1,883 2,135 2,418 6
2 1/4" Flow	4,012	4,501	4,968	6,122	7,260	9,515	11,73	15,00	20,41	25,70	30,95	36,27	41,55	46,65	32,23 36,75 41,28 7
Drop	140	158	174	215	254	334	411	525	714	889	1,082	1,272	1,457	1,637	1,410 1,605 1,790 8
3" Flow	6,211	6,945	7,665	9,455	11,21	14,68	18,10	23,14	31,48	39,67	47,80	56,00	64,15	71,95	50,00 57,25 64,33 9
Drop	399	454	509	623	737	951	1,165	1,479	1,908	2,337	2,766	3,195	3,624	4,053	3,861 4,290 4,719 10
4" Flow	10,69	11,96	13,20	16,27	19,30	25,27	31,17	39,87	54,25	68,30	82,30	96,45	110,3	124,0	87,15 99,70 112,0 11
Drop	66	74	82	101	120	157	194	248	338	424	512	600	687	771	649 743 820 12
5" Flow	16,83	18,82	20,75	25,38	30,33	39,73	49,00	62,70	85,35	107,3	129,5	151,6	173,5	195,0	137,7 157,7 177,1 13
Drop	404	454	509	623	737	951	1,165	1,479	1,908	2,337	2,766	3,195	3,624	4,053	404 454 509 14
6" Flow	24,27	27,16	29,96	36,94	43,80	57,35	70,75	90,50	123,2	155,1	186,8	218,0	250,5	281,5	197,5 226,1 253,8 15
Drop	637	724	812	1,006	1,194	1,581	1,968	2,554	3,341	4,128	4,915	5,702	6,489	7,276	561 648 735 16
7" Flow	42,95	48,08	53,03	65,38	77,50	101,5	125,2	160,2	217,8	274,4	330,7	387,3	443,3	498,0	346,0 395,7 444,8 17
Drop	1025	1168	1311	1604	1897	2480	2973	3806	4939	6072	7205	8338	9471	10604	7247 8282 9317 18
8" Flow	67,80	75,85	83,70	103,2	122,4	160,2	197,7	252,8	343,8	433,0	522,0	611,8	699,0	785,5	565,5 646,8 726,8 19
Drop	1019	1162	1305	1598	1891	2474	2967	3800	4933	6066	7199	8332	9465	10598	7247 8282 9317 20
9" Flow	96,50	107,9	119,1	146,8	174,2	228,0	281,2	359,5	489,2	618,9	748,6	878,3	1,008	1,137	821,5 940,5 1059,5 21
Drop	1015	1158	1301	1594	1887	2470	2963	3796	4929	6062	7195	8328	9461	10594	7247 8282 9317 22

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.

GAUGE PRESSURE IN POUNDS PER SQUARE INCH																	
STANDARD PIPE															EXTRA STRONG PIPE		
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	2364	2704	3038 1/2
Drop	2733	3100	3384	4180	4955	6500	8030	1025	1393	1734	2122	2482	2842	3185	3152	3600	4055 3/4
3/4 Flow	597	668	737	908	1077	1411	1740	2225	3029	3814	4593	5382	6160	6920	4272	5005	5621 1
Drop	1610	1803	1990	2452	2900	3805	4700	6000	8190	1029	1237	1453	1666	1868	1792	2053	2321 1/2
1 Flow	968	1083	1195	1473	1746	2287	2821	3608	4908	6182	7443	8730	9990	1122	7260	8310	9340 1
Drop	1061	1190	1310	1616	1913	2492	3090	3956	5385	6775	8165	9585	1099	1231	7260	8310	9340 1
1 1/2 Flow	1675	1873	2065	2548	3023	3958	4882	6241	8490	1070	1288	1511	1728	1942	1128	1292	1450 1 1/2
Drop	657	734	811	1000	1185	1555	1915	2448	3330	4190	5045	5938	6796	7617	6792	7730	8730 1 1/2
1 1/2 Flow	2281	2551	2816	3471	4113	5388	6650	8500	1157	1457	1756	2056	2353	2644	1785	2043	2295 1 1/2
Drop	505	566	624	770	910	1194	1472	1883	2564	3222	3889	4555	5222	5860	5150	5900	6610 1 1/2
2 Flow	3760	4208	4641	5721	6782	8880	1096	1402	1906	2402	2892	3390	3880	4358	2983	3413	3835 2
Drop	334	376	412	509	602	788	976	1243	1690	2160	2562	3110	3448	3865	3345	3890	4295 2
2 1/2 Flow	5365	6000	6621	8165	9680	1268	1564	2000	2720	3426	4128	4836	5535	6219	4280	4895	5500 2 1/2
Drop	250	280	309	382	452	592	731	933	1270	1598	1926	2260	2585	2902	2488	2850	3192 2 1/2
3 Flow	8280	9260	1022	1260	1493	1957	2413	3085	4200	5288	6370	7462	8545	9590	6670	7635	8585 3
Drop	177	199	220	272	322	421	520	664	905	1138	1370	1610	1840	2063	1754	2010	2260 3
4 Flow	1426	1596	1761	2170	2573	3370	4158	5315	7233	9110	1098	1286	1472	1653	1161	1328	1492 4
Drop	118	133	146	181	214	279	345	441	600	755	911	1068	1235	1370	1150	1318	1455 4
5 Flow	2243	2508	2768	3412	4045	5296	6532	8360	1137	1432	1724	2022	2313	2599	1837	2103	2363 5
Drop	1085	1206	1330	1630	1930	2520	3110	4000	5300	6600	7900	9200	10500	11800	825	945	1060 5
6 Flow	3236	3622	3995	4925	5838	7648	9430	1207	1642	2067	2490	2918	3340	3751	2633	3013	3384 6
Drop	1066	1204	1330	1630	1930	2520	3110	4000	5300	6600	7900	9200	10500	11800	825	945	1060 6
8 Flow	5730	6410	7072	8715	1034	1354	1669	2136	2910	3659	4408	5165	5910	6640	4612	5280	5933 8
Drop	1045	1181	1310	1616	1913	2492	3090	3956	5385	6775	8165	9585	1099	1231	7260	8310	9340 8
10 Flow	9040	1011	1116	1376	1631	2136	2634	3368	4385	5772	6950	8150	9328	1048	7542	8630	9690 10
Drop	1045	1181	1310	1616	1913	2492	3090	3956	5385	6775	8165	9585	1099	1231	7260	8310	9340 10
12 Flow	1286	1438	1588	1957	2320	3039	3746	4793	6250	8215	9890	1159	1327	1490	1093	1253	1407 12
Drop	.027	.031	.034	.042	.049	.064	.079	.101	.137	.172	.208	.244	.280	.313	.253	.289	.324

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, 5000 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	426	476	525	643	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	5,303	6,545	7,745	11,26	12,53	16,00	21,77	27,38	33,00	38,75	44,38	49,72	49,25	56,40	63,30
3/4 Flow	746	835	922	1,136	1,347	1,764	2,176	2,783	3,763	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	7,728	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	2,585	3,185	3,778	4,943	6,100	7,808	10,61	13,37	16,11	18,88	21,61	24,28	16,20	18,54	20,82 1 1/4
Drop	2,026	2,148	2,268	2,864	3,454	4,544	5,634	7,124	9,214	11,304	13,394	15,484	17,574	19,664	10,62	12,15	13,64
1 1/2 Flow	2,832	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 1 1/2
Drop	4,698	5,255	5,800	7,148	8,45	11,10	13,69	17,52	23,83	30,00	36,14	42,37	48,44	54,42	37,30	42,70	47,95 2
2 Flow	522	587	644	795	945	1,232	1,520	1,938	2,645	3,330	4,010	4,705	5,385	6,035	5,230	5,998	6,720
Drop	7,500	8,280	9,060	11,210	13,410	17,865	22,320	29,040	38,400	49,600	61,600	74,400	88,000	102,400	53,500	61,220	68,720 2
2 1/2 Flow	391	438	483	597	705	927	1,142	1,458	1,983	2,497	3,010	3,533	4,040	4,540	3,890	4,460	4,985
Drop	10,36	11,58	12,78	15,75	18,67	24,47	30,18	38,60	52,48	66,10	79,65	93,30	106,8	120,0	83,40	95,45	107,2 3
3 Flow	277	312	345	425	503	658	815	1,040	1,330	1,680	2,080	2,530	2,980	3,430	2,743	3,180	3,522
Drop	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	145,2	166,2	186,6 4
4 Flow	185	207	228	284	333	437	539	691	940	1,180	1,420	1,668	1,910	2,140	1,820	2,062	2,275
Drop	31,33	34,58	37,83	46,63	55,43	72,88	90,33	117,78	150,23	182,68	215,13	247,58	280,03	312,48	229,6	263,0	295,4 5
5 Flow	132	149	165	210	240	315	389	497	676	852	1,025	1,203	1,380	1,545	1,287	1,476	1,657
Drop	40,42	45,25	49,93	61,55	73,00	95,70	117,9	150,7	205,2	258,3	311,2	364,7	417,5	468,7	326,9	376,6	423,0 6
6 Flow	103	116	128	158	187	245	302	384	525	660	794	931	1,068	1,196	1,000	1,145	1,283
Drop	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	576,8	659,8	741,8 8
7 Flow	107	127	147	187	227	297	367	467	617	767	917	1,067	1,217	1,367	886	1,008	1,121 10
Drop	171,8	193,8	215,8	271,8	323,8	423,8	523,8	673,8	873,8	1,073,8	1,273,8	1,473,8	1,673,8	1,873,8	943,0	1,078	1,212 10
8 Flow	103	116	128	158	187	245	302	384	525	660	794	931	1,068	1,196	1,000	1,145	1,283
Drop	171,8	193,8	215,8	271,8	323,8	423,8	523,8	673,8	873,8	1,073,8	1,273,8	1,473,8	1,673,8	1,873,8	943,0	1,078	1,212 10
9 Flow	107	127	147	187	227	297	367	467	617	767	917	1,067	1,217	1,367	886	1,008	1,121 10
Drop	171,8	193,8	215,8	271,8	323,8	423,8	523,8	673,8	873,8	1,073,8	1,273,8	1,473,8	1,673,8	1,873,8	943,0	1,078	1,212 10
10 Flow	103	116	128	158	187	245	302	384	525	660	794	931	1,068	1,196	1,000	1,145	1,283
Drop	171,8	193,8	215,8	271,8	323,8	423,8	523,8	673,8	873,8	1,073,8	1,273,8	1,473,8	1,673,8	1,873,8	943,0	1,078	1,212 10
11 Flow	107	127	147	187	227	297	367	467	617	767	917	1,067	1,217	1,367	886	1,008	1,121 10
Drop	171,8	193,8	215,8	271,8	323,8	423,8	523,8	673,8	873,8	1,073,8	1,273,8	1,473,8	1,673,8	1,873,8	943,0	1,078	1,212 10
12 Flow	103	116	128	158	187	245	302	384	525	660	794	931	1,068	1,196	1,000	1,145	1,283
Drop	171,8	193,8	215,8	271,8	323,8	423,8	523,8	673,8	873,8	1,073,8	1,273,8	1,473,8	1,673,8	1,873,8	943,0	1,078	1,212 10
13 Flow	107	127	147	187	227	297	367	467	617	767	917	1,067	1,217	1,367	886	1,008	1,121 10
Drop	171,8	193,8	215,8	271,8	323,8	423,8	523,8	673,8	873,8	1,073,8	1,273,8	1,473,8	1,673,8	1,873,8	943,0	1,078	1,212 10
14 Flow	103	116	128	158	187	245	302	384	525	660	794	931	1,068	1,196	1,000	1,145	1,283
Drop	171,8	193,8	215,8	271,8	323,8	423,8	523,8	673,8	873,8	1,073,8	1,273,8	1,473,8	1,673,8	1,873,8	943,0	1,078	1,212 10
15 Flow	107	127	147	187	227	297	367	467	617	767	917	1,067	1,217	1,367	886	1,008	1,121 10
Drop	171,8	193,8	215,8	271,8	323,8	423,8	523,8	673,8	873,8	1,073,8	1,273,8	1,473,8	1,673,8	1,873,8	943,0	1,078	1,212 10
16 Flow	103	116	128	158	187	245	302	384	525	660	794	931	1,068	1,196	1,000	1,145	1,283
Drop	171,8	193,8	215,8	271,8	323,8	423,8	523,8	673,8	873,8	1,073,8	1,273,8	1,473,8	1,673,8	1,873,8	943,0	1,078	1,212 10
17 Flow	107	127	147	187	227	297	367	467	617	767	917	1,067	1,217	1,367	886	1,008	1,121 10
Drop	171,8	193,8	215,8	271,8	323,8	423,8	523,8	673,8	873,8	1,073,8	1,273,8	1,473,8	1,673,8	1,873,8	943,0	1,078	1,212 10
18 Flow	103	116	128	158	187	245	302	384	525	660	794	931	1,068	1,196	1,000	1,145	1,283
Drop	171,8	193,8	215,8	271,8	323,8	423,8	523,8	673,8	873,8	1,073,8	1,273,8	1,473,8	1,673,8	1,873,8	943,0	1,078	1,212 10
19 Flow	107	127	147	187	227	297	367	467	617	767	917	1,067	1,217	1,367	886	1,008	1,121 10
Drop	171,8	193,8	215,8	271,8	323,8	423,8	523,8	673,8	873,8	1,073,8	1,273,8	1,473,8	1,673,8	1,873,8	943,0	1,078	1,212 10
20 Flow	103	116	128	158	187	245	302	384	525	660	794	931	1,068	1,196	1,000	1,145	1,283
Drop	171,8	193,8	215,8	271,8	323,8	423,8	523,8	673,8	873,8	1,073,8	1,273,8	1,473,8	1,673,8	1,873,8	943,0	1,078	1,212 10
21 Flow	107	127	147	187	227	297	367	467	617	767	917	1,067	1,217	1,367	886	1,008	1,121 10
Drop	171,8	193,8	215,8	271,8	323,8	423,8	523,8	673,8	873,8	1,073,8	1,273,8	1,473,8	1,673,8	1,873,8	943,0	1,078	1,212 10
22 Flow	103	116	128	158	187	245	302	384	525	660	794	931	1,068	1,196	1,000	1,145	1,283
Drop	171,8	193,8	215,8	271,8	323,8	423,8	523,8	673,8	873,8	1,073,8	1,273,8	1,473,8	1,673,8	1,873,8	943,0	1,078	1,212 10
23 Flow	107	127	147	187	227	297	367	467	617	767	917	1,067	1,217	1,367	886	1,008	1,121 10
Drop	171,8	193,8	215,8	271,8	323,8	423,8	523,8	673,8	873,8	1,073,8	1,273,8	1,473,8	1,673,8	1,873,8	943,0	1,078	1,212 10
24 Flow	103	116	128	158	187	245	302	384	525	660	794	931	1,068	1,196	1,000	1,145	1,283
Drop	171,8	193,8	215,8	271,8	323,8	423,8	523,8	673,8	873,8	1,073,8	1,273,8	1,473,8	1,673,8	1,873,8	943,0	1,078	1,212 10
25 Flow	107	127	147	187	227	297	367	467	617	767	917	1,067	1,217	1,367	886	1,008	1,121 10
Drop	171,8	193,8	215,8	271,8	323,8	423,8	523,8	673,8	873,8	1,073,8	1,273,8	1,473,8	1,673,8	1,873,8	943,0	1,078	1,212 10
26 Flow	103	116	128	158	187	245	302	384	525	660	794	931	1,068	1,196	1,000	1,145	1,283
Drop	171,8	193,8	215,8	271,8	323,8	423,8	523,8	673,8	873,8	1,073,8	1,273,8	1,473,8	1,673,8	1,873,8	943,0	1,078	1,212 10
27 Flow	107	127	147	187	227	297	367	467	617	767	917	1,067	1,217	1,367	886	1,008	1,121 10
Drop	171,8	193,8	215,8	271,8	323,8	423,8	523,8	673,8	873,8	1,073,8	1,273,8	1,473,8	1,673,8	1,873,8	943,0	1,078	1,212 10
28 Flow	103	116	128	158	187	245	302	384	525	660	794	931	1,068	1,196	1,000	1,145	1,283
Drop	171,8	193,8	215,8	271,8	323,8	423,8	523,8	673,8	873,8	1,073,8	1,273,8	1,473,8	1,673,8	1,873,8	943,0	1,078	1,212 10
29 Flow	107	127	147	187	227	297	367	467	617	767	917	1,067	1,217	1,367	886	1,008	1,121 10
Drop	171,8	193,8	215,8	271,8	323,8	423,8	523,8	673,8	873,8	1,073,8	1,273,8	1,473,8	1,673,8	1,873,8	943,0	1,078	1,212 10
30 Flow	103	116	128	158	187	245	302	384	525	660	794	931	1,068	1,196	1,000	1,145	1,283
Drop	171,8																

Buffalo Steam Pump Co.

Buffalo, N. Y.

BRANCH OFFICES

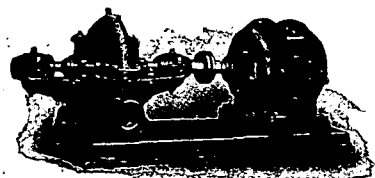
NEW YORK, N. Y., 39-41 Cortlandt St.
 PHILADELPHIA, PA., 1303 Land Title Bldg.
 BOSTON, MASS., 177 State St.
 CLEVELAND, O., 368 Rockefeller Bldg.
 PITTSBURGH, PA., 917 Union Arcade
 DETROIT, MICH., Coon De-Visser Co.
 CHICAGO, ILL., 562 W. Washington Blvd.
 WASHINGTON D. C., Washington Loan & Trust Bldg.
 ATLANTA, GA., Candler Bldg.
 INDIANAPOLIS, IND., 1016 Fletcher Saving & Trust Bldg.

ST. LOUIS, MO., 515 Chemical Bldg.
 CINCINNATI, O., 607 Mercantile Library Bldg.
 MINNEAPOLIS, MINN., 120 South Ninth St.
 DENVER, COLO., 1718 California St.
 LOS ANGELES, CALIF., 636 H. W. Hellman Bldg.
 CHARLOTTE, N. C., J. W. Fraser & Co.
 NEW ORLEANS, LA., Woodward Wight & Co.
 KANSAS CITY, MO., J. F. Pritchard & Co.
 SAN FRANCISCO, CALIF., 216 Pine St.
 PORTLAND ORE., 816-817 Lewis Bldg.

Canadian Blower & Forge Co., KITCHENER, ONT.

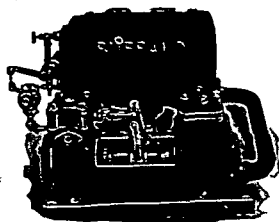
Products

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

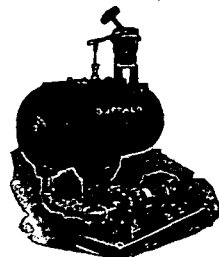
Horizontally divided casing. Extensively used with air washers, and for circulating systems and booster service.



Duplex Steam Pump and Receiver

Entirely automatic. Can be furnished for high or low boiler pressure.

COMPLETE CATALOGS WILL BE FURNISHED UPON REQUEST



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.

The Nash Engineering Company

South Norwalk, Conn., U. S. A.

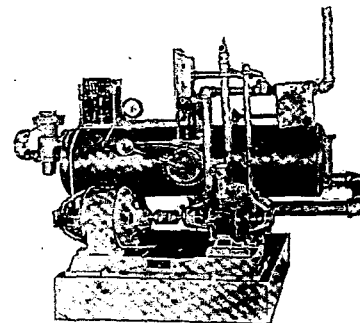
INDIANAPOLIS—821 Hume-Mansur Bldg.
 KANSAS CITY—208 Mutual Bank Bldg.
 LOS ANGELES—1824 S. Hope St.
 MINNEAPOLIS—501 S. Sixth Street
 MONTEAL—84 Inspector Street
 NEW ORLEANS—521 Baronne Street
 NEW YORK—350 Madison Ave.
 PHILADELPHIA—254 South 15th Street
 PORTLAND—224 Pine Street
 BOSTON—Nottingham 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 Dooly Bldg.
 SAN FRANCISCO—Sharon Bldg.
 SEATTLE—220 Railway Exchange
 ST. LOUIS—4200 Forest Park Blvd.
 TOLEDO—136 Huron Street
 TORONTO—1001 Kent Bldg.

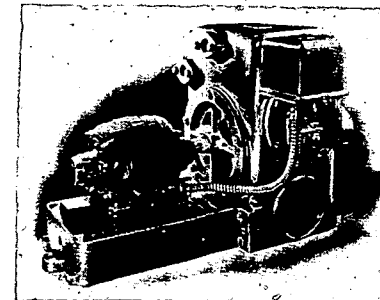
WASHINGTON—710 14th Street, N. W.



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

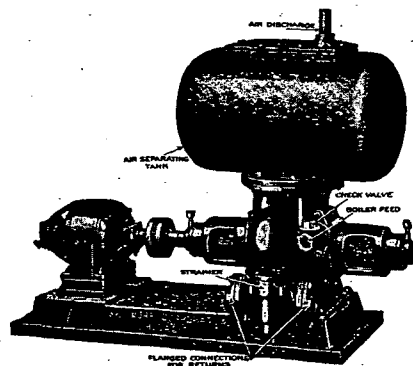
Size	Square Feet direct equivalent radiation surface	Air Capacity cubic feet per min.	Water Capacity gals. per min. 10 lbs. pres. 180° F.	Actual Horse Power	R. P. M.	Horse Power of Motor
M	5,000	3	8	.6	1700	3/4
A	8,000	6	11	.9	1800	1
B	16,000	11	22	1.4	1800	1 1/2
C	26,000	19	35	2.0	1800	2
D	40,000	25	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 St.

CHICAGO, U. S. A.



SKIDMORE HYDRO TURBINE VACUUM AND BOILER FEED PUMP

A new simple and efficient device for use on a vacuum heating system.

As there are no close clearances, this pump will maintain its original high efficiency indefinitely.

A self-contained unit all on one base with return connections close to floor.

A strainer arranged so that connections can be made to one or both sides as desired.

Shaft is Tobin bronze carried on heavy ball bearings.

Air rotor and centrifugal pump are cast bronze accurately machined.

Base, casing, bearing brackets and tank are close grained cast iron.

A unit of pleasing design of large capacity occupying less than half the floor space of pumps for similar service.

TABLE OF CAPACITIES
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 return openings	Size of discharge to boiler	Approx. floor space	Shipping weight lb.
1	8000	11	1	1 1/2	1 1/4"	1 1/4"	22"x50"	650
2	16000	22	1 1/2	2	1 1/2"	1 1/4"	24"x52"	700
3	26000	35	2	3	2"	1 1/4"	24"x56"	750
4	40000	60	3	5	2 1/2"	1 1/2"	24"x58"	850
5	65000	90	5	7 1/2	3"	2"	30"x62"	1025

R. P. M. 1,800 for all sizes.

Above weights are for continuous service, add 75 lb. for automatic control.

PUMP DIVISION

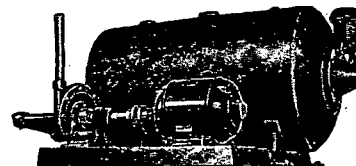
The Trane Company

La Crosse, Wis.

New York, Boston, Cleveland, Buffalo, Salt Lake City, Philadelphia, Detroit, Washington, D. C., Portland, Ore., Seattle, Knoxville, Greensboro, N. C.

The Trane System of Vapor Heating, Patented Heating Specialties
Trane Automatic Electric Pumps, For All Purposes

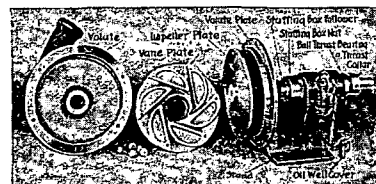
TRANE CONDENSATION PUMPS



This Style Unit, with Steel Tank, Furnished for 6,000-50,000 sq. ft. of Radiation

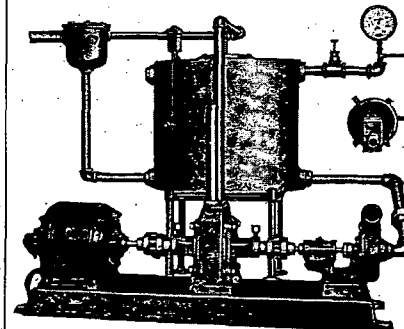
The Trane Company specializes in pumping equipment required for the mechanical equipment of buildings. A complete line of condensation, vacuum, circulating, booster, and water pumps is carried, suitable for any conditions which may ordinarily be encountered. Literature, prices, and full information for any requirements will gladly be submitted.

Standard centrifugal type condensation units are furnished as illustrated, handling from 6 g.p.m. at 10 lbs. pressure with 1/4 hp. motor, to 60 g.p.m. at 60 lbs. with 5 hp. Special sizes promptly made to order.



Parts of Standard Trane Single Stage Centrifugal Pump

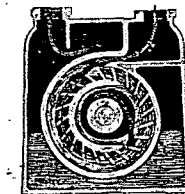
AIR LINE—RETURN LINE VACUUM PUMPS



Standard Trane vacuum units are available in all popular sizes, as illustrated.

The Trane vacuum pump embodies all desirable features of other pumps, and in addition has an operating efficiency that places it distinctly in a class by itself. As shown in the illustration below, there is but one moving part, and reciprocating action has been entirely eliminated.

The two-unit type, i.e., with two motors, one for the air pump and one for the water pump, and having individual control, can be furnished where required.



The Air Follows The Arrow

Fowler & Wolfe Mfg. Co.

Bulletin Building

Philadelphia, Pa.

FOWLER & WOLFE, WALL RADIATORS

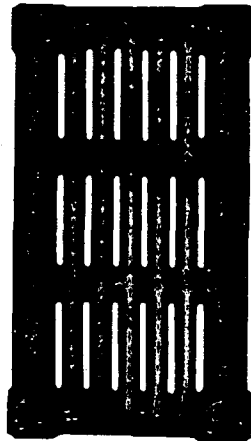
Made in six sizes—

10 sq. ft. section;	24" x 13 $\frac{1}{4}$ " x 3- $\frac{5}{8}$ "
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"

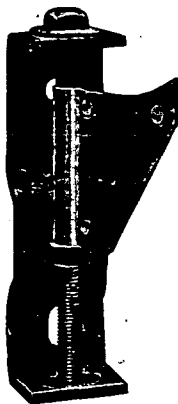
All made in vertical and horizontal forms; 9 sq. ft. and smaller sizes in plain or Ornamental patterns; 10 sq. ft. Plain only.

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.



Side-Wall Radiator



No. 33 Hanger

No. 33 Wrought Iron Adjustable Hanger—For radiators of vertical sections only.

Expansion and contraction of radiator is provided for by swaying of hook upon supporting bolt. Provides vertical adjustment of 1 in. before or after mounting the radiator, by turning easily operated hex. head of bolt, which, when radiator is in correct position, is practically concealed. Hook has lateral adjustment of $\frac{1}{8}$ in.

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 *F* fully illustrates and describes our Wall Radiators; also an extensive variety of Hangers and Supports, adjustable and non-adjustable, to meet practically any requirement.

A. F. Gleockle, Jr.

415 Bay Street, ROCHESTER, N. Y.

Sales Representatives in Principal Cities

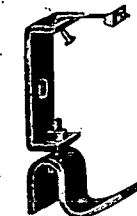
GLEOCKLE Wrought Iron Adjustable WALL and Column Radiator Brackets
(Patented March 23, 1920)

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—serviceable and durable. Several styles, and their application are shown.



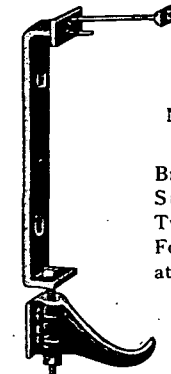
No. 1 Gleockle

Wall Radiator Bracket Supports 7' and 9' Vertical Wall Radiators.



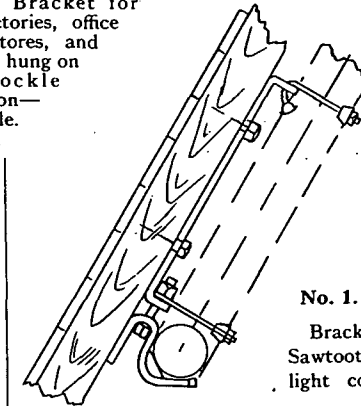
No. 2. Gleockle

Wall Radiator Bracket. Supports 5', 7' or 9' Horizontal or 5' Vertical Wall Radiators.



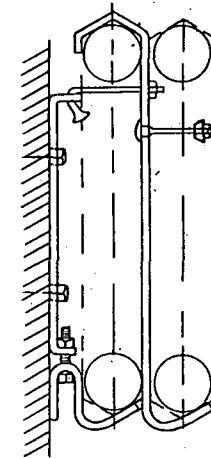
No. 9. Gleockle

Column Radiator Bracket. Made to Support Single Two, Three and Four Column Radiators.



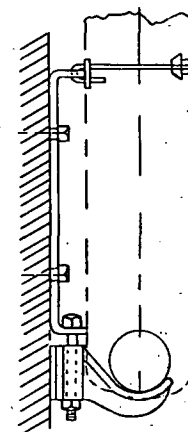
No. 1. Gleockle

Brackets used on Sawtooth or Skylight construction.



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

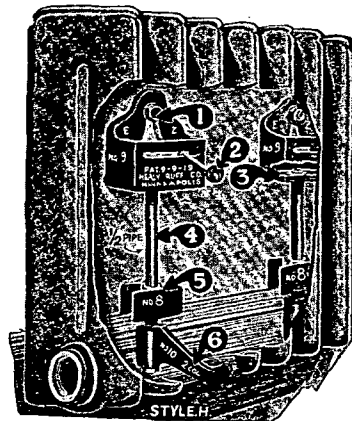
Atlanta, Ga., Pittsburgh, Pa., Indianapolis, Ind., Seattle, Wash., New York City, Denver Colo., Des Moines, Ia., Detroit, Mich., Amsterdam, N. Y., Chicago, Ill., Cincinnati, O., Toledo, O., El Paso, Tex., St. Louis, Mo., Birmingham, Ala., Kansas City, Mo., Omaha, Neb., Wichita, Kan., Knoxville, Tenn., Milwaukee, Wis., Buffalo, N. Y., Davenport, Ia., Philadelphia, Pa., Boston, Mass., Cleveland, O., Columbus, O., Salt Lake City, Utah, Los Angeles, Cal., Baltimore, Md., Washington, D. C., Tulsa, Okla.

CANADA

Toronto, Vancouver, Halifax, Montreal, Winnipeg, Ottawa, Calgary.

Manufacturers of E-Z Radiator Hangers

Write Dept. 19



1. One Bolt.
2. Invisible Washer.
3. Horizontal Adjustment.
4. Vertical Adjustment.
5. Adjustable for Baseboard.
6. Made for Wall and Column Radiation.

E-Z Radiator Hangers are suitable for Wall and all Column Radiation, are designed for Vertical and Horizontal alignment, and also designed to anticipate the use of temperature control valves.

Washer at top makes hanger absolutely invisible.

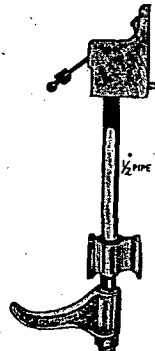
Style "H," shown above, places the radiator $2\frac{1}{2}$ " from the wall and provides for baseboard adjustment.

Style "R" places the radiator $1\frac{1}{2}$ " from the wall but is not adjustable for baseboards.

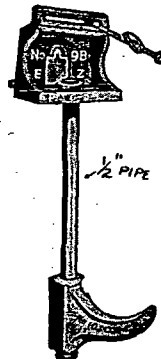
Typical Specifications

Where Baseboards are used.

All radiation, unless otherwise noted, shall be supported on wall by means of E-Z Radiator Hangers, Style "H," as manufactured by the Healy-Ruff Co., Minneapolis, Minn., or equal and approved in writing by the Architect arranged to support the radiator $2\frac{1}{2}$ " from the wall and with baseboard adjustment.



Style H



Style R

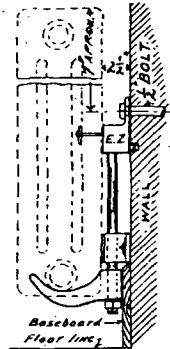


Diagram of Style H

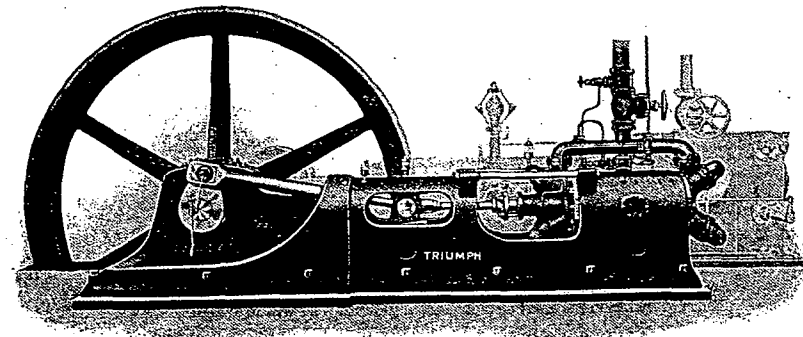
Where Baseboard Adjustment is not desired.

All radiation, unless otherwise noted, shall be supported on wall by means of E-Z Radiator Hangers, Style "R," as manufactured by the Healy-Ruff Co., Minneapolis, Minn., or equal and approved in writing by the Architect, arranged to support the radiator $1\frac{1}{2}$ " in. from the wall.

Pennsylvania Engineering Co.

Office and Works—1119-21 North Howard St.

Philadelphia, Pa.



Engine Driven Compressor

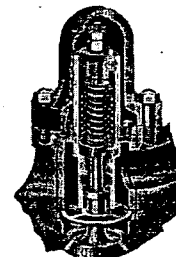
Engineers, manufacturers and builders of "The Famous Pennsylvania" Refrigerating and Ice-Making plants. Complete plans for refrigerating and ice making plants. All materials for such plants, especially Ammonia Fittings, which are carried in stock at all times.

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.

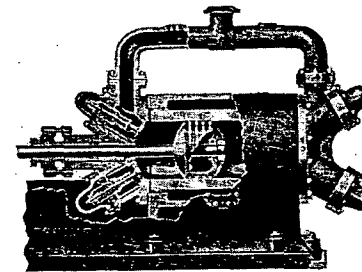
Every part of our machinery is of such generous proportions that we have never had a broken shaft, bed-plate, cylinder or bearing. All machinery which we furnish is guaranteed against defective material or workmanship, for a period of one year.

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.

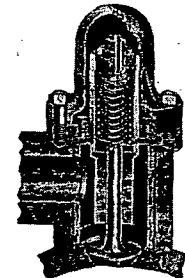
We will be glad to send upon request, an illustrated booklet showing many of our installations and containing detailed data upon design, construction, size and dimensions of our machines.



Suction Valve



Exterior of Cylinder



Discharge Valve

EXTERIOR OF CYLINDER

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.

THE DALZELL BROTHERS CO.

SHEET METAL SPECIALISTS

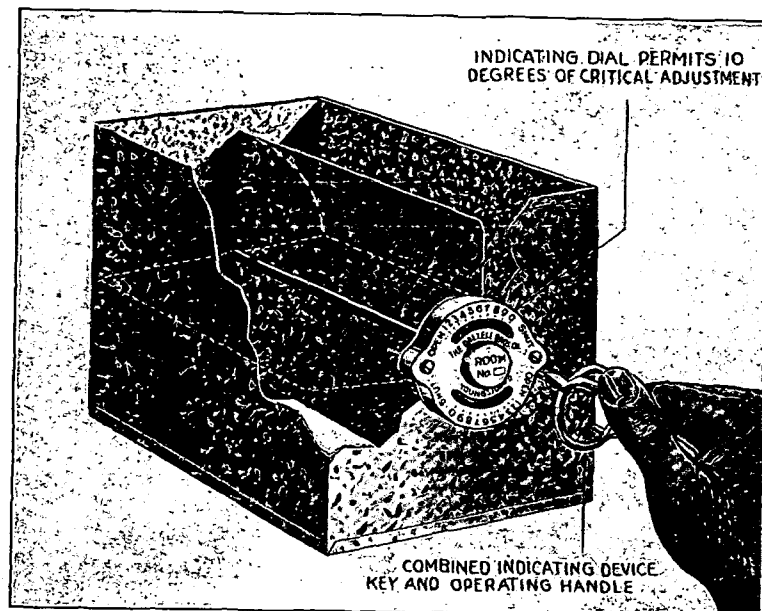
21 Holmes Street :: YOUNGSTOWN, OHIO

THE SURELOCK DAMPER REGULATOR 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 regulator is required to fit all sizes of pipe.

The SURELOCK Damper Regulator 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 H. G.



Carrier Construction Company

INCORPORATED

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.

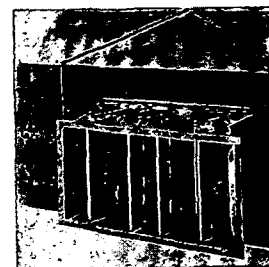
The Carrier Construction Co. is equipped with every facility for the fabrication and installation of sheet metal work, light machine work, acetylene and electrically welded work, pipe work, and special apparatus involving work of this general character.

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 Diffuser Outlet

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, 10 x 16 in., 16 x 24 in. and 24 x 36 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, 9 x 10 in., 10 x 15 in., 15 x 15 in., 15 x 21 in. and 15 x 27 in.

Prices upon request. Prompt delivery from stock.



Carrier Aertite Door

A. & P. Regulator Company

Park Ridge, Ill.

The A. & P. Automatic Hydraulic Vacuum Producer is an efficient device for removing air and maintaining a constant vacuum on steam heating systems in churches, schools, theatres, factories, apartments or residences. It is effective in producing more heat with less fuel on ordinary one or two-pipe and return line heating systems.

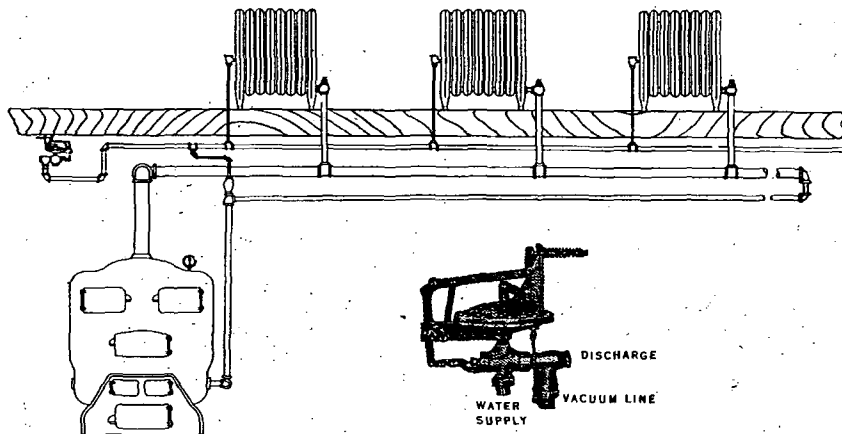
This vacuum producer operates by city water or house supply system carrying 20 lb. pressure or more, works automatically, is noiseless in operation, and eliminates noisy pipes and radiators and sputtering air valves.

The A. & P. Automatic Vacuum Producer completely shuts off the water supply when 3 to 5 in. of vacuum is established, and automatically operates when the vacuum drops. In operation, it requires about 3 gal. of water per min. and as its action is positive its operation is intermittent, the vacuum holding for several hours.

The illustration shows how the A. & P. Automatic Vacuum Producer is applied to a one pipe steam heating plant.

SPECIFICATIONS

Size of Pipe Connections	Max. Cap. With 20-lb. Water Pressure	Max. Cap. With 40-lb. Water Pressure	For Large Installations	Price
3/4 in.	2500 ft.	3500 ft.	Two or more units are used.	\$100.00



The use of the A. & P. Automatic Vacuum Producer is not confined entirely to heating. This specialty is adaptable to other lines of work where a vacuum must be maintained and can be arranged to operate with steam or air, as well as water, and designed for higher vacuum if so desired.

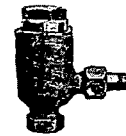
The Bishop & Babcock Co.

Cleveland, Ohio

BRANCHES IN ALL PRINCIPAL CITIES

THE B & B LINE

THE WORLD'S MOST COMPLETE LINE OF HEATING SPECIALTIES

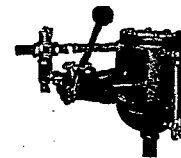


The B & B Multiplex Traps are used for draining radiators, drip and blast coils of air and condensation.

SCHEDULE OF MULTIPLEX TRAPS

Size	Capacity Vapor $\varnothing$	Capacity Vacuum $\varnothing$	Weight
1/2" No. 3	200	250	2 1/2
3/4" No. 3	500	600	3
1" No. 3	1,000	1,100	3 1/2

The B & B Automatic Receiver operates automatically, returning the water of condensation to the boiler at all times regardless of the pressure on the boiler, keeping the system free from air and preventing the loss of steam.



SCHEDULE OF ALTERNATING RECEIVERS

Size	Dimensions	Capacity $\varnothing$	Weight
No. 1	As illustrated	6,000	180
No. 2	20"x24"	10,000	270
No. 3	24"x30"	15,000	290
No. 4	24"x36"	18,000	325

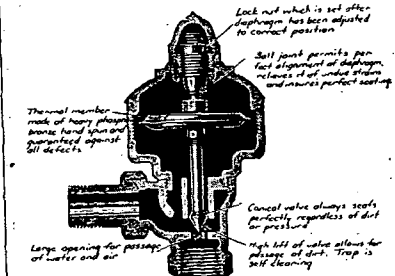
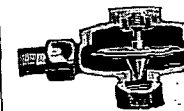


The B & B Multiplex Valve is packless, made of all metal furnished in wheel handle or lever handle any pattern.

SCHEDULE OF VALVES

Size	Capacity Vapor $\varnothing$	Capacity Vacuum $\varnothing$	Weight
1/2"	0 to 20	0 to 25	2
3/4"	21 to 60	26 to 75	2 1/2
1"	61 to 120	76 to 150	3
1 1/4"	121 to 200	151 to 300	6
1 1/2"	201 to 350	301 to 500	7
2"	351 to 450	501 to 650	10

The B & B Valve Traps are for use with vapor and Vacuum Systems for draining radiators, drip points and Blast Traps.



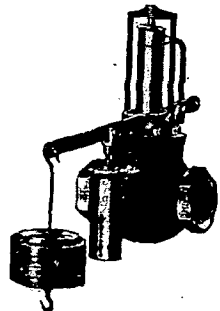
THE NEW IMPROVED THERMOGRADE AUTO VALVE

The new Auto Valve is factory adjusted, is so constructed that adjustments can be made at installation if necessary due to unusual conditions.

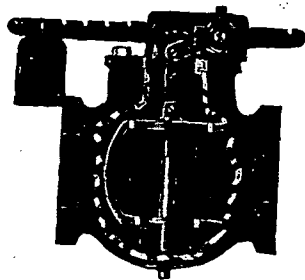
G. M. Davis Regulator Company

407 MILWAUKEE AVE., CHICAGO, ILL.

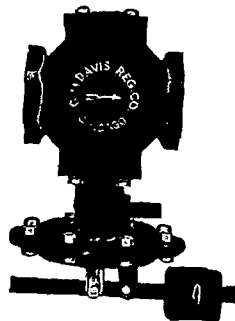
Since 1875 Manufacturers of, Better Valve Specialties



Davis Piston Type
Pressure Regulator
(Any service, pressure)



Davis Back Pressure Valve



Davis
Diaphragm
Type
Pressure
Regulator
(Low Service
Pressure)

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 $\frac{1}{2}$ to 14".

Davis Back Pressure Valve

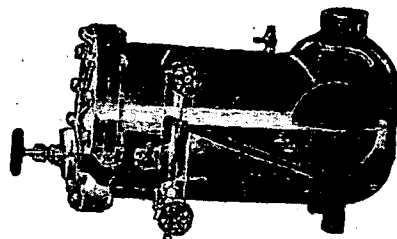
The Original semi-balanced exhaust line valve for maintaining a given back pressure. Has double seated piston disc—operates noiselessly—requires comparatively small counterweight, patented disc and seat construction prevents sticking. May be used horizontally or vertically. Sizes 2 to 30". Angle valves made to order.

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 $\frac{1}{2}$ to 3".

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.



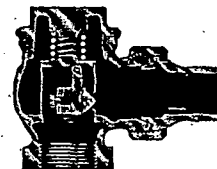
Davis Steam Trap

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 practical and theoretical experience of 37 years has developed the Donnelly Systems and the Donnelly Specialties.

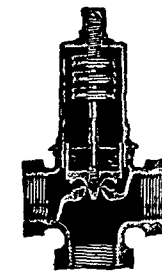
The general theory of design and control of the steam circulation in all Donnelly Systems is based upon the recognized principle that in small systems there are, for short runs and for a limited number of automatic return valve devices, no appreciable differences or losses in pressure. In other words, 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.



Thermo-Differential Valve

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.

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
160 Water Street

Distributors: Munsing & Co.
Paris, France
47 Rue Fontaine-au-roi

Manufacturers of Specialties for The Dunham Systems of Heating

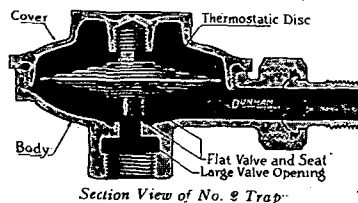


This Service is delivered through 60 Branch and Local Sales Offices throughout the United States and Canada, back of which organization are two modern and complete factories. Dunham Heating Service co-operates intimately with Consulting Engineers, Architects and Heating Contractors.

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.

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 Eliminator; Dunham Oil Separator; Dunham Suction Strainer; Dunham Air Vent; Dunham Damper Control.



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 large valve opening. 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.

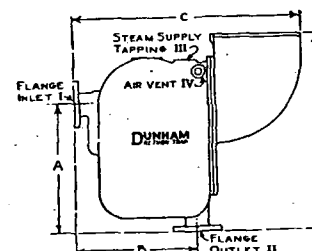
The working part of the Trap, the Thermostatic Disc, is fully exposed to the actual conditions within the radiator and it, therefore, responds instantly to any change taking place therein, preventing waste of unused steam.

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 without regard to the pressure carried in boiler or system. Not for use where steam pressures exceed 10 lb. gage.

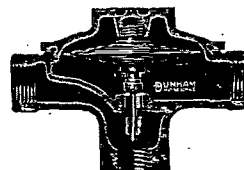


Size No.	Capacity, Sq. Ft.	Size Pipe Flange I, In.	Size Pipe Flange II, In.	Size Pipe Tapping III, In.	Size Pipe Tapping IV, In.	Dimensions, In.				Width Over All
						A	B	C	D	
10	3,500	1 1/2	1 1/2	1	1/2	14 1/2	14 1/2	25 3/4	21 1/4	9 3/8
11	6,000	2	2	1 1/2	3/4	16 3/4	15	28 3/4	26 1/4	17 1/2
12	12,000	3	3	2	3/4	16 3/4	22 3/4	36 3/4	26 1/4	18 3/4

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.

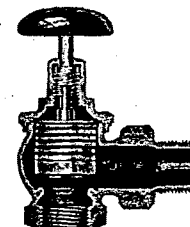
Designed for steam pressures higher than those used in heating systems. It handles air and condensate. Adapted for process work, hospital sterilizers and distilling apparatus, steam tables and kitchen equipment where a steam pressure of not less than 10 or more than 50 lb. is used.



Size	Pipe Connection, In.	Capacity, Water per Hour, Lb.
No. 13	1/2	100
No. 14	3/4	200
No. 15	1	400

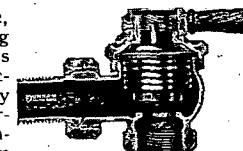
Always state operating pressure when ordering.

DUNHAM PACKLESS RADIATOR VALVE



Type 140—Wheel Handle

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 100—Lever Handle

Made in lever handle and wheel handle 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.



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

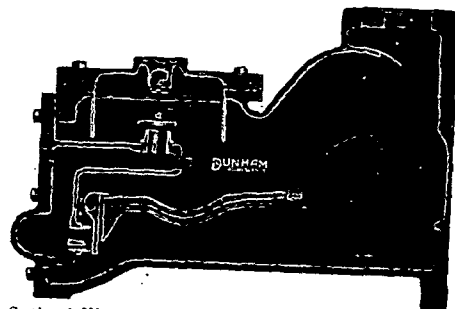
No. 4. Angle and Straightway

Tapping $\frac{3}{4}$ "; Capacity 1500 sq. ft. Rad.

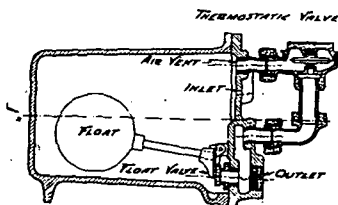
No. 5. Angle and Straightway

Tapping 1"; Capacity 3000 sq. ft. Rad.

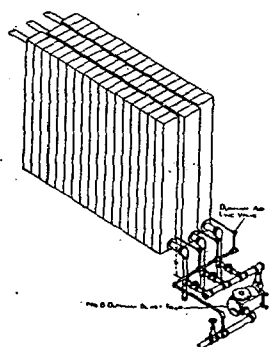
DUNHAM BLAST TRAP



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 No. 8 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 No. 8 and No. 16 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. 16	1	7,000
No. 16	$1\frac{1}{4}$	9,000
No. 16	$1\frac{1}{2}$	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

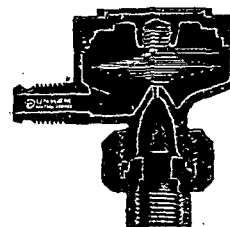
Made in all sizes from $2\frac{1}{2}$ to 6 in. Flanged connections.

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 $2\frac{1}{2}$ to 6 in., with flanged ends only.

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 adaptable in making old one-pipe heating systems more efficient. It is easily and economically installed, and insures the quick removal of air from the radiators.

The Dunham Home Heating System

This is specially for the home or small building. It uses steam at very low pressure, not over 8 oz. 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. 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.

Boston—New York—Philadelphia—Chicago—Minneapolis—Kansas City—Los Angeles
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 pressure throughout the whole range of pressure for which each valve is intended.

Air "bottled up" in a heating system has a very important relationship to the effectiveness of the system. By proper venting of air (including that released by condensation of steam) without steam loss, Hoffman valves greatly increase the thermal efficiency of the system.

Hoffman valves are automatic, non-adjustable and guaranteed to properly function for a period of five years from date of installation.

Hoffman Venting Valves for One-Pipe Gravity Systems

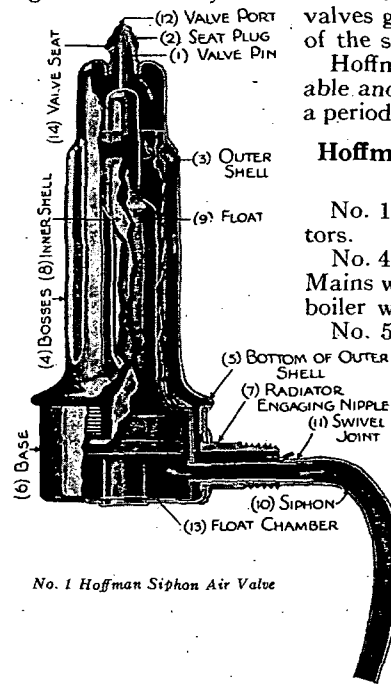
No. 1 Siphon Air Valve for venting Radiators.

No. 4 Quick Vent Valve for venting Return Mains where low point is at least 15 in. above boiler water line.

No. 5 Quick Vent Float Valve for venting Return Mains with low point less than 15 in. above water line or for conditions where valve may be required to prevent escape of water from pipe line.

No. 1 Hoffman Siphon Air Valve

The No. 1 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. Valve should not be used under pressure higher than 15 lb.



No. 1 Hoffman Siphon Air Valve

List Price—No. 1 Valve with $\frac{1}{8}$ -in. connection.....\$1.90

VENTING VALVES FOR ONE-PIPE GRAVITY SYSTEMS—(Continued)

NO. 4 HOFFMAN QUICK VENT VALVE

The No. 4 Hoffman quick vent valve is designed for use in venting risers or return mains where water will not come in contact with the valve. All air is freely vented through a $\frac{1}{8}$ -in. vent port without steam loss, but valve will not prevent escape of water. Limited to pressures not over 10 lb.

List Price—No. 4 Valve with $\frac{3}{4}$ -in. standard connection; also with $\frac{1}{4}$ -in. connection.....\$2.80

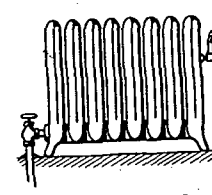
NO. 5 HOFFMAN QUICK VENT FLOAT AIR VALVE

The No. 5 Hoffman Quick Vent Float Air Valve is of the triple duty type, intended for venting return mains, indirect stacks and for use under all conditions where water is present in the system. It vents all air, closes tightly against steam and prevents escape of water through vent port. Installed on the end of return mains in one-pipe gravity systems, this valve causes steam to first flow to the end of the main, then into the radiators at a uniform rate so that radiators distant from the boiler will receive their supply of steam as quickly as those close to boiler.

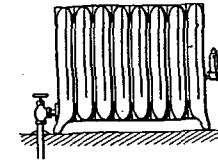
Furnished with $\frac{1}{8}$ -in. port for pressures below 3 lbs.; $\frac{1}{4}$ -in. port for 3 to 10 lb.

List Price—No. 5 Valve with $\frac{3}{8}$ -in. pipe connection.....\$8.00

SOME METHODS OF APPLICATION



No. 1 Valve on Steam Radiator in One-Pipe Gravity System.



No. 1 Valve on Radiators of Hot Water Type occasionally used in One-Pipe Steam Systems.

Fig. 1 shows correct application of Nos. 4 or 5 Valve for venting end of steam or return main.

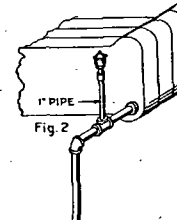


Fig. 2 shows correct application of Nos. 4 or 5 Valve for venting indirect radiator.

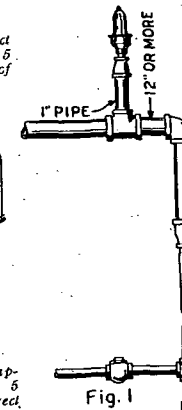


Fig. 1

Fig. 3 shows correct application of No. 5 Valve for venting False Water-line loop providing bypass for draining or cleaning.

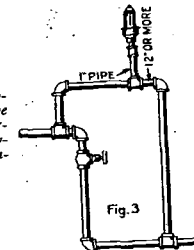


Fig. 3

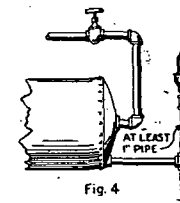
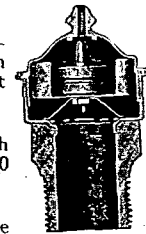
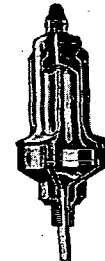


Fig. 4

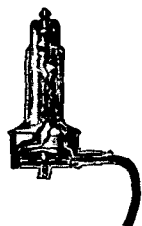
Fig. 4 shows correct application of Nos. 4 or 5 Hoffman Valve for venting steam coil in storage tank.



No. 4 Hoffman Quick Vent Valve



No. 5 Hoffman Quick Vent Float Air Valve.



No. 2 Hoffman
Siphon Air and
Vacuum Valve.

HOFFMAN VENTING VALVES FOR ONE-PIPE GRAVITY VACUUM SYSTEMS

No. 2 Siphon Air and Vacuum Valve for venting Radiators.

No. 6 Quick Vent Float Air and Vacuum Valve for venting Return Mains.

No. 2 Hoffman Siphon Air and Vacuum Valves

The No. 2 Siphon Air and Vacuum Valve is similar in construction to the No. 1, but in addition, when the radiator is once relieved of 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. Pressure limit, 10 lb.

List Price—No. 2 Valve with $\frac{1}{8}$ -in. connection.....\$4.50

No. 6 Hoffman Quick Vent Float Air and Vacuum Valve

The No. 6 Quick Vent Float Air and Vacuum Valve is like the No. 5 valve with the addition of a diaphragm in the base of the valve which holds the vent port closed when venting ceases and prevents intake of air through the valve port. The valve is used for venting return mains of small vapor-vacuum systems or wherever return of air to the system is not desirable.

Vent port for less than 3 lb. is $\frac{3}{8}$ -in.; for 3 to 10 lb. use $\frac{1}{2}$ -in. port.

List Price—No. 6 Valve with $\frac{3}{8}$ -in. pipe connection.....\$12.00

Method of Application

No. 2 and No. 6 Valves are installed in gravity vacuum systems in same manner as No. 1 and No. 5 Valves are in gravity systems (See p. 303)

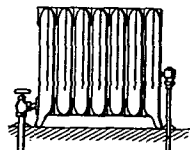
HOFFMAN VENTING VALVES FOR AIR LINE OR PAUL SYSTEMS

No. 3 Hoffman Air Line Valve

The No. 3 Hoffman Air Line 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. No adjustment is necessary either before or after installation.

Designed for not over 10 lb. pressure.

List Price—No. 3 Valve with $\frac{1}{8}$ -in. male radiator connection and $\frac{1}{4}$ -in. air line connection.....\$2.50



No. 3 Valve installed
on Air Line System of
either Gravity or Va-
cuum Type.

HOFFMAN "CONTROLLED HEAT" EQUIPMENT

The following specialties in various combinations are used in "Controlled Heat" Installations.

No. 7 Adjustable Modulating Valve for controlling amount of steam admitted to the radiators.

No. 8 and 9 Return Line Valves for controlling the return side of the radiator.

No. 10 Vapor Valve for relieving air from return mains in Vapor Systems.

No. 11 Vapor Vacuum Valve for venting air from return mains in Vapor Vacuum Systems and preventing return of air through vent port.

No. 12 Blast Trap for handling large quantities of water in Blast Coil Work, draining long steam mains into dry returns and dripping large risers.

Differential Loop for controlling and maintaining a steady boiler water-line in Vapor or Vapor Vacuum Systems.

Damper Regulator for controlling boiler drafts and causing them to instantly respond to radiator demands.

Mercury Gage for accurately measuring pressure in ounces.

For the convenience of the engineer in specifying and the heating contractor in estimating the specialties have been grouped into two distinct classifications viz.: Radiator Specialties and Basement Specialties.

RADIATOR SPECIALTIES

One $\frac{3}{4}$ " Hoffman Adjustable Modulating Valve.....	List price per radiator \$12.00
(Capacity up to 200 sq. ft. radiation.)	
One $\frac{1}{2}$ " Hoffman Return Line Valve.....	List price per radiator \$12.00
(Capacity up to 200 sq. ft. radiation.)	

BASEMENT SPECIALTIES

Class "A" Basement Specialties for installations up to 2000 sq. ft. direct radiation consist of—

- 2 No. 8 Hoffman Return Line Valves, for venting steam mains.
- 1 No. 1 Hoffman Differential Loop.
- 1 No. 11 Hoffman Vapor Vacuum Valve.
- 1 Hoffman Damper Regulator.
- 1 Hoffman Pressure Gage.

List Price.....\$112.00

Class "C" Basement Specialties for installations of 3501 to 7500 sq. ft. direct radiation consists of—

- 4 No. 8 Hoffman Return Line Valves for venting steam mains.
- 1 No. 3 Hoffman Differential Loop.
- 1 No. 11 Hoffman Vapor Vacuum Valve.
- 1 Hoffman Damper Regulator.
- 1 Hoffman Pressure Gage.

List Price.....\$165.00

Class "B" Basement Specialties for installations of 2001 to 3500 sq. ft. direct radiation consists of—

- 3 No. 8 Hoffman Return Line Valves for venting steam mains.
- 1 No. 2 Hoffman Differential Loop.
- 1 No. 11 Hoffman Vapor Vacuum Valve.
- 1 Hoffman Damper Regulator.
- 1 Hoffman Pressure Gage.

List Price.....\$133.00

Class "D" Basement Specialties for installations of 7501 to 15000 sq. ft. direct radiation consists of—

- 6 No. 8 Hoffman Return Line Valves for venting steam mains.
- 1 No. 4 Hoffman Differential Loop.
- 2 No. 11 Hoffman Vapor Vacuum Valve.
- 1 Hoffman Damper Regulator.
- 1 Hoffman Pressure Gage.

List Price.....\$242.00

EXTRA EQUIPMENT

Where 50 ft. risers or ends of 100 ft. steam mains are dripped through Return Line Valves, add \$6.00 list for each No. 8, or \$8.00 list for each No. 9 Valve. For longer risers or steam mains add \$30.00 list for each No. 12 Valve.

Where more than one boiler is used, add \$37.00 per boiler for additional specialties required.

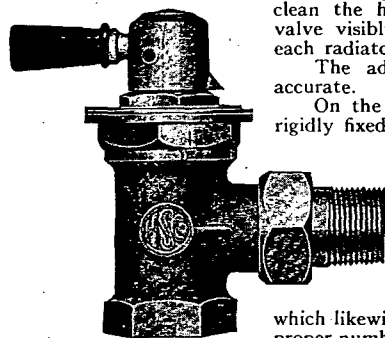
Special or larger installations than indicated above quoted on application.

HOFFMAN "CONTROLLED HEAT" EQUIPMENT—(Continued)

No. 7 Adjustable Modulating Valve

The No. 7 Valve is made in one size only, $\frac{3}{4}$ in., having a range of adjustment up to 200 sq. ft. of direct radiation.

Valves are shipped and installed with wide open ports.



After system has been in operation and thoroughly clean the heating contractor without dismantling the valve visibly adjusts the port for the requirements of each radiator.

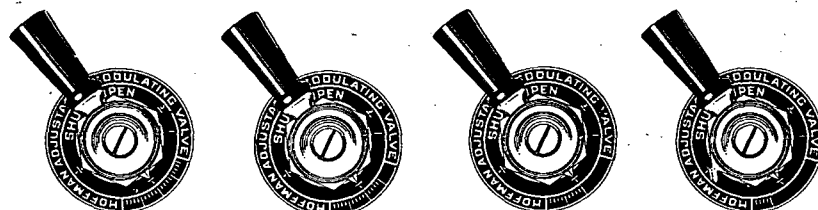
The adjustment is very simple and extremely accurate.

On the valve bonnet there are two dial plates, one rigidly fixed to the bonnet marked with 20 graduations each of which represents a port area equivalent to 10 sq. ft. of radiation. The top plate is attached to a revolving sleeve, which upon loosening a lock nut, can be turned to various positions, thus making different port areas. To adjust the valve for the radiator requirements it is only necessary to loosen the locknut and turn the valve handle,

which likewise turns the top dial plate and sleeve, until the proper number of graduations are visible on the lower dial plate. Thus with 20 graduations visible the port area is sufficient for a 200 sq. ft. radiator, with 15 graduations for 150 sq. ft., etc.

The following illustrations will indicate the method of valve adjustment and also show the variation in port area for different positions of the dial plate.

POSITIONS OF TOP DIAL PLATE FOR VARIOUS SIZES OF RADIATORS

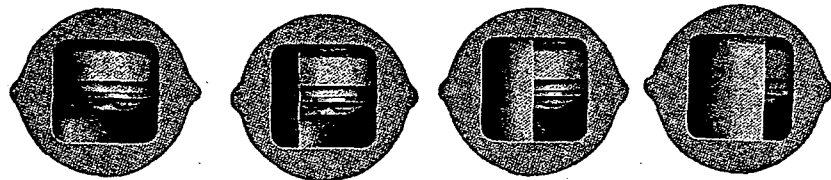


All Graduations exposed
200 sq. ft.

15 Graduations exposed
150 sq. ft.

10 Graduations exposed
100 sq. ft.

5 Graduations exposed
50 sq. ft.



CORRESPONDING POSITIONS OF ROTARY SLEEVE SHOWING PORT AREAS FOR ABOVE RADIATORS

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.

HOFFMAN "CONTROLLED HEAT" EQUIPMENT—(Continued)

The No. 7 Valve has a metallic fibre packing in the stem stuffing box that will last indefinitely without attention. Provision however is made for tightening the stuffing nut without removal of handle. In the stuffing nut are four grooves in alignment with a small hole in the handle cap. By inserting a nail in the hole, engaging one of the grooves and turning the lever handle the stuffing nut is tightened.

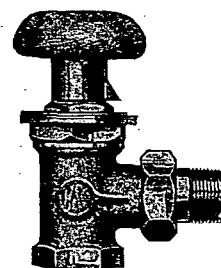
The No. 7 Valve is regularly supplied with lever handle. It can however be supplied with wood wheel, lock shield or closed tops (the two latter styles being intended for forced hot water systems). Extension stems and handles and chain operated valves are also made.

List Price—No. 7 Valve with $\frac{3}{4}$ -in. connections in Lever Handle, Wood Wheel, Lock Shield and Closed Top Types\$6.00

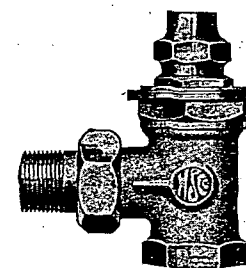
List Price—No. 7 Valve with Extension Stem and Handle\$10.00

List Price—No. 7 Valve with Chain Wheel\$12.00

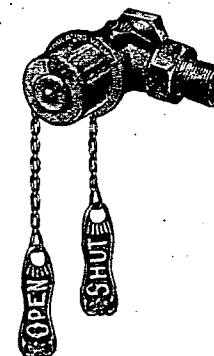
For roughing measurements (see page 308)



No. 7 Valve with Wood Wheel



No. 7 Valve with Lock Shield



No. 7 Valve with Chain Wheel

NO. 8 AND 9 RETURN LINE VALVES

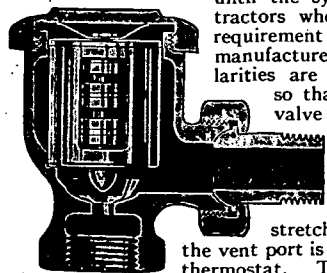
Hoffman Return Line Valves have an established reputation for efficiency and consistency of operation. This has been obtained in service under both high and low pressures and also in various impartial laboratory tests. Originally designed for low pressure service they have been improved from time to time, without changing the original principles and adhering to the same dimensions so that present thermostats may be installed in valves of first manufacture, and also without making changes or adjustments of any sort valves may be installed under pressures of 50 lb. Under high pressures the valves operate as sensitively and accurately as under 1 oz. or less.

The wide range of pressure makes it possible to standardize on Hoffman Valves in hotels, hospitals, factories, etc., where they are used on the heating system as well as for draining steam heated kitchen utensils, sterilizers, driers and other equipment using steam in manufacturing processes.

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, for within its working range the trap operates with the same degree of sensitiveness.

HOFFMAN "CONTROLLED HEAT" EQUIPMENT—(Continued)

The thermostatic member of the No. 8 and No. 9 Valves is held in a cage which rests on a shoulder in the valve body. The thermostat is removable and may be interchanged from one valve to another of the same size without need for adjustment. This feature is appreciated by engineers who require the removal of thermostat from valves until the system is thoroughly clean and likewise by contractors who comply with such specifications. To fulfill this requirement extreme care and accuracy must be exercised in manufacture. By a special process all manufacturing irregularities are eliminated in a final operation before assembling so that each and every thermostat will have the same valve opening for the same temperature drop.

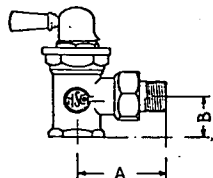


No. 8 Return Line Valve

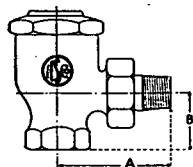
Manufacturers of thermostatic devices have always and most of them still are having difficulty in obtaining a diaphragm metal which will not stretch or soften under repeated action and in high temperatures. The softening of the metal and the stretching results in improper valve action and ultimately the vent port is permanently closed because of the elongation of the thermostat. The Hoffman Laboratory after extensive research developed a special diaphragm alloy. Comparative tests indicate that this alloy cannot be equalled in the field of valve manufacture. The alloy is tough, durable, will not soften or stretch and insures a continued and uninterrupted service for a period far in excess of the regular Five-Year Hoffman Guarantee.

The Valve body is made of high-grade steam metal, cap and tail piece of hot brass forgings having a tensile strength three times that of cast brass.

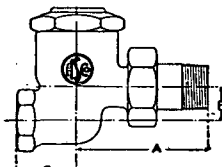
No. 8 Valves are made in 1/2-in. size, in angle, straightway, right and left-hand offset patterns. No. 9 Valve is made in angle pattern only.



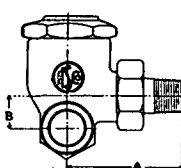
No. 7 Angle Pattern



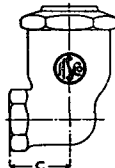
No. 8 or 9 Angle Pattern



No. 8 Straightway Pattern



No. 8 Right or Left Offset Pattern



DATA AND LIST PRICES

STYLE	Size	Diameter Valve Port	Maximum Capacity Square Feet	DIMENSIONS			List Price
				A	B	C	
No. 7 Angle.....	3/4"	3/4"	200	2 3/4"	1 1/4"	...	\$6.00
No. 8 Angle.....	1"	1"	200	2 1/4"	1 1/4"	...	6.00
No. 8 Straightway.....	1"	1"	200	2 1/4"	1 1/4"	1 1/4"	6.00
No. 8 Offset.....	1"	1"	200	2 1/4"	1 1/4"	1 3/4"	6.00
No. 9 Angle.....	1 1/2"	1 1/2"	600	3 3/4"	1 1/4"	...	8.00

*No. 9 Valve furnished with 3/4-in. Port for pressure above 15 lbs.

HOFFMAN "CONTROLLED HEAT" EQUIPMENT
(Continued)

NO. 10 VAPOR VALVE

The No. 10 Vapor Valve is intended for venting the return mains in vapor systems or for other conditions where a large capacity vent is required. The vent port is 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 the 3/4-in. port and the other an auxiliary port 1/8-in. diameter. When water recedes from the valve and pressure is maintained the 1/8-in. port is first opened and as the air pressure is relieved the 3/4-in. port opens and full venting capacity is obtained. The thermostat is located above the float chamber and controls a separate port. The valve is of rugged construction, nickel-plated all over.

List Price—No. 10 Valve with 3/4-in. connections.....\$25.00



No. 10 Hoffman Vapor Valve



No. 11 Hoffman Vapor Vacuum Valve

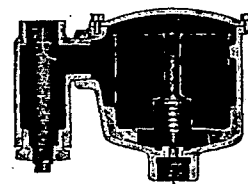
NO. 11 VAPOR VACUUM VALVE

The No. 11 Valve is similar in construction to the No. 10, but with the addition of a check on the upper port which prevents the return of air to the system through the vent port.

List Price—No. 11 Valve with 3/4-in. connections.....\$28.00

NO. 12 BLAST TRAP

The No. 12 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.



No. 12 Blast Trap

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 large 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.

As a part of the trap a strainer is supplied, having a heavy brass screen.

Trap is made of Cast Iron; float of drawn brass and seat of bronze.

List Price—No. 12 Blast Trap with Strainer, 1-in. Pipe connections.....\$30.00

TABLE OF NOMINAL CAPACITIES

Pressure, lb. per sq. in.	1	2	3	4	5	10	15	20
Capacity, lb. per hr.	400	450	500	550	625	780	900	950

HOFFMAN "CONTROLLED HEAT" EQUIPMENT—(Continued)



Hoffman Differential Loop

DIFFERENTIAL LOOP

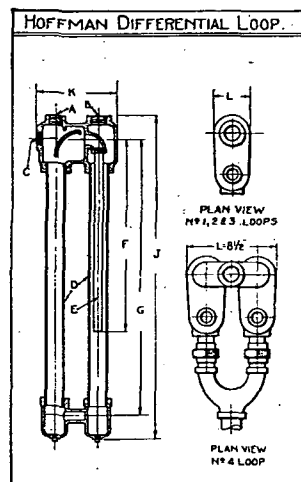
The Differential Loop is the safety device for maintaining a steady water line in vapor and vapor vacuum systems. It is entirely automatic, non-adjustable and has no moving parts to stick at a critical moment.

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.

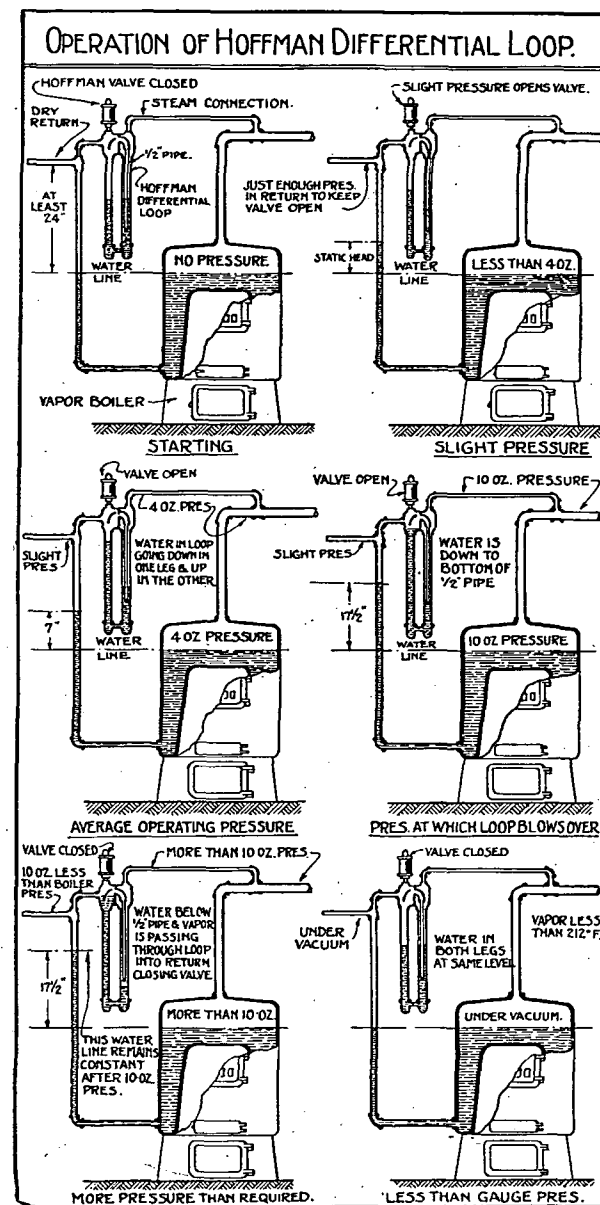
No. 1 and No. 2 Loops should not be used where the low point in the dry return is less than 24 in. above boiler water line; with the No. 3 and No. 4 Loops this distance must be at least 30 in.



DIMENSIONS AND CAPACITIES AND LIST PRICES OF LOOPS

Loop No.	A	B	C	D	E	F	G	J	K	L	Capacity Sq. Ft. Rad.	List Price
1	3/4"	1 1/4"	1 1/4"	1 1/2"	1 1/2"	18 1/4"	26"	30 3/8"	7 5/8"	3"	2000	\$50.00
2	3/4"	1 1/4"	1 1/4"	1 1/2"	3/4"	18 1/4"	26"	30 3/8"	7 5/8"	3"	3500	75.00
3	3/4"	1 1/2"	1 1/2"	2"	1"	25"	32"	37 1/4"	10"	3 3/4"	7500	100.00
4	3/4"	2"	2"	2"	1"	25"	32"	37 1/4"	10"	8 1/2"	15000	225.00

HOFFMAN "CONTROLLED HEAT" EQUIPMENT—(Continued)



HOFFMAN "CONTROLLED HEAT" EQUIPMENT—(Continued)

TYPICAL INSTALLATIONS

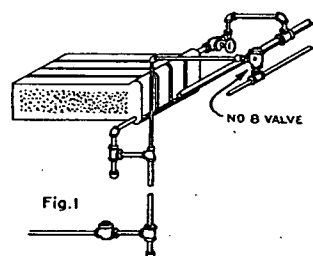


Fig. 1 shows application of No. 8 and 9 Hoffman Valves for venting and dripping indirect radiator into gravity or vacuum return line.

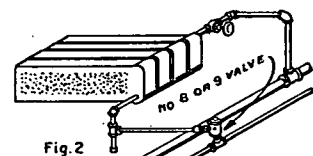


Fig. 2 shows application of No. 8 or 9 Hoffman Valve for venting and draining indirect radiator into air line, dry or vacuum return. Use No. 12 Valve for large radiators.

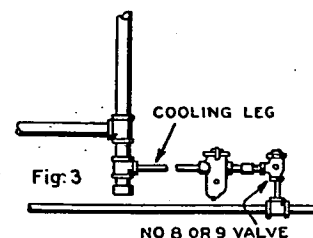
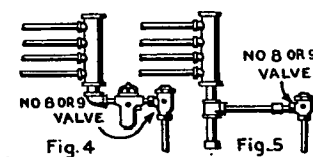


Fig. 3. Dripping heel of riser thru dirt strainer and venting thru No. 8 or 9 Hoffman Valve into gravity or vacuum return. Cooling legs wherever shown must not be less than 5 feet long.



Figs. 4 and 5 show proper application of No. 8 or 9 Hoffman Valves for dripping coils. Dirt strainers should be used when steam pressure exceeds 5 pounds.

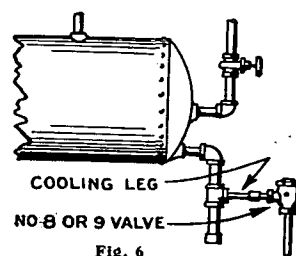


Fig. 6 shows the proper application of No. 8 or 9 Hoffman Valves for dripping storage tank coils into gravity or vacuum return. Cooling leg to be at least four feet or more in length.

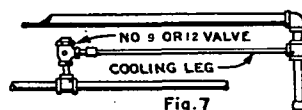


Fig. 7 and 8 show typical methods of dripping ends of mains or branches into gravity or vacuum returns, thru No. 9 or 12 Hoffman Valves. Cooling leg to be at least 5 feet or more in length.

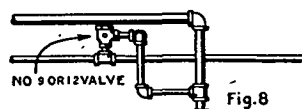
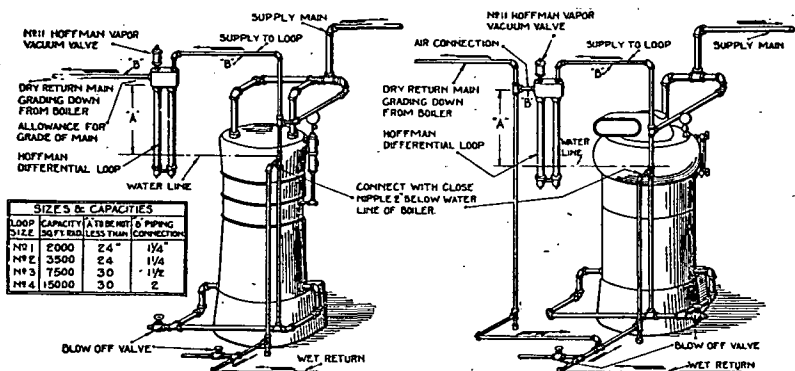
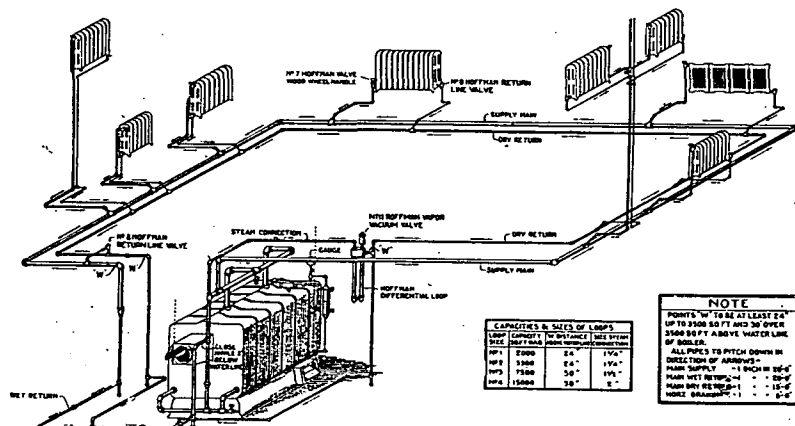
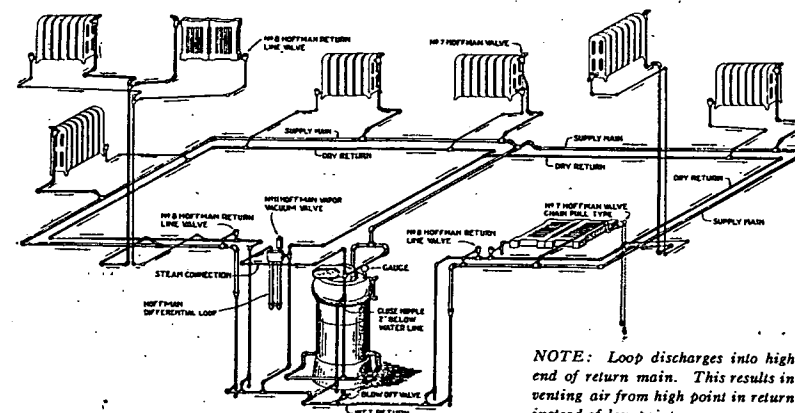


Fig. 8 shows application of No. 8 Hoffman Valve for venting end of steam main into dry return.

HOFFMAN "CONTROLLED HEAT" EQUIPMENT—(Continued)

TYPICAL INSTALLATIONS



LOOP CAPACITY (AT 20 PSI) & PIPING SIZE (SCHEDULE 40)	NO. 8	NO. 9	NO. 12
NO. 1 2000	2 1/2"	2 1/2"	2 1/2"
NO. 2 3500	2 1/2"	2 1/2"	2 1/2"
NO. 3 7500	3"	3"	3"
NO. 4 15000	3"	3"	3"

POINTS "W" TO BE AT LEAST 24" UP TO 3500 SQ FT AND 30" OVER 3500 SQ FT ABOVE WATER LINE OF BOILER.
ALL PIPES TO FITCH OPEN IN DIRECTION OF FLOW.
MAIN SUPPLY - 1" INCH IN 100'
MAIN DRY RETURN - 1" INCH IN 100'
MAIN WET RETURN - 1" INCH IN 100'

Illinois Engineering Company

General Offices and Factory: CHICAGO

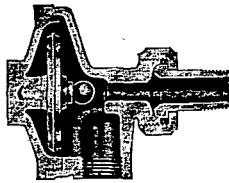
Branches and Representatives

ATLANTA	CLEVELAND	HOUSTON	MINNEAPOLIS	PORTLAND	SPOKANE
BALTIMORE	COLUMBUS	INDIANAPOLIS	NEW YORK	RICHMOND	ST. LOUIS
BOSTON	DALLAS	KANSAS CITY	OMAHA	ROCHESTER	SAN FRANCISCO
BUFFALO	DETROIT	LOS ANGELES	PEORIA	SCRANTON	WICHITA
CEDAR RAPIDS	HARRISBURG	MILWAUKEE	PHILADELPHIA	SEATTLE	

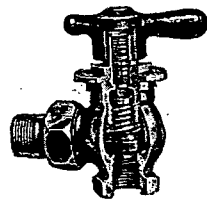
PRODUCTS—ILLINOIS HEATING SYSTEMS ECLIPSE STEAM SPECIALTIES

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.

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.



Thermo Trap



Modulating Valve

Illinois Thermo Trap—Quick Opening—only a half turn of handle from open to closed position. Packless, Bakelite handle, steam tight on 50 lbs. pressure.

Illinois Supply Valve—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 of an hour each 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 HEAT RETAINER**—Browne Patent, a device which marks an epoch in the heating art.

The **ILLINOIS RETURN TRAP** is the improved product of 13 years manufacture and experience, and positively returns water of condensation to the boiler regardless of boiler pressure.

Our Sales-Engineering Organization will be glad to give detailed technical information regarding our products and to advise as to their proper installation.

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.

Exhaust Heads, Steam Traps, all pressures.

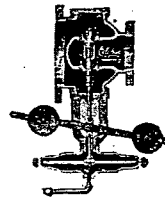
Non Return or Stop and Check Valves.

Pump Governors, Balanced Valves.

Float Valves, Expansion Joints, Pipe Strainers.

Fig. 71—Reducing Valves.

For use in Vacuum or low pressure Heating Systems. Will reduce to 4 oz. pressure.



Reducing Valve

Catalogs and Bulletins

Illinois Heating Systems—88 pages.

BULLETINS

No. 11—Heating Specialties.	No. 301—Steam Traps.
No. 21—Vapor System Details.	No. 452—Non Return Valves.
No. 102—Pressure Reducing Valves.	No. 502—Separators—Oil and Steam.
No. 202—Back Pressure, and Relief Valves, Exhaust Heads.	No. 703—Float and Balanced Valves.

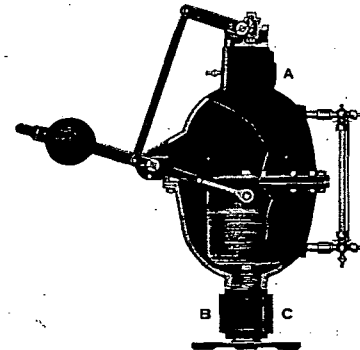
Kieley & Mueller Co., Inc.

34-38 West 13th Street

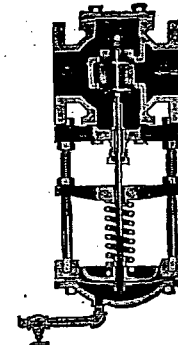
New York City

Agents in all principal cities.

Manufacturers of Steam Specialties



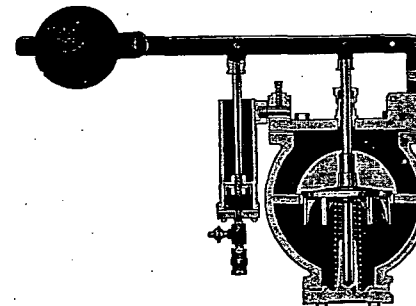
Pump Governor



Reducing Valve

The illustrated specialties make a complete economy outfit, reducing steam from High to Low pressure; utilizing the exhaust and returning all condensation back to boilers automatically.

In addition thereto, we carry a complete line of various Reducing Valves for Steam, Water and Air. Tank Controllers High and Low Pressure Damper Regulators, Return and non-return traps for all pressures. Back Pressure Valves for Condensing and non-condensing Engines. Float and Pump Governor Valves. Controlling devices for Liquid Ammonia and Brine.



Back Pressure Valve

Our Catalog No. 27 and information on your difficult problems, will be gladly furnished on request.

THE McALEAR MFG. CO.

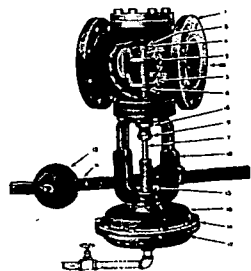
1901-1907 So. Western Avenue

Chicago

Power and Heating Specialties for Controlling Pressures and Flow of Steam, Water, Air or Gas

THE McALEAR HEATING SPECIALTIES

PRESSURE REDUCING VALVES—used in Low Pressure, Vacuum or Vapor heating systems or any other service where close regulation and absolute control is required.



McAlear Vacuum-Vapor Pressure Regulating Valve, Full Area

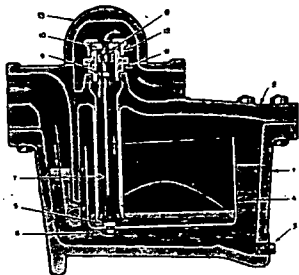
USE

Fig. 155, 165 and 175 for initial pressure up to 150 lb. and reducing to service pressures 0-10 lb.

Fig. 185-195 single Seated Valves on dead end service where reduced pressure is below 10 lb.

Fig. 235-245 Spring Weighted type for initial pressures up to 150 lb. and reducing to service pressures above 10 lb. Fig. 255-265 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.



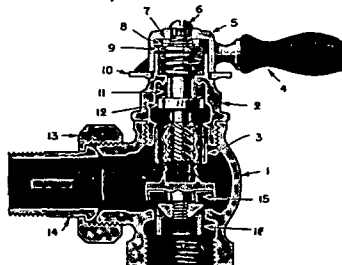
McAlear Steam Trap, Reversible Seat

SPECIFY

Fig. 685 for pressures up to 30 lbs.
Fig. 695 for pressures up to 125 lbs.
Fig. 705 for pressures above 125 lbs.
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, Return Steam Traps, Air Vents, Stop and Check Valves and many other devices. Catalog No. 27 covering our complete line gladly furnished upon request.

PACKLESS RADIATOR VALVES—Are constructed of brass bodies highly nickel plated, wooden lever handles graduated and modulating types.



McAlear Packless Radiator Valve

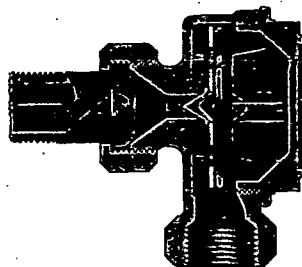
Fig. 38 Wood Wheel-handle, angle pattern.

Fig. 40 Wood Wheel handle, corner pattern.

Fig. 42 Lever Handle Graduating Type, angle pattern. Lock shield attachment, keys and special extension handles are furnished when requested.

THERMOSTATIC RADIATOR TRAPS—for the automatic escape of water and air from Low Pressure heating units and close absolutely tight against steam.

McAlear Traps are—Positive in action. Efficient in operation. Non-adjustable, self-cleaning and Noiseless. Suitable for either Vacuum or Gravity return. Expansion discs guaranteed for five year period.



McAlear Thermostatic Radiator Trap

Fig. 28—1/2".....150 Sq. Ft.
Fig. 29—1/2".....300 Sq. Ft.
Fig. 33—1/2".....400 Sq. Ft.
Fig. 34—1/2".....600 Sq. Ft.
Fig. 36—1".....800 Sq. Ft.

Monash-Younger Co.

Chicago



New York

Thermostatic Return Line Traps, Adjustable and Non-Adjustable Automatic Air Valves for Radiators, Packless Radiator Supply Valves

SPECIFICATIONS FOR RETURN LINE TRAPS SUBMITTED TO ARCHITECTS AND SPECIFYING ENGINEERS TO BE EMBODIED IN THEIR SPECIFICATIONS

DEAR SIR:—

You are, no doubt, desirous of safe-guarding the interest of your Client, and with that point in view, we are submitting for your consideration the wording of specifications for THERMOSTATIC RETURN LINE TRAPS.

Vacuum Radiator Traps

"The Vacuum Radiator Trap shall be of a THERMOSTATIC TYPE, brass or iron body, nickel plated, MONASH OR ANY OTHER of approved make, and the THERMOSTATIC DIAPHRAGM in the TRAP shall be GUARANTEED against fracture or rupture on pressure up to ten pounds. The GUARANTEE shall be in writing for a period of TEN YEARS after date of installation and shall be delivered to the Architect in duplicate for transmission to the Owner of the Building.

The TRAPS to be installed, shall be noiseless in operation and the Manufacturer of the TRAPS shall furnish a GUARANTEE in writing that if the TRAPS do not function so, he will have them removed at his expense, and install in their place TRAPS that are noiseless in operation."

If some such wording as above, is embodied in your specifications, it will eliminate the use of TRAPS that do not measure up to that standard, for there are TRAPS on the market, that are sold as—noiseless in operation—but in reality, have been found, wanting in this respect, hence—

You will agree with us that it is to the benefit of your Client to protect him against the installation of TRAPS that are NOT noiseless in operation, and against UP-KEEP COST of the DIAPHRAGM for TEN YEARS.

If you desire a copy of the TEN YEAR GUARANTEE that we furnish or any literature regarding our TRAPS, please drop us a line, and it will be forthcoming.

"THIRTY-THREE YEARS of QUALITY VALVE MAKING"—our record.

Trusting that the above meets with your idea, we remain,

Monash-Younger Co.,

Chicago—New York

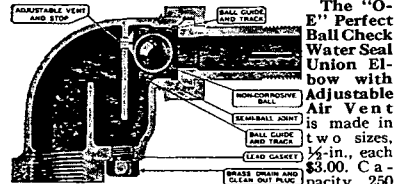
O-E Specialty Mfg. Co.

5-7-9 Keefe Ave., MILWAUKEE, WIS.

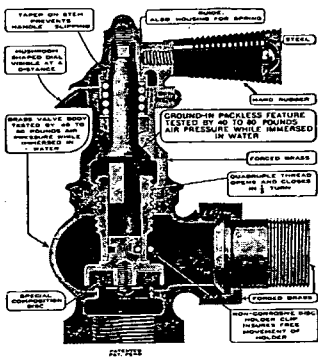
Packless Graduated Valves, Ball-Check Return Elbows, Thermo-Nickel Return Traps, Air Exhausters, Vacuum Valves, Vacuum Pressure Gages, Differential Return Traps and Balanced Swing Check Valves.

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.

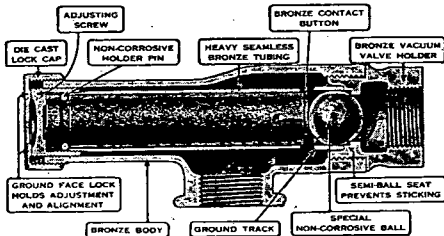
An air vent is tapped in the slot of the screw stop in the return elbow which not only allows air to escape freely into return system when Supply Valve is open, but also equalizes the pressure on both sides of Water Seal, thus preventing it from syphoning out, which it might otherwise do. All air and 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.



Capacity 500 sq. ft.



List Prices— $\frac{1}{2}$ in. \$6.00; $1\frac{1}{4}$ 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, the ball is away from seat and steam is able 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.

The "O-E" Improved Perfect Packless Graduated Valve is *absolutely packless* and never requires packing. It is tested by air and water test before shipment. It is quick opening, little more than one-half turn fully opens the close. Sand blasted and nickel plated. The handle being made of hard rubber, will not crack and is always cool and easy to operate. The graduated dial and pointer admit of partial opening so that just the amount of heat desired can be obtained. The valve is made in two composition disc on a swivel seat without extra charge. Graduated Supply Disc will be attached when specified, at slight additional cost.

\$4.25; 1/2 in., \$5.00; 1 in.,

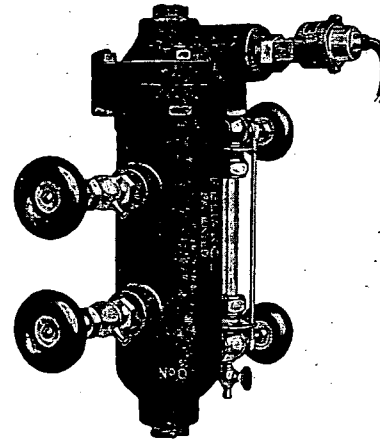
Specialties, Heating

The Reliance Gauge Column Co.

5918 Carnegie Avenue CLEVELAND, OHIO

**Manufacturers of Reliance Safety Water Columns,
Electric Low Water Alarms, Gauge Cocks, Water
Gauges, Seamless Copper Floats, Steam Traps.**

Reliance

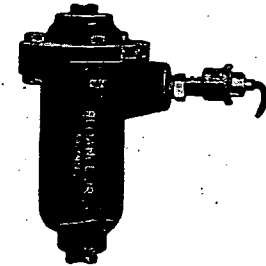


Reliance No. 0 Column with Electric Pressureless Alarm for Heating Boilers

This is the new safety water column for heating plants, replacing the plain column with a low-water alarm. It is especially necessary where the attendant is generally absent from the boiler room.

The device gives a startling alarm when for any reason the water level in the boiler falls to a predetermined point. The signal may be bell, red light or buzzer in janitor's quarters or anywhere else desired in the building.

The column works equally well on pressure, vapor or vacuum systems. It is easily attached to the boiler. For boilers equipped with plain columns, use Reliance Column No. 0; where water gauge and



*Reliance Junior Low-Water Alarm Column Filled
with Electric Pressureless Alarm*

This column was designed for use where water gauges and gauge cocks are tapped in the boiler shell or the front section. It is intended especially for heating plants, tire repair shops, creameries, bakeries, laundries, saw mills, hoisting engines, etc. It costs little and is easy to install. A mark cast on the outside shows the water level at which it signals. Usual Reliance quality—as in our complete line of safety water columns for all boiler service.

We are the manufacturers also of the RELIANCE Solid-Shell Float, "The Quality Float for Quality Toilet Tanks."

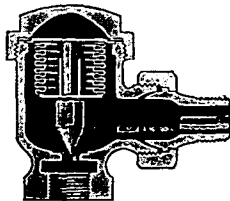
Sarco Co., Inc.

233 Broadway, NEW YORK

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	2 1/4	2 1/4

Write for Steam Trap Bulletin.

heavy. There is no danger of cracking or straining the trap when connecting same. Made in 1/2 and 3/4 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.

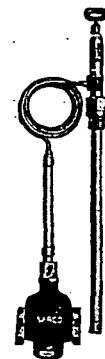
Sarco Regulators operate steam, water and gas valves 1/2 to 6 in. They have 6 ft. of connecting tubing between elements, which can be increased where conditions necessitate. Supplied for any temperature between 30 and 300 deg. Fahr.

Ask for Booklet 77.

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 1/4	\$75.00	\$60.00
3/4	8	2 3/8	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 3/4	170.00	165.00
5	132	15 3/4	225.00	215.00
6	158	18	275.00	265.00

Write for description of SARCO RECORDING AND INDICATING THERMOMETERS.



Type T. R. 21 for Air Ducts and Tanks

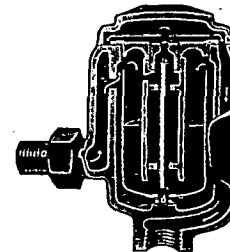
Stickle Steam Specialties Company

Main Office and Works Indianapolis, Ind.

PHILADELPHIA OFFICE
Machinery Dept., The BourseBOSTON OFFICE
52 Sudbury St.

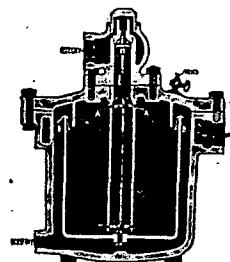
PRODUCTS

Steam Traps. Vacuum Heating Specialties. Feed Water Heaters. Oil and Steam Separators. Damper Regulators. Pressure Reducing and Controlling Valves. Unit and Blast Coil Heaters.



The Stickle Radiator Valve

The Stickle Radiator Trap is of the open bucket type. Our basic patent is "The air by-pass under and through the valve." The trap is wide open when steam is first turned on, same as a thermostatic trap, leaving free passage for air. Will not close until condensate is all discharged. It then closes and does not allow steam to escape. It will operate under the higher steam pressures without injury.



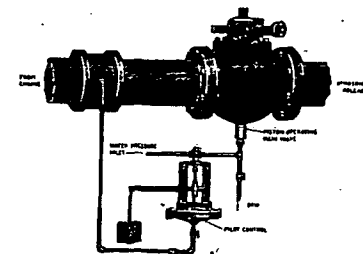
Stickle Steam Traps

Stickle Steam Traps are made in four classes, Class A high pressure; Class B low pressure; Class T Thermic Vacuum, and Pop Valve. Simplicity of construction and years of practical steam trap experience have placed this line of steam traps in hundreds of the large manufacturing industries. Positive action due to

no friction. Valve rotates on the seat and is regrinding. Large thermic vacuum traps on blast coil service maintain a guaranteed perfect circulation. Ask for catalogue.

S. S. S. Hot Blast Unit Heater

This type of radiation is so constructed that it can be operated under vacuum. It is made up of horizontally disposed sections, 9" wide and 36" long, making a continuous steam liberating space in each section. The condensation that forms flows in a thin film on the bottom of the section in the presence of steam, causing revaporization. High temperature condensation is as effective as steam in transmitting heat in this coil. We build them in the small unit type as well as in the larger sizes for indirect heating and ventilating.



Stickle Pilot Operated Back Pressure Release Valve

Positive action guaranteed, opening and closing with 1/2 lb. variation in pressure. The controlling pilot valve can be located at the most convenient point for attention, in the engine room if desired. The main valve can be located at any remote point.

VAPOR-VACUUM DIVISION

The Trane Company

La Crosse, Wis.

New York, Boston, Cleveland, Buffalo, Salt Lake City, Philadelphia, Detroit, Washington, D. C., Portland, Ore., Seattle, Knoxville, Greensboro, N. C.

**The Trane System of Vapor Heating, Patented Heating Specialties
Trane Automatic Electric Pumps, For All Purposes**

Trane Direct Return Trap

For returning the water of condensation of any heating system to the boiler during periods when pressure difference between boiler and return pipe is such as to prevent the returning of the condensation by gravity. This efficient device allows steam to enter the trap whenever the trap body becomes filled with water, thereby equalizing the pressure and allowing the water to return to the boiler by gravity.

The Trane Direct Return-Trap mechanism is all inside the case, as shown in the accompanying cut. Because of its simple, efficient construction this trap requires no attention after being installed. Note that it has no stuffing boxes, outside joints, or weights.

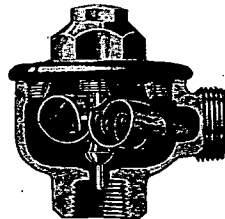
Complete detailed drawings for installing are furnished with each trap.



Trane Direct Return Trap in Section. Note that this Trap has no Stuffing Boxes, Outside Joints, or Weights

Trane Thermetal Radiator Trap

The distinctive feature of this trap is that it has no diaphragm. In all other respects, there is no radical departure in its entire construction from the best accepted principles of radiator trap construction. Eliminating the diaphragm eliminates all



Semi-sectional view of Trap, showing Ther-metal member in position. This trap has a safety factor of fourteen

source of trouble. This trap is fully as sensitive as the delicate diaphragm type of trap, yet so rugged that it is not injured by high pressure.

The thermostatic member in the Trane Trap is made entirely of metal. No liquids are used, and nothing can happen to render its force inoperative.

Use it on all two-pipe vapor or vacuum systems, in residences, apartments, hotels, factories, warehouses, garages, schools, churches, hospitals, offices, etc. Trane Thermetal Traps meet the highest engineering standards as well as the practical need for an absolutely dependable and permanent radiator trap.

Bulletins on other specialties, on The Trane System of Vapor Heating, and on Trane Pumps are obtainable for the asking.

Warren Webster & Company

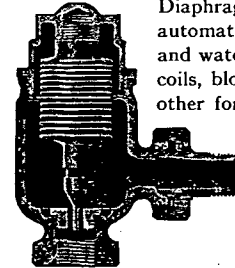
Camden, N. J.

BRANCHES IN ALL PRINCIPAL CITIES

Heating Systems, Heating and Power Specialties

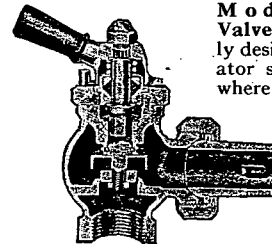
The Webster Heating Specialties include:

Radiator Traps—Sylphon Bellows and Diaphragm types—for the automatic removal of air and water from radiators, coils, blower sections and other forms of apparatus emitting heat due to condensation of low pressure steam.



Heavy-duty Traps for discharging unusually large volumes of air and water from low-pressure radiating units. This is a float trap with a built-in thermostatic trap in the air-pass. For steam pressures ranging from 15 to 50 lb. per sq. in. a similar trap is known as the Webster High Differential Heavy-duty Trap.

Double-Service Valves for accomplishing the two-fold purpose of draining down-feed risers and supplying steam to radiators at adjacent points.



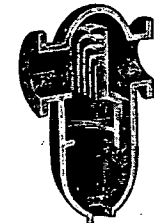
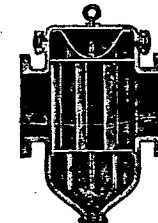
Modulation Valves are especially desirable as radiator supply valves where graduated or modulated heating as well as quick heating are the objective.

Quick-opening Radiator Valves are of the highest quality of construction and are similar to Modulation Valves without the graduation feature.

High-pressure Sylphon Traps are used for draining sterilizers, kitchen equipment or other apparatus using steam at pressures up to 100 lb. per sq. in.

Vent Traps are used in Modulation and other Open Return Heating Systems for ensuring the automatic removal of air from the return and the discharge of the condensation to the boiler, when the pressure difference between the boiler and the main return is normally less than the available gravity head between the return main and the boiler.

Where the design of the system requires a continuous operating steam pressure varying from two or three pounds to occasionally ten pounds, or where special grades of fuel make it difficult at times to maintain a low steam pressure, even with careful firing, the Webster Boiler Return Trap is installed. This trap alternately frees the system of air and returns the condensate to the boiler regardless of the pressure in the boiler or in the return piping.



Miscellaneous Specialties for Webster Heating Systems include Oil Separators, Grease and Oil Traps, Dirt Strainers, Suction Strainers, Lift Fittings, Vacuum Governors, Air-Separating Tanks, Hydro-pneumatic Tanks, Vacuum Controllers, Conserving Valves, Low-pressure Boiler Feeders, Damper Regulators, Water Accumulators, Expansion Joints, Vapor Economizers, etc.

Webster Power Specialties include Feed Water Heaters, Heater Meters, Steam Separators, etc.

See our Service Bulletins or Data Books for complete description of apparatus, and its application to Webster Systems.

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., 177 North Dearborn Street
CINCINNATI, OHIO, 319 Gwynne Building
CLEVELAND, OHIO, 2028 East 22nd Street
DENVER, COLO., 517 Boston Building
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-eighth 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.

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

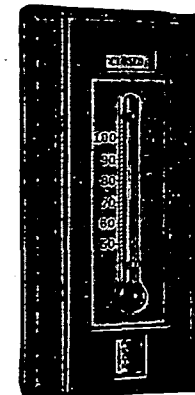
right relative position to deliver a mixture of air that will keep the rooms at a uniform temperature. When the temperature reaches the point at which the thermostat is set to operate, it will hold the mixing dampers in an intermediate position.

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.



Model R. I. Cover
4 3/4" x 2" x 1 1/8" deep

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.

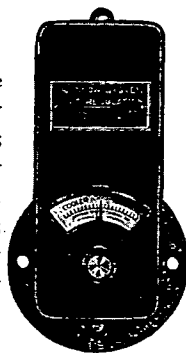


Model Positive Metal
Diaphragm Thermostat

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.



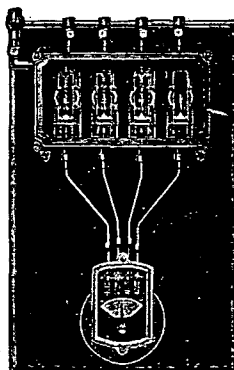
Pneumatic Insertion
Thermostat

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 degree and to minimum space of $2\frac{1}{2}$ degree.

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

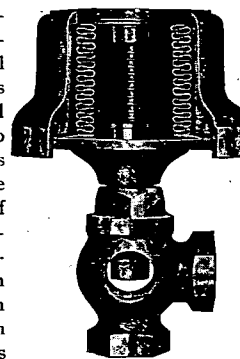
The supplying of moisture to the heated air in buildings and the automatic control of the percentage of moisture in this air are recognized by authorities to be as important as maintaining proper temperatures.

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

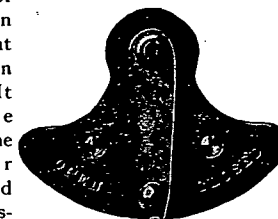
This valve having an indestructible 1-piece metal diaphragm, is permanent and requires no repairs. Its value for the control of steam is obvious and particularly so in connection with steam coils, registers in wall boxes where excessive heat would destroy rubber diaphragms.



"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.

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, 4½ in. by 2 by 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 degree 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.

THE POWERS REGULATOR CO.

Specialists in Automatic Heat 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:

BOSTON, MASS.
CINCINNATI, OHIO
DETROIT, MICH.
DES MOINES, IOWA
MINNEAPOLIS, MINN.
EL PASO, TEXAS
CLEVELAND, OHIO
BUFFALO, N. Y.

ROCHESTER, N. Y.
SAN FRANCISCO, CAL.
ST. LOUIS, MO.
PITTSBURGH, PA.
SEATTLE, WASH.
KANSAS CITY, MO.
SALT LAKE CITY, UTAH
INDIANAPOLIS, IND.

CHARLOTTE, N. C.
LOS ANGELES, CAL.
BUTTE, MONT.
MILWAUKEE, WIS.
PORTLAND, ORE.
BALTIMORE, MD.
PHILADELPHIA, PA.

THE CANADIAN POWERS REGULATOR CO., LTD., TORONTO, ONT.

BRANCHES:
MONTREAL, WINNIPEG, CALGARY, 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 Heat Regulating 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.

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 the only type 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



Residence
Thermostat

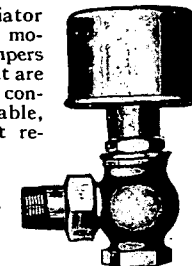
instruments; in operation, sure, with gradual or positive action, as conditions require.

Diaphragm radiator valves, diaphragm motors, mixing dampers and other equipment are especially rugged in construction, dependable, and durable; built regardless of expense, wherever strength is needed for efficiency and long service.

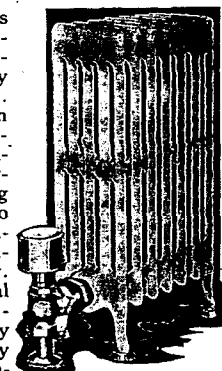
Motive power used in these systems is compressed air. The company builds its own air compressors, operated by steam, electricity or water, and characterized by their reliability, noiseless operation, perfect control and long life.

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.



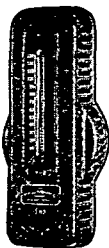
All-Metal Radiator Valve



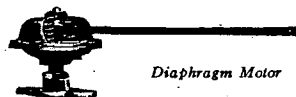
Valve Attached to Radiator

Prices

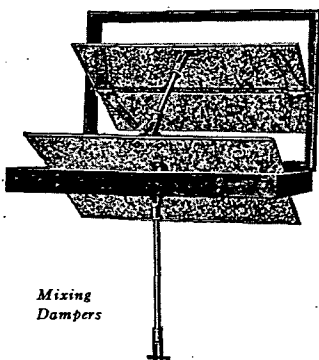
Price for Powers Regulation covers the system installed complete, and is only named after a careful study of the requirements. Our price is not lowest, but no other system will be found as efficient and economical. Customers are served with the sole aim of getting results for them; and experience shows that satisfactory service from a temperature controlling system is of much more importance than its first cost.



Heavy Duty Thermostat



Diaphragm Motor



Mixing Dampers

Specifications

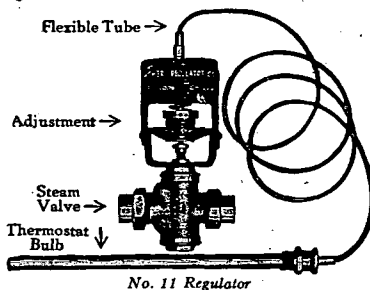
An opportunity is solicited to submit to any architect or engineer a detailed specification, accompanied by a guaranteed price, to cover complete system of temperature control installed, the price to hold if specification is used. This guarantees full protection to the client against advantage being 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 Co. has unusual facilities for solving problems in this particular field.

Tank Temperature Regulation

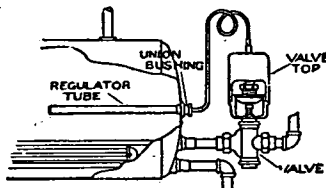
No. 11 Regulator controls temperature of liquids of all kinds under all conditions.

Self-contained, requiring no water or other auxiliary operating power. All-metal. Of great durability, guaranteed accurate and positive in action. Very easily installed. Largely 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 equipment. On request, it is furnished complete with chains and pulleys, for control of dampers of auxiliary coal burning tank heater, both heat sources being controlled with one regulator.



No. 11 Regulator



Typical Installation on No. 11 Regulator in Hot Water Heater

For more detailed information on No. 11 or No. 12, ask for Bulletin No. 129.

Price List, No. 11 and No. 12 Regulators Complete with Valves

Size of valve, in.	Price	Size of valve, in.	Price
1/2	\$60.00	3	\$100.00
3/4	65.00	3 1/2	110.00
1	70.00	4	120.00
1 1/4	75.00	5	175.00
1 1/2	80.00	6	200.00
2	90.00	8	250.00
2 1/2	95.00		

Screwed union valves up to 1 1/4-in. inclusive. 2-in., 2 1/2-in. and 3-in., screwed iron body; larger sizes, iron body flanged. Flexible connecting tube is 6 ft. long for size 1 1/4 in. and smaller; 8 ft. for 2 to 4 in. inclusive; and 10 ft. for larger sizes. Extra charge for special lengths. Bulb lengths, 14 to 24 in. requiring 1-in. and 1 1/4-in. tapping.

Liberal discount to the trade.

Water Line Temperature Regulation

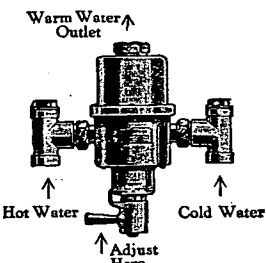
Shower Bath Controller

This device furnishes absolute thermostatic control of the water supply to shower baths, either singly or in gangs. Entirely automatic in operation, and thermostatically controlled against scalding. Will cut off hot water completely if cold water supply fails. Made in several sizes, to control from 1 shower to 50.

The larger sizes may be installed in the hot water line, to prevent extremely hot water from going to the bathroom, saving wear and tear on the fixtures, but permitting the kitchen and laundry to take it as hot as may be desired. Furnished complete as illustrated, with unions, strainers, and check valves, ready to connect.

Regularly furnished with maximum temperature adjustment of 110 deg. fahr.

Higher adjustment furnished when specified. Always state purpose for which controller will be used.



Smaller sizes, full nickel finish. Larger sizes, black enamel or aluminum finish.

Shower Bath Controller

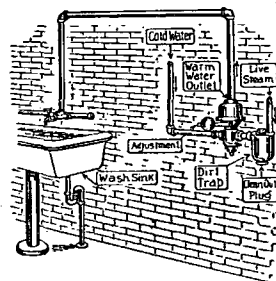
PRICE LIST, POWERS SHOWER BATH CONTROLLERS

No.	Description	Pipe Sizes		Capacity, gals. per min.	Price
		Inlet, in.	Outlet, in.		
1	Nickelplated brass body, screwed connections.....	1/2	3/4	Individual shower.	\$100.00
3	Nickelplated brass body, screwed connections.....	3/4	1	25	125.00
4	Nickelplated brass body, screwed connections.....	1	1 1/4	50	150.00
5	Galvanized iron bodies, painted, flanged connections.....	1 1/4	1 1/2	80	175.00
6	Galvanized iron bodies, painted, flanged connections.....	1 1/2	2	100	185.00
7	Galvanized iron bodies, painted, flanged connections.....	2	2 1/2	150	200.00
8	Galvanized iron bodies, painted, flanged connections.....	2 1/2	2 1/2	200	225.00

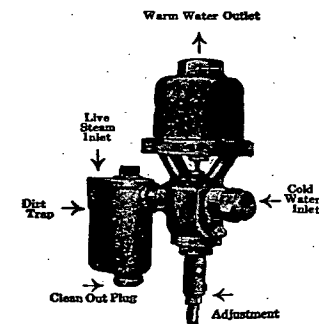
Capacities are based on 40 lb. water pressure. Liberal discount to the trade. For more detailed description ask for Bulletin No. 124.

Thermostatic Water Heater

A safe, sure and accurate method of heating water with high pressure steam. Thermostatically controlled. Adapted to workmen's wash sinks, shower baths, etc., in factories, mines and other industrial plants, and to a great variety of purposes where a supply of warm or hot water of a specified temperature is desired at irregular intervals.



Typical Installation of Thermostatic Water Heater in Workmen's Wash Sinks



Thermostatic Water Heater

PRICE LIST, STEAM AND WATER MIXERS

No.	Pipe Sizes		Capacity, gals. per min.	Shipping weight, lbs.	Price
	Inlet, in.	Outlet, in.			
	Steam	Water			
1	1	3/4	25	60	\$100.00
2	1 1/4	1	40	75	150.00

Liberal discount to the trade. For more detailed information ask for Bulletin No. 137.

Honeywell Heating Specialties Company

Wabash, Indiana

Manufacturers of Honeywell and Arco Temperature Regulators for Residential or other Heating Plants—Hot Water, Vapor, Steam, or Hot Air.



Model 8 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

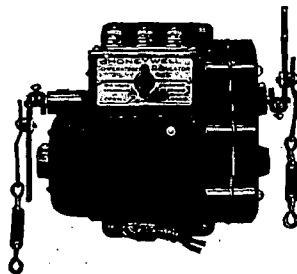
MODEL 8, Eight-day automatic thermostat, automatic night-to-day and day-to-night temperature regulation..... 65.00

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

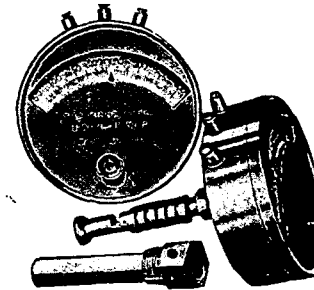
MINNEAPOLIS HEAT REGULATOR CO.

MAIN OFFICE

Minneapolis, Minn.

Service Branches in Principal Cities. Mfgs. of Temperature Controlling Devices

In addition to the standard line of Minneapolis Heat Regulators for use in residences for the control of the central heating systems, this Company manufactures the special devices shown below which have a wide range of uses in special work. Our engineering department is always at the service of the profession in working out special adaptations of these devices.



Model No. 65 Hot Water Thermostat

This Model is especially made for the control of domestic hot water supply in residences, apartments, hotels, etc. It can be used to control a coal heater in summer and steam valve in winter. It will give an accurate and dependable control. It is long-lived and fool-proof. Can be used with Minneapolis A. C. or spring motors.

Other Uses

Control of hot water boilers in residences in connection with room thermostat control.

Enameling and bake ovens, dry kilns, glue, oil, paraffin and chocolate vats. Refrigerating systems, etc.

Description

Size—Diameter, 4 in.

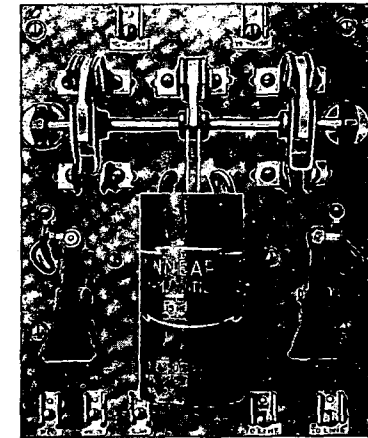
Standard Extension, 2 to 4 in.

Standard Scale, 100 to 240 deg.

On special order instruments can be furnished with ranges up to 500 deg. and extensions up to 24 in.

List Price, \$20.00.

"List prices subject to trade discounts."



Minneapolis Thermostatic Relay Switch

This Switch has extensive uses in the control of electric motors, electric heating units in connection with thermostats.

Send for special bulletin giving complete description and details. List price, \$35.00.

Model No. 70 Pressure Regulator

The Pressure Regulator used in connection with the Thermostat is the ideal instrument in connection with house heating plants, whether steam or vapor. There

are two independent sources of control working on the boiler, both temperature and pressure. The pressurestat acts in dual control as a limiting device as the Model No. 65 does on hot water heating installations. It is simple, rugged and sturdy in construction, applicable to any type of pressure control. Standard range 0 to 5 lb., special ranges to order.

List price \$25.00 each.



The Heating and Ventilating Magazine

A Monthly Journal of Engineering Progress

Devoted Exclusively to the Field
of Heating, Ventilating and
Air Conditioning

Established 1904

The paid circulation of over 2500 comprises Heating and Ventilating Engineers, Engineers of Boards of Education, Superintendents of Central Station Heating Plants and the big Heating and Piping Contractors throughout the United States.

The reader interest is maintained by means of original articles by recognized engineers describing the latest ideas successfully applied in the mechanical equipment of various types of buildings such as Schools, Theatres, Hospitals, Apartment Houses, Office Buildings and Factories. Another important feature is the monthly publication of four pages of standard Heating and Ventilating data for use by Engineers in designing and laying out heating and ventilating and air conditioning systems.

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Over 100 manufacturers of heating and ventilating apparatus and appliances are using the advertising columns of THE HEATING AND VENTILATING MAGAZINE every month in the year.

Rate card and detailed A. B. C. statement, on request.

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JOURNAL

OF AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

29 West 39th Street NEW YORK, N. Y.



THE JOURNAL

of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS is the official organ of the Society, whose purpose is to promote the art of heating and ventilating, to act as a medium for the exchange of engineering experience, to standardize the industry by means of codes of design and testing, and to conduct research investigations for ascertaining the uncertain factors in the art.

The JOURNAL appearing monthly (except February, June and August), is read by 2,500 consulting engineers, architects and contractors actively engaged in heating and ventilating work. It gives them technical articles on important subjects, makes a permanent record of discoveries, experiments and other developments in the industry and thereby keeps them in constant touch with the best thought in the profession. The Society's meetings, news of the local Chapter events, and other happenings in the heating and ventilating field are also reported.

An exclusive service to JOURNAL readers is the presentation of the reports, made by the Society's Research Laboratory, reference data which is invaluable to the engineer, contractor and manufacturer in his daily work.

The JOURNAL offers manufacturers the opportunity of placing their equipment before a large group of discriminating

buyers at a minimum cost. The fact that it is the only technical journal exclusively in the heating and ventilating field makes it a most desirable advertising medium and especially so because of its class circulation. In addition to its proven merit as an advertising medium, its use by manufacturers indicates their desire to co-operate with the Society in advancing the interests of heating and ventilating.

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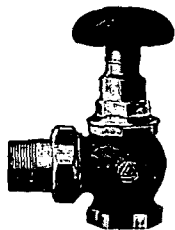
DETROIT LUBRICATOR COMPANY

DETROIT, U. S. A.

NEW YORK

CHICAGO

Largest Manufacturers of Radiator Valves in the World



Detroit Type "A" Packless Valve

The "Genuine Detroit" Type "A" 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 perfectly adapted also 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 and is easy turning.

A new and better design of handle is offered for the first time. It is a hard rubber finish, non-heat conductive, molded type, which will not break, lose its finish nor work loose on the stem.

Manufactured in angles, corners and globes $\frac{1}{2}$ to 2 in. sizes, and in satin finish with polished trimmings, nickel plated, Jenkins Bro. discs.

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.

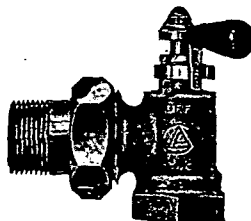
It is particularly sturdy in design with a stem which will stand hard usage and is equipped with a new type of non-breakable, non-heat-conducting round handle, with a handsome permanent black hard-rubber finish.

The handle has an indicator which 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 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 system to be easily and perfectly 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

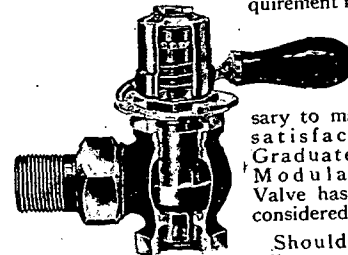
1923-1933 Carroll Avenue

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 neces-



Lever Handle Type of Dole Packless

sary to make a satisfactory Graduated or Modulating Valve has been considered.

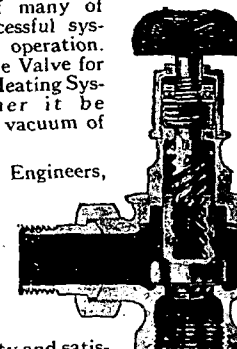
Should any adjustment be desired after the valve is installed

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.

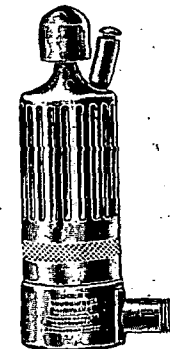
Dole Packless Graduated Valves have proven particularly valuable in the proper functioning of many of the most successful systems now in operation. There is a Dole Valve for every type of Heating System—whether it be steam, vapor, vacuum or hot water.

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 indorse Dole Valves in the most

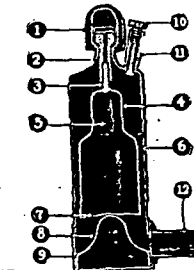


Knob Handle Style of Dole Packless

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.



Dole Shure-Vent Air Valve



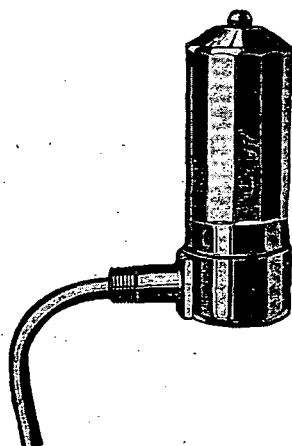
Twelve Superior Points of Shure-Vent Valves

1. Double Cap Prevents Wall Soil above Valve.
2. Seating Screw Projecting Prevents Clogging of Valve Seat.
3. Seating Pin Arrangement Insures Positive Closing Seat.
4. Annealed Brass Float Positively Prevents Flooding.
5. Expansion Fluid in Inner Chamber Causes Valves to Close.
6. Finely Drawn Brass Shell Permits Free Passage of Air and Natural Drain for Water.
7. Expansion Diaphragm Made of Special Spring Bronze.
8. Drawn Brass Float Rest Insures Complete Drainage of Valve.
9. Heavy Drawn Brass Base—a Positive Non-Leakable Connection of Great Durability.
10. Push Button—Impossible to Remove or Get Out of Adjustment.
11. Exclusive Hand Vent Solves the Problem of Water-Logging.
12. Heavy Brass Nipple or Inlet Adaptable to All Radiators.

DOLE SYPHON AIR VALVES

Seating Pin—finely machined hard metal seating point, hydraulic pressed to perfect radius, preventing possibility of sticking or binding.

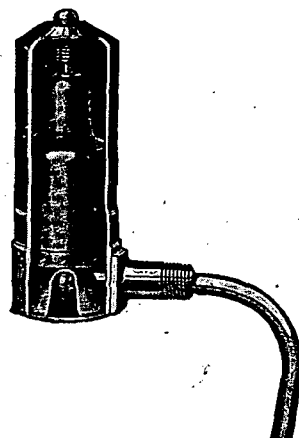
Float—made of light but strong annealed brass, rising when water enters the valve and positively prevents leakage.



Dole Syphon Air Valve

Venting Seat—heavy construction, threaded and brazed into valve casing, thus preventing possible injury to venting seat after valve is installed.

NOTE—Venting seat projects into interior of valve $\frac{3}{8}$ -inch. Water striking against this projection sprays down, preventing any possible spilling of water. Also forms obstruction, keeping dirt or flake from working into seat or valve.



Sectional View of Syphon Air Valve

Inner Chamber of Float—contains exactly proper amount of thermostatic liquid, which forms a powerful gas the instant steam comes in contact, expanding diaphragm and closing valve against escape of steam or water.

Diaphragm—made of special spring bronze, convex shape, corrugated. Expands with heat, contracts back when cold, thus opening and closing valve automatically.

Float Rest—one-piece, finely drawn brass, open on four sides to permit water to drain through syphon. Firmly braced into base, forming strong, substantial rest for float.

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.

The Fulton Company

Knoxville, Tennessee

BRANCHES:

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50 Church Street

DETROIT
Book Bldg.
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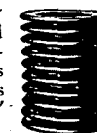
CHICAGO
Wrigley Bldg.
Michigan Boulevard

Representatives in All Principal Centers

Patentees and manufacturers of Syphon products. Syphon 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; Valves and other Heating Specialties.

Advantages

All Syphon 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 Syphon Products. Syphon diaphragms or bellows are made in sizes ranging from $1\frac{1}{2}$ " to 12" O. D.



No. 465 Standard Type Radiator Valve

A standard packed type radiator valve of unusual quality. Body, tail nut and tail pipe used are of a superior quality to those generally made for standard valves. Extra strong seats, hexes, unions, and spuds.

Ask for Bulletin RPV 3



No. 536 Syphon Air Radiator Valve

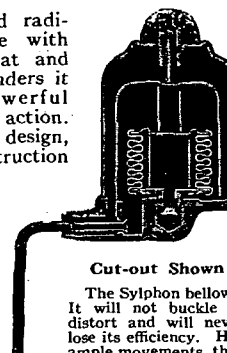
An improved radiator air valve with large thermostat and float which renders it extremely powerful and positive in action. It is pleasing in design, rigid in construction and durable.

The active principle is the Syphon bellows which for many years has been used by this company in all of its heating boiler specialties.

Cut-out Shown

The Syphon 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.

Ask for Bulletin RAV 3



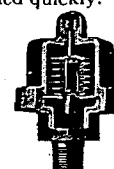
No. 527 Quick Vent Valve

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 $\frac{3}{4}$ " diameter. Valve connection $\frac{3}{8}$ " 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 draft so as to maintain a constant steam pressure up to 5 lb. This

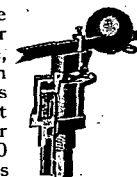
regulator is sensitive, positive in action and will last a life time, due to the Syphon one-piece, seamless, solderless, flexible metal bellows which it contains.

Ask for Bulletin RD 3



No. 45-A Water 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 degrees and 220 degrees 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



No. 930 and No. 931 Temperature Regulator

For nearly all requirements where liquids are heated by steam, and especially industrial uses. Regulators are regularly furnished with a temperature range of 140 degrees to 180 degrees Fahr. Special regulators can be furnished with adjustment for 20 degrees above or below the operating point for temperatures not lower than 20 degrees nor higher than 320 degrees 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 have placed them in a class by themselves, and made them applicable in hundreds of ways. No. 931 Regulators are furnished regularly in sizes from $\frac{1}{2}$ " to $2\frac{1}{2}$ " inclusive, and the No. 930 Regulator in sizes from $\frac{1}{2}$ " to 8" inclusive.

Upon application, a chart will be furnished showing size of regulator for any given condition.

Ask for Chart and Bulletin TR 3

No. 932 Temperature Regulator

Detachable Tube Type: This is the latest development in self-contained regulators. This regulator, is composed of three distinct and separable units. These

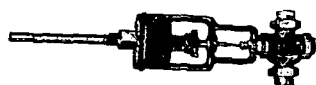
units are made so that each may be separately removed or replaced for repairs as the case may be. If the flexible tubing should become damaged or broken, the power transmitting unit may readily be replaced by loosening two lock nuts, and the repair part slipped in to place. The operation is similar to No. 930 and No. 931 instruments.

Ask for Bulletin TR 3

No. 933 Temperature Regulator

Direct Connected Type: Valve mounted directly on thermostatic bulb. For hot water storage tanks in hotels, office buildings, apartment houses, restaurants, clubs, etc. Adapted for use when steam pipe

"Specification Data"—Send for our "Specifications of Value" which gives complete engineering data in regard to the above products.



which supplies heating coil can be run past the point where regulator bulb is installed. Made in valve sizes $\frac{1}{2}$ " to $1\frac{1}{2}$ ". All valves are double-seated balanced type, with bronze discs and seats.

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 degrees to 80 degrees Fahr. It is largely used in offices and industrial plants. Small and neat in appearance, being 6" wide by $7\frac{1}{2}$ " long.

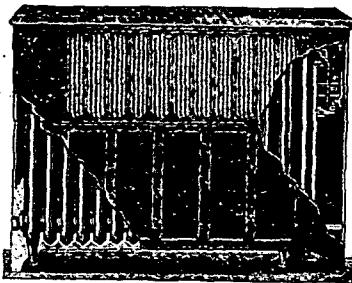
Ask for Bulletin RR 3

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.

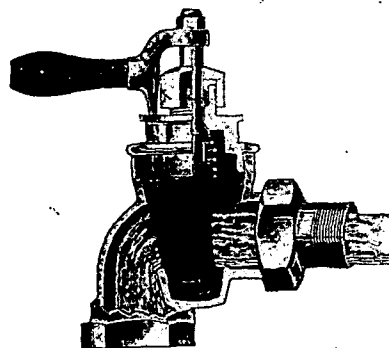
1917 Fisher Building, CHICAGO, ILL.

Steam and Hot Water Heating Boilers; Quarter Turn Packing Lock Radiator Valves; Single Pipe Vapor Heating System.

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 ten to twelve hours with one firing. They are built for both steam and hot water systems.

RADIATOR VALVES



The Gorton Quarter Turn Packing Lock Radiator Valve is applicable for all Steam, Vapor, Vacuum and Hot Water Heating Systems. It is made throughout of the best materials obtainable. It has the following advantages:—

It is quick opening, a turn of the wrist or a touch of the foot opens or closes it, a quarter turn of the lever is all that is needed. This tends to coal economy. Because of its easy operation women will shut off a radiator to cool a room.

The valve is made tight by means of a ball shoulder on valve stem seating in a ground opening in the under side of bonnet, like the seat of a safety valve. What slight wear may occur only tends to produce a better bearing surface. This is supplemented by soft but firm packing rings, forced and locked into the groove in valve stem by a gland forced down by the packing box nut. This combination insures a tight valve, and one that will remain tight.

The disc is made of a mineral composition; is not affected by steam or water. The disc and seat are both ground to perfect taper surface. This combination is proof against corrosion, wedging, cutting, abrasion and leaking.

Reference to the illustration shows the valve has a full pipe size, unobstructed, straight passageway. This permits a free rapid passage of steam or water through the valve unrestricted by friction, giving a quicker flow than in ordinary valves. This permits the use of a valve one size smaller than required when using the ordinary valve.

SCHEDULE OF GORTON VALVE SIZES
STEAM HEATING, SINGLE PIPE CONNECTION

Radiators up to 25 ft.	$\frac{1}{4}$ in. Valve
From 25 to 60 ft.	$\frac{1}{2}$ in. Valve
From 60 to 100 ft.	$\frac{3}{4}$ in. Valve
From 100 to 200 ft.	$1\frac{1}{4}$ in. Valve

VAPOR AND VACUUM HEATING, TWO PIPE CONNECTIONS

Radiators up to 90 ft.	$\frac{1}{4}$ in. Valve
From 90 to 180 ft.	$\frac{1}{2}$ in. Valve
From 180 to 360 ft.	$\frac{3}{4}$ in. Valve
From 360 to 540 ft.	$1\frac{1}{4}$ in. Valve
From 540 to 720 ft.	$1\frac{3}{4}$ in. Valve

HOT WATER HEATING

Use the regular size of Valves, according to the System installed.

The Gorton Quarter Turn Packing Lock Valve is made in both the Straightway and Angle patterns. Where a corner or offset valve is required, the Straightway Valve is used and connection made to it with a street elbow at any angle desired.

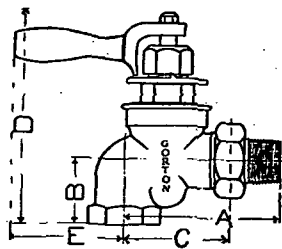
SINGLE PIPE VAPOR SYSTEM

The full opening in the valve, combined with the shape of this opening, allows the water of condensation from the radiator to flow along the bottom of the valve without interfering with the inflow of steam or vapor. This enables vapor to circulate through the entire system at low pressure. The Gorton Air Relief Valve gives easy, rapid and complete clearance of air at vapor pressure. These two features, the Gorton Supply Valve and the Gorton Air Relief Valve, give a Single Pipe Vapor System that has proven a great success.

LOCK SHIELDS

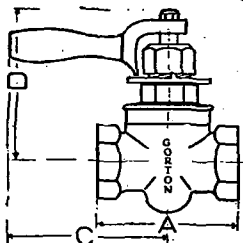
All Radiator Valves can be supplied with lock shields.

Roughing-in Dimensions—Radiator Valve



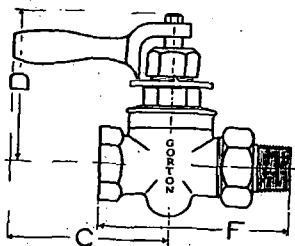
Size.....	1/2"	3/4"	1"	1 1/4"	1 1/2"
A	3 1/2	3 7/8	4 3/8	5	5 3/4
B	1 5/8	2	2 1/8	2 3/8	2 5/8
C	2 1/4	2 5/8	3	3 1/2	4
D	5 5/8	6	6 5/8	7 1/8	7 1/2
E	3	2 7/8	3 1/4	3 3/4	2 7/8

Straightway Valve



Size.....	1/2"	3/4"	1"	1 1/4"	1 1/2"
A	2 3/4	3 1/4	3 3/4	4 1/4	4 3/4
C	3 5/8	3 5/8	4 3/8	4 3/8	4 3/8
D	4	4 1/4	4 3/4	4 7/8	5 1/8

Straightway Valve with Union



Size.....	1/2"	3/4"	1"	1 1/4"	1 1/2"
F	4	4 5/8	5 1/4	5 3/8	6 3/8
C	3 5/8	3 5/8	4 3/8	4 3/8	4 3/8
D	4	4 1/4	4 3/4	4 7/8	5 1/8

Dimensions of modulating valves are the same as given above for radiator valves.

Pierce, Butler & Pierce Mfg. Corp.

41 E. 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

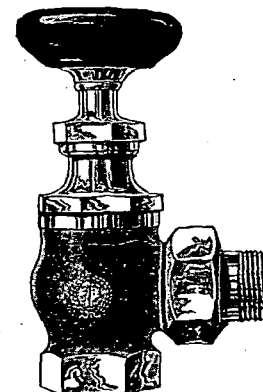
A Few of Its Outstanding Features

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.*

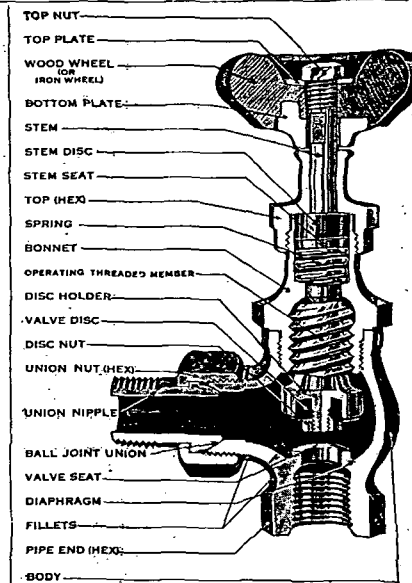
The stem disc can be renewed in a few minutes (if after years of service there appears need of renewal) *without shutting off or interfering with the steam line.*

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.

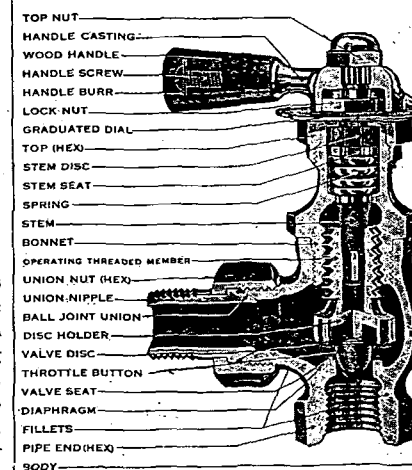
The Pierce Valve is of heavy proportions with strong hex's and walls. It is made from high grade bronze castings and nickel plated before assembly, thereby avoiding deposits of nickel salts in working parts. Its joints are graphited before setting up and are accordingly easy to take apart. All parts 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 Smolensky Valve Co., Inc.

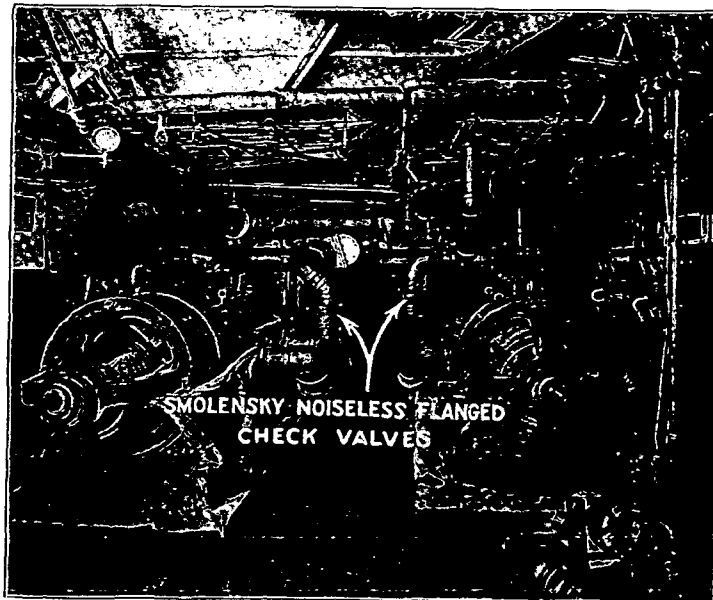
Cleveland, Ohio

Branch Offices

CHICAGO, ILL., 1307 Security Bldg. H. T. SWARD, Dist. Mgr.
 NEW YORK, N. Y., Grand Central Palace. C. A. McMANN, Dist. Mgr.
 PHILADELPHIA, PA., 509 Franklin Trust Bldg. H. L. SCHWARTZ
 HARTFORD, CONN. J. B. ENGR. SALES CO.
 SAN FRANCISCO, CAL., Rialto Bldg. KIRK W. EICHELBERGER

SMOLENSKY VALVES

FOR EVERY HEATING PURPOSE—EFFICIENT—ECONOMICAL—DURABLE



View Showing Centrifugal Pumps with Smolensky Noiseless Check Valves

LIST PRICES

STANDARD SMOLENSKY REGRINDING PACKLESS VALVES

Sizes (Woodwheel Type)	Inches	1/2"	3/4"	1"	1 1/4"	1 1/2"	2"
Finished and Plated All Over	Each	\$2.30	2.70	3.45	4.50	5.90	8.95
Dimensions—A	Inches	2 3/8"	2 7/8"	3 1/4"	3 7/8"	4 1/4"	5 1/4"
Sizes (Cast Iron Wheel)	Inches	1/2"	3/4"	1"	1 1/4"	1 1/2"	2"
Finished and Plated All Over	Each	\$1.45	1.50	1.65	2.04	2.75	3.60
Dimensions—A	Inches	2 1/4"	2 3/4"	3 1/8"	3 5/8"	4 1/8"	5 1/8"

STANDARD AND EXTRA HEAVY SMOLENSKY NOISELESS CHECK VALVES

Sizes (125 lb. pressure)	Inches	2"	2 1/2"	3"	4"	5"	6"	7"	8"	9"	10"	12"	14"	16"
Flanged	Each	\$25.00	29.00	30.00	39.00	63.25	85.95	103.97	130.70	190.00	230.00	310.00	450.00	520.00
Dimensions Face to Face In.	Inches	2 1/4"	2 3/4"	3 1/8"	3 5/8"	4 1/8"	5 1/8"	6 1/8"	6 3/4"	7 1/4"	8 1/2"	10 1/2"	12 1/4"	14 1/4"
Sizes (250 lb. pressure)	Inches	1 1/2"	2"	2 1/2"	3"	4"	5"	6"	8"	10"	12"	14"	16"	18"
Flanged	Each	\$16.35	28.25	31.50	39.80	49.00	69.86	105.00	130.00	190.00	230.00	310.00	450.00	520.00
Dimensions Face to Face	Inches	2 1/4"	2 3/4"	3 1/8"	3 5/8"	4 1/8"	5 1/8"	6 1/8"	6 3/4"	7 1/4"	8 1/2"	10 1/2"	12 1/4"	14 1/4"

STANDARD SMOLENSKY REGRINDING PACKLESS RADIATOR VALVES

Sizes	Inches	1/2"	3/4"	1"	1 1/4"	1 1/2"	2"
Finished, Plated all Over, Screwed Ends	Each	\$3.75	3.80	4.00	6.40	8.10	13.10
Dimensions—A	Inches	3"	3 1/4"	3 1/2"	3 3/4"	4"	4 1/4"

LIBERAL TRADE DISCOUNTS FROM LIST PRICES

American Larson Ventilating Co.

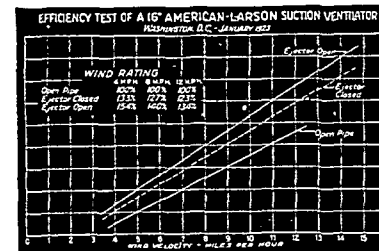
Main Office: PITTSBURGH, PA.

Product: American-Larson Rotary Suction Ventilators—proven, by competitive tests, to be the most efficient ventilator on the market.

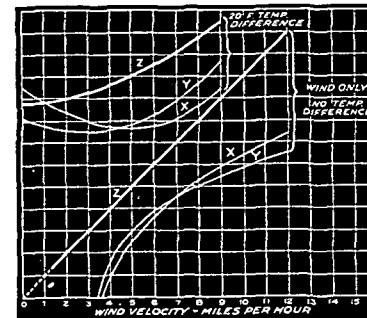
Efficiency: In a recent (January, 1923) test conducted by a disinterested party, more than 50 makes of ventilators were tested over a wide range of wind velocities and temperature differences with the result that the American-Larson Ventilator was shown to have the highest rating.

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 10
Dining rooms	8 to 12
Kitchens	8 to 12
Toilet and bathrooms	10 to 12
Foundries	15 to 20
Pickling rooms	10 to 12
Tanneries, paint rooms	5 to 6
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:

$$Q = A \left[\frac{36 H \sqrt{(t^0 - t^i)}}{6 + v} + 20 \times v \right]$$

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^i 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.

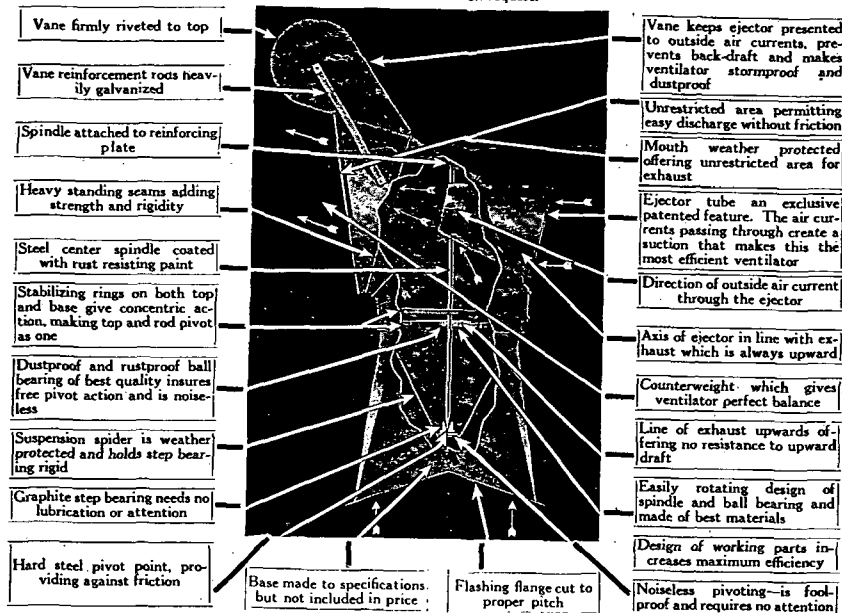
(4) The ventilators shall be erected plumb and in a substantial manner. Where extension pipes are used they shall be anchored to four points with heavy gauge guy wires.

(5) Ventilators for—shall be equipped with fusible links to close dampers automatically in case of fire.

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.	Discharge 5 miles velocity, cu. ft. per hr.
8	27	10	10	10	24	\$1.50	\$20.00	12	26	11,550
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	18	20.00	170.00	390	560	412,500
54	187	72	63	63	18	25.00	220.00	620	820	524,700
60	208	80	76	76	18	35.00	300.00	790	1025	646,800
66	229	88	84	84	18	35.00	375.00	930	1215	782,100

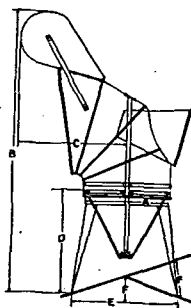
Prices subject to change without notice. Discounts furnished on request.



AMERICAN-LARSON SUCTION VENTILATOR (Patented)
5939 S.E.—2/2—17.5

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.
Asbestos protected 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.



THE JOHN CALL Co's., products, include: The Liberty Super-Syphon Vortex Vacuum Ventilator, a roof ventilator for ventilating any type building or enclosure such as Schools, Hospitals, Foundries, Barns, Churches, Armories, Residences and similar structures.

They are successful in assisting drafts in chimneys, flues, stacks, etc. The Liberty Super-Syphon Vortex Vacuum Ventilator will not back draft. They have no moving parts and will not rattle or get out of order. They are substantially and staunchly built of any metal desired. Large stocks for prompt shipment.

Write for catalogs and prices.



Liberty Super-Syphon Vortex Vacuum Ventilator showing construction



Callaway showing Spiral Blades and Interior construction of Liberty Super-Syphon Ventilator

Description—The Liberty Super-Syphon Vortex Ventilator consists of cylindrical education pipe to which are attached eight blades at correctly pitched angle. At top of education tube between each blade is V shaped slot. Over blades is a skirt in shape of frustum of cone. This forms vortex and siphon chambers between education tube and skirt. Over education tube is correctly proportioned cone cap, with inverted cone beneath, outside of cone cap is scientifically constructed storm band.

Write for catalogs and prices.

The John Call Company

VENTILATING SPECIALISTS

128 North Franklin Street
Philadelphia, Pa.

BRANCHES IN ALL PRINCIPAL CITIES

ROOF VENTILATORS AND WINDOW VENTILATORS

THE PUL-AIR IMPINGMENT VENTILATOR



The Pul-Air Ventilator

A good practical roof ventilator of the mushroom type consisting of 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.

Write for prices and catalogs.

Useful where the Liberty Super-Syphon Roof Ventilator is not desired.

THE CALL UNIT WINDOW VENTILATOR

Purpose—To provide positive ventilation with window ventilator which is accomplished by positively exhausting air with exhaust fan. Consists of pressed steel, adjustable panel, finished in baked enamel with electric driven exhaust fan. Easy to install. Portable and Light.



Call Window Ventilator

Write for "A Breath of Fresh Air."

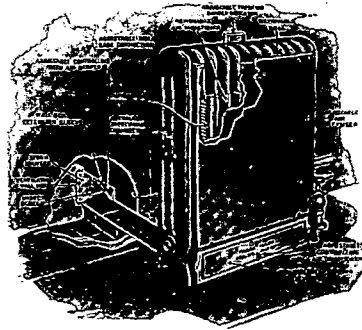
Prices and data on application.

C. C. Shipp & Company Indianapolis, Ind.

MANUFACTURERS OF

D-I Heating and Ventilating Specialties

Patented March 7, 1916, September 19, 1916, November 7, 1916,
January 16, 1917, March 13, 1917, December 17, 1918,
December 17, 1919, April 13, 1920, August 23, 1921,
September 26, 1922, January 23, 1923.



The D-I Unit

The D-I System is a natural, easy, simple, efficient and economical way of obtaining heat, ventilation and humidity, for new or old buildings. Especially adapted for use in schools and other public buildings.

The illustration shows a sectional end and front view of a standard 3-column, 38" steam radiator with 6" legs, completely equipped with the D-I ventilating specialties and with the exact location of each. The following specialties are shown:

Ventilating wall box; storm louvers; insect screens; wall box extension sleeve and adjustable controlling fresh air damper with dust-proof and non-corroding hinges; adjustable box base connection; adjustable ventilating box base; adjustable controlling fresh air damper arm; adjustable air diffusers with

removable rolls; adjustable fresh air damper indicator; and No. 12 removable air moisteners, with automatic supply and air release valves.

The specialties above are listed in the order of their installation on a 12-section radiator, equipped with series No. 2, 8"x24" D-I wall box outfit, furnishing and diffusing into the room, without drafts, a supply of fresh air sufficient for eight pupils, regardless of outside atmospheric conditions, when heating system is in operation.

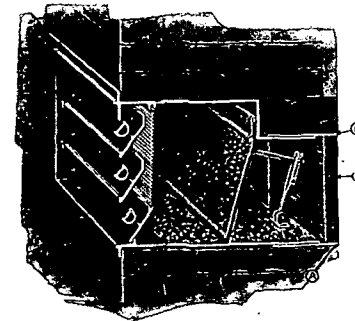
CAPACITIES, 8 IN. SERIES

Series No.	Size D-I Wall Box Inches	Air Capacity Sq. In.	Cu. Ft. Air Per Minute	Cu. Ft. Air Per Pupil	Sections of Radiator Covered
1	8x20	120	180	30	8
2	8x24	144	240	30	10
3	8x30	180	300	30	12

CAPACITIES, 10 1/2 IN. SERIES

Series No.	Size D-I Wall Box Inches	Air Capacity Sq. In.	Cu. Ft. Air Per Minute	Cu. Ft. Air Per Pupil	Sections of Radiator Covered
4	10 1/2 x 20	160	270	30	10
5	10 1/2 x 24	192	330	30	10
6	10 1/2 x 30	240	420	30	12

PRICES QUOTED UPON APPLICATION



D-I Ventilating Wall Box

The illustration herewith shows a sectional end and side view of a D-I Ventilating Wall Box, D-I Wall Box Extension Sleeve and adjustable controlling fresh air damper with dust-proof and non-corroding hinges, fully set up and ready to place in the wall just as it is shipped.

"A" Bottom of wall box to be set 1" above finished floor.

"C" A 2x4 should be placed in the off-set of the sleeve and extend 6 inches on each side to be used as a nailing strip.

"E" This board should not be removed from its place until the time of setting radiator.

When the damper is closed, as shown in the illustration, it prevents any seepage of air from outside the building—the harder the wind blows, the tighter it closes.

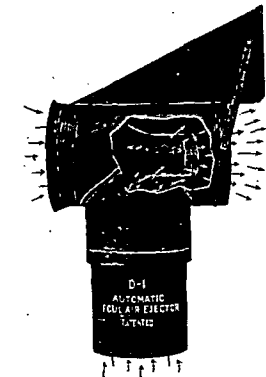
D-I Automatic Foul Air Ejectors.

This is a positive turning device, revolving on ball bearings, and is noiseless in operation. It is not only weather-proof but is a real ventilator, doing its work at all times and under all conditions.

By means of utilizing the air current, a powerful ejector principle is constructed, insuring high velocity in the discharge of the air. The high efficiency will allow the use of smaller ventilators, or if the same size ventilator is used, greater results can be secured.

With this ejector, it is not a question of temperature of the air to be exhausted, and heavy gases, smoke or cold air are lifted and discharged with ease.

Furnished in galvanized iron unless otherwise ordered.



D-I Automatic Foul Air Ejector

Diameter (Inches)	Area of Diameter (Square Inches)	Price, Each
8	50	\$ 20.00
10	78	25.00
12	113	30.00
14	153	35.00
15	177	40.00
16	201	46.00
18	255	52.00
20	314	58.00
22	380	64.00
24	452	70.00
26	530	78.00
28	615	86.00
30	707	94.00
32	804	102.00

Base extra.

Diameter (Inches)	Area of Diameter (Square Inches)	Price, Each
34	908	\$ 110.00
36	1,018	120.00
38	1,123	130.00
40	1,256	145.00
42	1,386	160.00
44	1,520	180.00
46	1,650	205.00
48	1,809	230.00
50	1,962	260.00
52	2,128	290.00
54	2,290	320.00
56	2,473	360.00
58	2,642	400.00
60	2,828	450.00

Anti-Corrosion Engineering Co., Inc.

117 West 54th Street
New York, N. Y.

Apparatus for Removing and Preventing Rust in Hot and Cold Water Systems

Free Dissolved Oxygen contained in all natural waters is usually the cause of internal corrosion of water supply systems in power plants and buildings. This leads to destruction of apparatus, leaks, dirty water and choked circulation. Salts in the water accelerate corrosion, but without oxygen these salts are inactive. The removal of the **DISSOLVED OXYGEN** removes the cause of rust.

Corrosion is prevented in power plants and buildings by Anti-Corrosion Engineering Co., equipment by removing the free dissolved oxygen from the raw water. Our process is called **DEACTIVATION**. This apparatus is made in three distinct types to fit various conditions, of which there are over 200 now in successful operation.

Deoxidizing Deactivators are used for larger residences, apartment houses, smaller hotels, smaller office buildings and certain types of factory buildings. This type removes the free dissolved oxygen from the raw water by passing it through a deactivator filled with a series of perforated plates of a special highly corrosive metal—Sufficient time of contact is allowed to fix the free dissolved oxygen by expending its corrosive activity upon these plates. The resulting rust is precipitated and ejected through blow-out openings. Usually the water is filtered after leaving the deactivator before going to the house service, in order to remove the colloidal rust. Proper coagulation is accomplished by the passage of the raw water through a special coagulant before it reaches the deactivating tank.

Deaerating Deactivators are used for the larger hotels, larger office buildings and institutions, such as hospitals, colleges, etc., where a steady supply of steam is available. The dissolved oxygen and other gases are eliminated from the raw water in this deactivator by heating the water to a boiling temperature under mechanical agitation. The natural expansion process

resulting from the agitation of the water at the boiling temperature sets free all dissolved gases. This apparatus acts both as a deactivator and heater and little or no additional reheating of the water is required to obtain the desired temperature for any service. This apparatus may be located either on the roof or in the basement of the building.

Both the deoxidizing-deactivator and the deaerating-deactivator are applied to hot water supply systems only and are sufficient to overcome the corrosion problems under most conditions, as corrosion is much more rapid at higher than at lower temperatures.

Vacuum Type Cold Water Deactivators are used wherever the cold water as well as the hot water supply system have reached a serious condition through the action of rust in the piping and apparatus. In this apparatus the water from the source of supply is taken into the deactivator under a vacuum where it is mechanically agitated and broken up. The vacuum applied to this tank removes the gases leaving the water free from these agencies which cause corrosion. A removal pump takes the water from the deactivator and delivers it to the house pumps of the building. Both cold and hot water are then delivered under pump pressure to the cold and hot water systems of the building. Where a building is provided with a roof tank this acts as a reserve at any time the pressure pumps should be shut down.

The effect of the deactivation of the cold as well as the hot water supply is to gradually break down and remove the accumulated products of corrosion, restoring full circulation of water and protecting the piping against disintegration which is the cause of leaks.

Refer to the **GUIDE 1922**, for further details and apply to us for specifications, dimensions, weights, capacities, recommendations, etc.

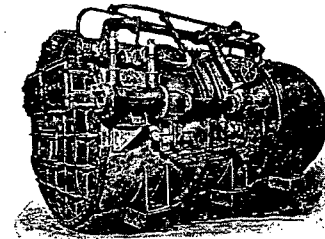
H. S. B. W.-Cochrane Corporation

Formerly Harrison Safety Boiler Works.

3120 North 17th Street

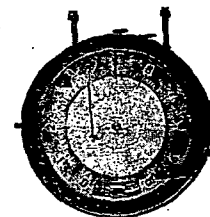
PHILADELPHIA, PA.

"COCHRANIZE THE HEATING SYSTEM"

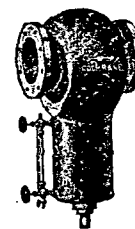


The **Cochrane Deaerating Heater** expels oxygen and other gases from water and thereby prevents corrosion in hot water heating and service piping, economizers and boilers. The water is delivered at any temperature above 140 deg. Fahr., using only the amount of exhaust steam necessary to heat the water to the desired final temperature, no steam or heat being wasted. 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 occupies much less space than a heater with an independent separator in a by-pass, and saves the cost of installing the independent separator.

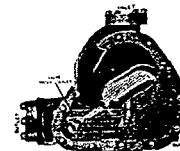


The **Cochrane Flow Meter** is a simple, reliable and accurate device for measuring water, steam or air flowing in pipes. There are no working parts in the pressure chambers and no stuffing boxes. The chart divisions are uniform. The pressure connections are included in the orifice plate, eliminating 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. Each disc has an independent dash pot and is held to its seat by an independent spring, the tension upon all the springs being adjusted by a hand-wheel inside the housing. The predetermined back pressure cannot be exceeded.

The **Cochrane Oil Separator**. Exhaust steam purified 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 Multiport Drainer** removes condensate or drips from heating or drying coils, radiators, jackets, low-pressure steam and oil separators, etc. The balanced cylindrical valve has large ports, and large capacity with low operating pressure. It never leaves its seat, is self-cleaning and is always water-sealed. There are no stuffing boxes, packings, springs or links.

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Carrier Air Conditioning Co.
Carrier Engineering Corp.
Clarage Fan Co.
Drying Systems, Inc.
Fleisher, W. L., & Co., Inc.
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Ames Iron Works
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Gorton & Lidgerwood Co.
International Heater Co.
Kewanee Boiler Co.
Molby Boiler Co., Inc.
Oil City Boiler Works
Page, Wm. H., Boiler Co.
Prox, Frank, Co.
Reading Heater & Supply Co., Inc.
Richardson & Boynton Co.
Richmond Radiator Co.
Smith, H. B., Co.
Standard Heater Co.
Thatcher Furnace Co.
XXth Century Heating & Ventilating Co.
U. S. Radiator Corp.
Utica Heater Co.
- Heating (Gas Fired)**
American Radiator Co.
Bryant Heater & Mfg. Co.
- Heating (Oil Fired)**
Petroleum Heat & Power Co.
- Tubular**
Ames Iron Works
Brownell Co.
Davis, J. F., & Sons Co.
Kewanee Boiler Co.
Oil City Boiler Works
- BRACKETS** (See *Hangers, Pipe and Radiator*)
- BRICK—Fire**
Johns-Manville, Inc.
Kier Fire Brick Co.
- Insulating**
Celite Products Co.
Johns-Manville, Inc.
- BURNERS—Oil (For Heating Boilers and Furnaces)**
Petroleum Heat & Power Co.
- CEMENT—Asbestos** (See *Asbestos and Insulating Products*)
- Fire Brick**
Celite Products Co.
Johns-Manville, Inc.
- Pipe Joint**
Crane Co.
- Water Proof**
Celite Products Co.
- CENTRIFUGAL DRYERS** (See *Drying Apparatus*)
- COCKS—Air**
Crane Co.
Detroit Lubricator Co.
- Boiler Drain**
Crane Co.
Detroit Lubricator Co.
- Gage**
Crane Co.
Detroit Lubricator Co.
O-E Specialty Mfg. Co.
Reliance Gauge Column Co.
- COILS—Ammonia**
American Blower Co.
Carrier Construction Co.
Crane Co.
Pennsylvania Engineering Co.
- Blast**
Crane Co.
Stickie Steam Specialties Co.
- Pipe**
Badger, E. B. & Sons Co.
Crane Co.
- Tank**
Badger, E. B. & Sons Co.
Carrier Construction Co.
Crane Co.
Sturtevant, B. F., Co., Inc.
- COLLECTORS, DUST** (See *Dust Collectors*)
- COLUMNS—Water**
Bryant Heater & Mfg. Co.
Crane Co.
Reliance Gauge Column Co.
- COMPOUNDS—Boiler**
Johns-Manville, Inc.
"X" Laboratories
- COMPRESSORS**
Bishop & Babcock Co.
Nash Engineering Co.
- CONDENSERS**
American Radiator Co.
Buffalo Steam Pump Co.
Carrier Construction Co.
Carrier Engineering Corp.
Ross Heater & Mfg. Co., Inc.
Westinghouse Electric & Mfg. Co.
- CONDUIT—Underground**
Johns-Manville, Inc.
Ric-wil Co.
- CONTROL SWITCHES** (See *Switches, Control*)
- CONTROLLERS—Boiler**
McAlear Mfg. Co.
- Electric Heat**
Honeywell Heating Specialties Co.
Johnson Service Co.
Minneapolis Heat Regulator Co.
Powers Regulator Co.
Westinghouse Electric & Mfg. Co.
- Fan Engine**
General Electric Co.
- Feed Water**
Davis, G. M. Regulator Co.
Kieley & Mueller, Inc.
McAlear Mfg. Co.

INDEX TO MODERN EQUIPMENT

- Motor**
General Electric Co.
- Pump**
Buffalo Steam Pump Co.
Davis, G. M., Regulator Co.
Dunham, C. A., Co.
General Electric Co.
Illinois Engineering Co.
Kieley & Mueller, Inc.
McAlear Mfg. Co.
Stickie Steam Specialties Co.
Webster, Warren & Co.
- Tank**
McAlear Mfg. Co.
Powers Regulator Co.
- Temperature** (See *Regulators, Temperature*)
- CONVEYING SYSTEMS** (See *Systems, Dust Collecting and Exhaust*)
- COOLING TOWERS**
Badger, E. B. & Sons Co.
Cooling Tower Co., Inc.
- COVERING—Boiler** (See *Asbestos and Insulating Products*)
- Magnesia**
Johns-Manville, Inc.
Kearbey, Robert A., Co.
Kearbey & Mattison Co.
- Pipe and Tank**
American Radiator Co.
Celite Products Co.
Johns-Manville, Inc.
Kearbey, Robert A., Co.
Kearbey & Mattison Co.
Ric-wil Co.
- Wood Pipe**
Celite Products Co.
- DAMPER REGULATORS**
(See *Regulators, Damper*)
- DEHUMIDIFYING — APPARATUS**
American Blower Co.
Atmospheric Conditioning Corp.
Carrier Engineering Corp.
Fleisher, W. L., & Co., Inc.
Sturtevant, B. F., Co., Inc.
- DIFFERENTIAL LOOPS**
Hoffman Specialty Co., Inc.
- DRYING APPARATUS**
American Blower Co.
Atmospheric Conditioning Corp.
Bayley Mfg. Co.
Buffalo Forge Co.
Carrier Construction Co.
Carrier Engineering Corp.
Clarage Fan Co.
Drying Systems, Inc.
Fleisher, W. L., & Co., Inc.
Reed, William, Eng. Co., Inc.
Skinner Bros. Mfg. Co.
Sturtevant, B. F., Co., Inc.
York Heating & Ventilating Corp.
- DUST COLLECTING SYSTEMS**
(See *Systems, Dust Collecting*)
- DUST COLLECTORS**
American Blower Co.
Bayley Mfg. Co.
Buffalo Forge Co.
Carrier Construction Co.
Carrier Engineering Corp.
Clarage Fan Co.
- Hersh Brothers Co.**
Skinner Bros. Mfg. Co., Inc.
Sturtevant, B. F., Co., Inc.
York Heating & Ventilating Corp.
- DUST SEPARATORS** (See *Separators, Dust*)
- ELECTRIC MOTORS** (See *Motors, Electric*)
- ELIMINATORS—Air**
Bishop & Babcock Co.
Dunham, C. A., Co.
Hoffman Specialty Co., Inc.
Illinois Engineering Co.
Monash-Younger Co.
McAlear Mfg. Co.
O-E Specialty Mfg. Co.
Trane Co.
Webster, Warren, & Co.
- ENGINES—Fan**
American Blower Co.
Bayley Mfg. Co.
Brownell Co.
Buffalo Forge Co.
Clarage Fan Co.
Sturtevant, B. F., Co., Inc.
- Steam (Automatic, High Speed, Throttling, Una-Flow, and Vertical)**
Ames Iron Works
American Blower Co.
Automatic Furnace Co.
Bayley Mfg. Co.
Brownell Co.
Clarage Fan Co.
Sturtevant, B. F., Co., Inc.
Westinghouse Electric & Mfg. Co.
- EQUALIZING LOOPS**
Hoffman Specialty Co., Inc.
- EVAPORATORS**
Badger, E. B., & Sons Co.
- EXHAUST FANS** (See *Fans, Exhaust*)
- EXHAUST HEADS**
Carrier Construction Co.
Crane Co.
Illinois Engineering Co.
McAlear Mfg. Co.
Patterson-Kelley Co.
Skinner Bros. Mfg. Co., Inc.
- EXHAUST SYSTEMS**
American Blower Co.
Bayley Mfg. Co.
Buffalo Forge Co.
Carrier Construction Co.
Carrier Engineering Corp.
Clarage Fan Co.
Gordon, Robert, Inc.
Skinner Bros. Mfg. Co., Inc.
Sturtevant, B. F., Co., Inc.
York Heating & Ventilating Corp.
- EXPANSION JOINTS** (See *Joints, Expansion*)
- EXPANSION TANKS** (See *Tanks, Expansion*)
- FANS—Blower** (See *Blowers, Fan*)
- Exhaust**
American Blower Co.
Bayley Mfg. Co.
Buffalo Forge Co.
Clarage Fan Co.
General Electric Co.
Hersh Brothers Co.
- Skinner Bros. Mfg. Co., Inc.**
Sturtevant, B. F., Co., Inc.
Westinghouse Electric & Mfg. Co.
York Heating & Ventilating Corp.
- Ventilating**
American Blower Co.
Bayley Mfg. Co.
Buffalo Forge Co.
Clarage Fan Co.
General Electric Co.
Hersh Brothers Co.
Skinner Bros. Mfg. Co., Inc.
Sturtevant, B. F., Co., Inc.
York Heating & Ventilating Corp.
Westinghouse Electric & Mfg. Co.
Wing, L. J., Mfg. Co.
- FILTERS—Air**
Carrier Engineering Corp.
Midwest Air Filters, Inc.
Reed, Wm., Eng. Co., Inc.
- FIRE BRICK CEMENT** (See *Cement, Fire Brick*)
- FITTINGS—Flanged**
Crane Co.
- Furnace**
Haynes-Langenberg Mfg. Co.
International Heater Co.
- Pipe**
Crane Co.
International Heater Co.
- Union**
Crane Co.
- FURNACES—Automatic**
Automatic Furnace Co.
Riley Sanford Stoker Co.
- Gas**
Bryant Heater & Mfg. Co.
- Pipeless**
Cox, Abram, Stove Co.
International Heater Co.
Richardson & Boynton Co.
Thatcher Furnace Co.
Utica Heater Co.
- Warm Air**
American Foundry & Furnace Co.
Cox, Abram, Stove Co.
Haynes-Langenberg Mfg. Co.
Richardson & Boynton Co.
Thatcher Furnace Co.
XXth Century Heat. & Vent. Co.
Utica Heater Co.
- GAGE—Boards**
Bishop & Babcock Co.
McAlear Mfg. Co.
Webster, Warren, & Co.
- Cocks** (See *Cocks, Gage*)
- Glasses** (See *Glasses, Gage*)
- Valves** (See *Valves, Gage*)
- GAGES—Pressure**
Crane Co.
Donnelly Systems Co.
Dunham, C. A., Co.
O-E Specialty Mfg. Co.
Pennsylvania Engineering Co.
Pierce Butler & Pierce Mfg. Corp.
Stack Heater Co.
- Steam**
Detroit Lubricator Co.
O-E Specialty Mfg. Co.

Vacuum

Bishop & Babcock Co.
Donnelly Systems Co.
Dunham, C. A., Co.
O-E Specialty Mfg. Co.
Trane Co.

Water

Crane Co.
Detroit Lubricator Co.
Pennsylvania Engineering Co.
Pierce Butler & Pierce Mfg. Corp.
Reliance Gauge Column Co.

GAS—Burners

Bryant Heater & Mfg. Co.

Furnaces (See Furnaces, Gas)

Heaters—Room (See Heaters, Gas)

Heating Systems (See Heating Systems, Gas)

Water Heaters

Bryant Heater & Mfg. Co.
EverHot Heater Co.

GASKETS—Asbestos

Crane Co.
Johns-Manville, Inc.
Keasbey & Mattison Co.

Boiler

Johns-Manville, Inc.

Metallic

Crane Co.

Rubber

Crane Co.

GATES—Blast

American Blower Co.
Bayley Mfg. Co.
Buffalo Forge Co.
Carrier Engineering Corp.
Clarage Fan Co.
Sturtevant, B. F., Co., Inc.
York Heating & Ventilating Corp.

GENERATOR COOLING SYSTEMS

Atmospheric Conditioning Corp.
Carrier Engineering Corp.
Cooling Tower Co., Inc.
Sturtevant, B. F., Co., Inc.

GENERATORS—Hot-Water

EverHot Heater Co.
Excelso Specialty Works
Reading Heater & Supply Co., Inc.
Thermal Appliance Co.

Electric

General Electric Co.
Sturtevant, B. F., Co., Inc.
Westinghouse Electric & Mfg. Co.

Heat (See Boilers, Furnaces and Heaters)

Vacuum

A. & P. Regulator Co.

GLASSES—Gage

Crane Co.
Detroit Lubricator Co.

GOVERNORS—Condensation

McAlear Mfg. Co.

Pump (See Regulators, Pump)

Vacuum (See Regulators, Vacuum)

GRATES—Dumping

Automatic Furnace Co.
Kewanee Boiler Co.

Rocking

Kewanee Boiler Co.

Shaking

Automatic Furnace Co.
Kewanee Boiler Co.

GRILLES AND REGISTERS (See Registers and Grilles)

HANGERS—Adjustable Pipe

Fowler & Wolfe Mfg. Co.
Gleockle, A. F., Jr.

Pipe

Crane Co.

Radiator

American Foundry & Furnace Co.
Fowler & Wolfe Mfg. Co.
Gleockle, A. F., Jr.
Healy-Ruff Co.

HEADERS

Crane Co.

HEAT INTERCHANGERS

Carrier Engineering Corp.
Drying System Inc.
Ross Heater & Mfg. Co., Inc.
Sturtevant, B. F., Co., Inc.

HEATERS—Automatic Hot Water

EverHot Heater Co.
Thermal Appliance Co.

Feed Water

American Blower Co.
Brownell Co.
H. S. B. W.-Cochrane Corp.
Kieley & Mueller, Inc.
Patterson-Kelley Co.
Ross Heater & Mfg. Co., Inc.
Standard Heater Co.
Stickley Steam Specialties Co.
Webster, Warren, & Co.

Gas

Bryant Heater & Mfg. Co.

Hot Water Service

Burnham Boiler Corp.
Continental Heater Corp.
EverHot Heater Co.
Excelso Specialty Works
International Heater Co.
Kewanee Boiler Co.
Page, Wm. A., Boiler Co.
Pierce, Butler & Pierce Mfg. Corp.
Prox, Frank, Co.
Reading Heater & Supply Co., Inc.
Richardson & Boynton Co.
Richmond Radiator Co.
Ross Heater & Mfg. Co., Inc.
Smith, H. B., Co.
Thatcher Furnace Co.
Thermal Appliance Co.
U. S. Radiator Corp.
Utica Heater Co.

Indirect

American Radiator Co.
Excelso Specialty Works
Sturtevant, B. F., Co., Inc.
Thermal Appliance Co.
York Heating & Ventilating Corp.

Industrial

Carrier Construction Co.
Drying Systems, Inc.
Gordon, Robert, Inc.
Ross Heater & Mfg. Co., Inc.
Wing, L. J., Mfg. Co.

Instantaneous Hot Water

EverHot Heater Co.
Patterson-Kelley Co.

Powers Regulator Co.

Ross Heater & Mfg. Co., Inc.
Stack Heater Co.
Thermal Appliance Co.

Room

American Foundry & Furnace Co.
Haynes-Langenberg Mfg. Co.
International Heater Co.
Thatcher Furnace Co.
Utica Heater Co.
XXth Century Heat. & Vent. Co.

Tank

Burnham Boiler Corp.
Cox, Abram, Stove Co.
H. S. B. W.-Cochrane Corp.
International Heater Co.
Kewanee Boiler Co.
Page, Wm. H., Boiler Co.
Patterson-Kelley Co.
Pierce, Butler & Pierce Mfg. Corp.
Prox, Frank, Co.
Reading Heater & Supply Co., Inc.
Richardson & Boynton Co.
Richmond Radiator Co.
Ross Heater & Mfg. Co., Inc.
Smith, H. B., Co.
Thatcher Furnace Co.
U. S. Radiator Corp.

Unit

American Blower Co.
Bayley Mfg. Co.
Clarage Fan Co.
Skinner Bros. Mfg. Co., Inc.
Stickley Steam Specialties Co.
Sturtevant, B. F., Co., Inc.
Wing, L. J., Mfg. Co.
York Heating & Ventilating Corp.

HEATING AND VENTILATING APPARATUS

American Blower Co.
American Radiator Co.
Buffalo Forge Co.
Carrier Construction Co.
Carrier Engineering Corp.
Clarage Fan Co.
Fleisher, W. L., & Co., Inc.
Gordon, Robert, Inc.
Haynes-Langenberg Mfg. Co.
Hersh Brothers Co.
Illinois Engineering Co.
International Heater Co.
Molby Boiler Co., Inc.
Reading Heater & Supply Co., Inc.
Reed, William, Eng. Co., Inc.
Shipp, C. C., & Co.
Skinner Bros. Mfg. Co., Inc.
Smith, H. B., Co.
Sturtevant, B. F., Co., Inc.
Wing, L. J., Mfg. Co.
York Heating & Ventilating Corp.

HEATING SPECIALTIES

A. & P. Regulator Co.
Bishop & Babcock Co.
Dalzell Bros. Co.
Donnelly Systems Co.
Excelso Specialty Works
Fulton Co.
Hoffman Specialty Co., Inc.
Honeywell Heating Specialties Co.
Illinois Engineering Co.
Monash-Younger Co.
Pierce, Butler & Pierce Mfg. Co.
Reading Heater & Supply Co., Inc.
Reed, William, Eng. Co., Inc.
Shipp, C. C., & Co.
Trane Co.
Webster, Warren, & Co.
York Heating & Ventilating Corp.

HEATING SYSTEMS—Gas

Bryant Heater & Mfg. Co.
Gordon, Robert, Inc.

Hot Blast

American Blower Co.
Buffalo Forge Co.

Carrier Construction Co.
Carrier Engineering Corp.
Clarage Fan Co.
Gordon, Robert, Inc.
International Heater Co.
Skinner Bros. Mfg. Co., Inc.
Sturtevant, B. F., Co., Inc.
York Heating & Ventilating Corp.

Hot Water

American Radiator Co.
Bryant Heater & Mfg. Co.
Burnham Boiler Corp.
Continental Heater Corp.
Cox, Abram, Stove Co.
D. & T. Mfg. Co.
International Heater Co.
Prox, Frank, Co.
Reading Heater & Supply Co., Inc.
Richardson & Boynton Co.
Ross Heater & Mfg. Co., Inc.
Standard Heater Co.
Thatcher Furnace Co.
Utica Heater Co.

Steam

American Blower Co.
American Radiator Co.
Burnham Boiler Corp.
Cox, Abram, Stove Co.
Dunham, C. A., Co.
Gordon, Robert, Inc.
International Heater Co.
O-E Specialty Mfg. Co.
Skinner Bros. Mfg. Co., Inc.
Webster, Warren, & Co.

Steam (Exhaust)

Gordon, Robert, Inc.
Webster, Warren, & Co.

Steam (Vacuum)

Bishop & Babcock Co.
Dunham, C. A., Co.
Gordon, Robert, Inc.
Illinois Engineering Co.
O-E Specialty Mfg. Co.
Webster, Warren, & Co.

Steam (Vapor)

American Radiator Co.
Bishop & Babcock Co.
Gordon, Robert, Inc.
Gorton & Lidgerwood Co.
Illinois Engineering Co.
International Heater Co.
O-E Specialty Mfg. Co.
Richardson & Boynton Co.
Trane Co.
Webster, Warren, & Co.

Warm-Air

Cox, Abram, Stove Co.
Gordon, Robert, Inc.
International Heater Co.
Haynes-Langenberg Mfg. Co.
XXth Century Heat. & Vent. Co.

HOT BLAST HEATING SYSTEMS (See Heating Systems, Hot Blast)

HOT WATER HEATERS, AUTOMATIC (See Heaters, Automatic Hot Water)

HOT WATER HEATERS, SERVICE (See Heaters, Hot Water Service)

HOT WATER HEATERS, INSTANTANEOUS (See Heaters Instantaneous Hot Water)

HOT WATER HEATING SYSTEMS (See Heating Systems, Hot Water)

HUMIDIFIERS

American Blower Co.
Atmospheric Conditioning Corp.

Bahnson Co.
Bayley Mfg. Co.
Bishop & Babcock Co.
Carrier Air Conditioning Co.
Carrier Engineering Corp.
Drying Systems, Inc.
Fleisher, W. L., & Co., Inc.
Shipp, C. C., & Co.
Skinner Bros. Mfg. Co., Inc.
Sturtevant, B. F., Co., Inc.

HUMIDITY CONTROL

American Blower Co.
Atmospheric Conditioning Corp.
Bahnson Co.
Bayley Mfg. Co.
Bishop & Babcock Co.
Carrier Engineering Corp.
Clarage Fan Co.
Drying Systems, Inc.
Fleisher, W. L., & Co., Inc.
Fulton Co.
Johnson Service Co.
Shipp, C. C., & Co.
Sturtevant, B. F., Co., Inc.

INSTRUMENTS—Indicating

Sarco Co., Inc.

Recording

Westinghouse Electric & Mfg. Co.

INSULATING MATERIALS (See Asbestos and Insulating Products)

Cold

Johns-Manville, Inc.
Keasbey & Mattison Co.

Heat

Celite Products Co.
Johns-Manville, Inc.
Keasbey & Mattison Co.
Ric-wil Co.

JOINTS—Expansion

Badger, E. B., & Sons Co.
Crane Co.
Illinois Engineering Co.
Ric-wil Co.
Ross Heater & Mfg. Co., Inc.
Webster, Warren, & Co.

Pipe

Crane Co.

KILNS, DRY

American Blower Co.
Carrier Construction Co.
Drying Systems, Inc.
Sturtevant, B. F., Co., Inc.

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.
Carrier Engineering Corp.
Clarage Fan Co.
Sturtevant, B. F., Co., Inc.

METAL WEATHER STRIPS

Monarch Metal Products Co.

METERS—Feed Water

H. S. B. W.-Cochrane Corp.
Webster, Warren, & Co.

Flow

H. S. B. W.-Cochrane Corp.

Pitot Tube

American Blower Co.

Steam

H. S. B. W.-Cochrane Corp.

MICA

Johns-Manville, Inc.
Westinghouse Electric & Mfg. Co.

MOISTENERS, AIR (See Humidifiers)

MOTOR CONTROLLERS (See Controllers, Motor)

MOTORS—Electric

Honeywell Heating Specialties Co.
General Electric Co.
Sturtevant, B. F., Co., Inc.
Westinghouse Electric & Mfg. Co.

NOZZLES—Brine Spray

Atmospheric Conditioning Corp.
Buffalo Forge Co.
Carrier Engineering Corp.

Spray

American Blower Co.
Atmospheric Conditioning Corp.
Carrier Engineering Corp.
Cooling Tower Co., Inc.
Sturtevant, B. F., Co., Inc.

OIL BURNERS

Petroleum Heat & Power Co.

OILERS

Detroit Lubricator Co.

PACKING—Asbestos

Crane Co.
Johns-Manville, Inc.
Keasbey, Robert A., Co.

Metallic

Johns-Manville, Inc.

Rubber

Crane Co.
Johns-Manville, Inc.

PIPE—Bending

Badger, E. B., & Sons Co.

Cast Iron

Crane Co.

Coils (See Coils, Pipe)

Covering (See Covering, Pipe and Tank; Wood Pipe; also, Conduits)

Fittings

Crane Co.

Hangers (See Hangers, Pipe)

Joint Cement (See Cement, Pipe Joint)

Plugs (See Plugs, Pipe)

Wrought Iron and Steel

Crane Co.

PIPELESS FURNACES (See Furnaces, Pipeless)

PLUGS—Fusible, Detroit Lubricator Co.

Pipe Crane Co.

Radiator American Radiator Co. Crane Co. Richmond Radiator Co. U. S. Radiator Corp.

POWER PLANT SUPPLIES Badger, E. B., & Sons Co. Crane Co.

PRESSURE GAGES (See Gages, Pressure)

PROTECTORS—Radiator Fulton Co.

PUBLICATIONS Heating and Ventilating Magazine. Journal of the American Society of Heating and Ventilating Engineers.

PUMPS—Air Bishop & Babcock Co. Nash Engineering Co. Trane Co.

Boiler Feed Bishop & Babcock Co. Buffalo Steam Pump Co. Nash Engineering Co. Skidmore Corp.

Centrifugal Bishop & Babcock Co. Buffalo Steam Pump Co. Nash Engineering Co.

Condensation Bishop & Babcock Co. Buffalo Steam Pump Co. Nash Engineering Co. O-E Specialty Mfg. Co. Trane Co.

Electric Buffalo Steam Pump Co.

Rotary Nash Engineering Co.

Steam Bishop & Babcock Co. Buffalo Steam Pump Co. Detroit Lubricator Co. McAlear Mfg. Co. Nash Engineering Co.

Turbine Nash Engineering Co. Skidmore Corp. Westinghouse Electric & Mfg. Co.

Vacuum Bishop & Babcock Co. Buffalo Steam Pump Co. McAlear Mfg. Co. Nash Engineering Co. Ross Heater & Mfg. Co. Skidmore Corp. Trane Co. Westinghouse Electric & Mfg. Co.

RADIATOR—Air Valves (See Valves, Air)

Brackets Fowler & Wolfe Mfg. Co. Gleockle, A. F., Jr. Healy-Ruff Co.

Covers

Fulton Co.

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—Hot Water

American Radiator Co.
Kewanee Boiler Co.
Pierce, Butler & Pierce Mfg. Corp.
Richmond Radiator Co.
Smith, H. B., Co.
Standard Heater Co.
U. S. Radiator Corp.

Steam

American Radiator Co.
Continental Heater Corp.
Kewanee Boiler Co.
Page, Wm. H., Boiler Co.
Richmond Radiator Co.
Smith, H. B., Co.
Standard Heater Co.
U. S. Radiator Corp.

Wall

American Radiator Co.
Fowler & Wolfe Mfg. Co.
Richmond Radiator Co.
Smith, H. B., Co.
U. S. Radiator Corp.

RECEIVERS—Air

Brownell Co.
Kewanee Boiler Co.

Ammonia Crane Co.

Ash

Brownell Co.

Condensation

Davis, G. M., Regulator Co.
H. S. B. W.-Cochrane Corp.
McAlear Mfg. Co.

REFRIGERATING MACHINERY

Carrier Engineering Corp.
Cooling Tower Co., Inc.
Johns-Manville, Inc.
Pennsylvania Engineering Co.

REGISTERS AND GRILLES

Haynes-Langenberg Mfg. Co.
Utica Heater Co.

REGULATORS—Damper

Bishop & Babcock Co.
Carrier Construction Co.
Carrier Engineering Corp.
D. & T. Manufacturing Co.
Dalzell Bros. Co.
Donnelly Systems Co.
Dunham, C. A., Co.
Fulton Co.
Hoffman Specialty Co., Inc.
Honeywell Heating Specialties Co.
Illinois Engineering Co.
Johnson Service Co.
Kieley & Mueller, Inc.
McAlear Mfg. Co.
Minneapolis Heat Regulator Co.
Monash-Younger Co.
O-E Specialty Mfg. Co.
Reading Heater & Supply Co., Inc.
Sarco Co., Inc.
Shipp, C. C., & Co.

Stickie Steam Specialties Co.
U. S. Radiator Corp.
Webster, Warren, & Co.
Wing, L. J., Mfg. Co.

Feed Water

Kieley & Mueller, Inc.
McAlear Mfg. Co.

Humidity

American Blower Co.
Carrier Engineering Corp.
Fleisher, W. L., & Co., Inc.
Fulton Co.
Johnson Service Co.

Pressure

Bryant Heater & Mfg. Co.
Crane Co.
Davis, G. M., Regulator Co.
Fulton Co.
Illinois Engineering Co.
Kieley & Mueller, Inc.
McAlear Mfg. Co.
Minneapolis Heat Regulator Co.
Stickie Steam Specialties Co.
U. S. Radiator Corp.

Pump

Davis, G. M., Regulator Co.
Dunham, C. A., Co.
H. S. B. W.-Cochrane Corp.
Illinois Engineering Co.
Kieley & Mueller, Inc.
McAlear Mfg. Co.
Stickie Steam Specialties Co.
Webster, Warren, & Co.

Steam

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Kieley & Mueller, Inc.
Minneapolis Heat Regulator Co.
Powers Regulator Co.
Reading Heat & Supply Co., Inc.
Sarco Co., Inc.
U. S. Radiator Corp.

Vacuum

A. & P. Regulator Co.
American Radiator Co.
Bishop & Babcock Co.
Davis, G. M., Regulator Co.
Fulton Co.
Illinois Engineering Co.
Johnson Service Co.
McAlear Mfg. Co.
Minneapolis Heat Regulator Co.
Powers Regulator Co.
Stickie Steam Specialties Co.
Webster, Warren, & Co.

Vapor

American Radiator Co.
Bishop & Babcock Co.
Donnelly Systems Co.
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Gorton & Lidgerwood Co.
Hoffman Specialty Co., Inc.
Honeywell Heating Specialties Co.
Illinois Engineering Co.
McAlear Mfg. Co.
Minneapolis Heat Regulator Co.
O-E Specialty Mfg. Co.
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Webster, Warren, & Co.

Water

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Sturtevant, B. F., Co., Inc.

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SCALE REMOVER—Boiler "X" Laboratories

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Keasbey & Mattison Co.

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Carrier Construction Co.
Dalzell Bros. Co.
York Heating & Ventilating Corp.

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Johns-Manville, Inc.
Kieley & Mueller, Inc.
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Reliance Gauge Column Co.

STOKERS

Automatic Furnace Co.
Riley, Sanford, Stoker Co.
Sturtevant, B. F., Co., Inc.
Westinghouse Electric & Mfg. Co.

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McAlear Mfg. Co.
Sarco Co., Inc.

Steam

Davis, G. M., Regulator Co.
McAlear Mfg. Co.
Sarco Co., Inc.

Water

Ross Heater & Mfg. Co., Inc.
Sarco Co., Inc.

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Anti-Corrosion Eng. Co., Inc.

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Gordon, Robert, Inc.
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Gordon, Robert, Inc.
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Powers Regulator Co.

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TRAPS—Radiator

Bishop & Babcock Co.
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Sarco Co., Inc.
Trane Co.
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Return

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Crane Co.
Donnelly Systems Co.
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Kieley & Mueller, Inc.
McAlear Mfg. Co.
Monash-Younger Co.
O-E Specialty Mfg. Co.
Trane Co.
Webster, Warren, & Co.

Steam

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Bayley Mfg. Co.
Crane Co.
Davis, G. M., Regulator Co.
Dunham, C. A., Co.
H. S. B. W.-Cochrane Corp.
Hoffman Specialty Co., Inc.
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Johns-Manville, Inc.
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Patterson-Kelley Co.
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Reliance Gauge Column Co.
Sarco Co., Inc.
Stickie Steam Specialties Co.
Sturtevant, B. F., Co., Inc.
Trane Co.

Vacuum

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Bishop & Babcock Co.
Crane Co.
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Hoffman Specialty Co., Inc.
Illinois Engineering Co.
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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
ACHESON, Albert R. (1919), Prof. of Mech. Engr., Syracuse University, and (for mail) 601 Eckel Theatre Bldg., Syracuse, N. Y.
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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., 1446 S. Canal St., Chicago, and (for mail) Franklin St., Geneva, Ill.

ATKINSON, Henry G. (Junior 1921), Johns-Manville Co., 296 Madison Ave., New York, N. Y., and Alpine, N. J.

ATKINSON, Robert E. (1897), (Board of Governors 1907), 6 Trafalgar Rd., Birkdale, Southport, England.

AUBINGER, Edw. W. (1921), Gen. Mgr., Heat Dept., Haines, Jones and Cadbury Co., 1136 Ridge Ave., and 4622 Pilling St., Philadelphia, Pa.

AUSTIN, Frank L. (1914), Archt., 246 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 Pbg. & Heat Co., 109 Jackson St., and 3437 Belvidere Ave., Seattle, Wash.

B

BABBITT, Edward C. (1923), Asst. Engr., Frank L. Packard, 16 E. Broad St., and (for mail) 1157 E. Monna St., Columbus, O.

BACHLER, Harry C. (Junior 1921), Heat Engr., (for mail) C. F. Bachler & Son, 139 N. 4th St., and 836 Kenmore Rd., Philadelphia, Pa.

BACHLER, Leonard J. (1918), Heat and Sales Engr., 101 Park Ave., and 157 W. 49th St., New York, N. Y.

BACKUS, Theodore H. L. (1916), Schumacker & Backus, 308 S. Main St., and 1018 Vaughn St., Ann Arbor, Mich.

BACON, John H., Jr. (1909), Sales Mgr., The Kennedy Co., 1849 Prospect Ave., and (for mail) 1832 E. 79th St., Cleveland, O.

BAETZ, Henry (1919), (for mail) Skinner Bros. Mfg. Co., Inc., 1424 S. Vandeventer 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, Winfield C. (1913), Sales Engr., Warren Webster & Co., 15 W. 34th St., New York, and P. O. Box 94, Milton-on-Hudson, N. Y.

BAIN, James C. (1920), Pres., Ideal Specialty Co., Box 493, Helena, Mont.

BAKER, E. E. (1910), Pres., Kewanee Boiler Co., Kewanee, Ill.

BAKER, Harry W. H. (1918), Sanitary and Heat Engr., Gordon & Co., Ltd., 110 Szechuen Rd., Shanghai, China.

BAKER, Howard C. (1921), Pres., The Howard C. Baker Co., 213 Michigan St., and 15 Columbia St., Toledo, O.

BAKER, Irving C. (1921), Engr., American Blower Co., 1027 Atlanta Trust Co. Bldg., Atlanta, Ga.

BALDWIN, William H. (1921), Sales Engr., C. A. Dunham Co., Ltd., 229 College St., and 600 Windermere Ave., Toronto, Ont.

BALDWIN, William J.* (1915), (Honorary Member), Consulting Engr., (for mail) Thomas Jefferson Bldg., 4 Court Sq., and 151 Halsey St., Brooklyn, N. Y.

BALLENGER, D. P. (1921), Sales Engr., Pierce, Butler & Pierce Mfg. Corp., Lorraine and Grand River Ave., Detroit, and (for mail) 1320 Clifford St., Flint, Mich.

BAMPTON, C. Morton (1919), Secy. and Mgr., Ideal Heat Co., 915 Gates Ave., Brooklyn, and (for mail) 8806 191st St., Hollis, L. I., N. Y.

BARGER, Paul R. (Associate 1920), Pres., (for mail) Barger Sheet Metal Co., 1433 Hamilton Ave., and 10548 Remington Ave., Cleveland, O.

BARKER, Arthur H.* (1906), Consulting Engr., (for mail) 100 Victoria St., Westminster, London, S. W. 1, and 32 Bromley Rd., Beckenham, Kent, England.

BARNES, Arthur F. (1921), Mech. Engr. and Mgr., Houston Office, (for mail) Barglebaugh & Whitson, Great Southern Life Bldg., and 703 Webster Ave., Houston, Tex.

BARR, George W. (1905), Pres., Roach Stoker Co., Presser Bldg., Philadelphia, and (for mail) Box 95, Bala, Cynwyd, Pa.

BARRETT, Leonard L.* (1922), Mgr. Eng. Dept., (for mail) Keasbey & Mattison Co., 217 Broadway, New York, and 11 Tennis Apts., Forest Hills, L. I., N. Y.

BARROWS, Charles E. (Associate 1921), Mgr. City Sales, Crane Co., (for mail) 156 N. Jefferson St., Chicago, and 114 Kedzie St., Evanston, Ill.

BARTH, Herbert E. (1920), Dist. Mgr., (for mail) American Blower Co., 526 Sweetland Bldg., and 334 Hotel Winton, Cleveland, O.

BARRY, Patrick I. (1920), Heat Engr., M. Barry & Co., 4 Marlboro St., and Grand View Terrace, Victoria Rd., Cork, Ireland.

BARTLETT, Amos C. (1919), Sales Mgr., Massachusetts Blower Co., Watertown, and 10 Dunbarton Rd., Wollaston, Mass.

BARTLETT, C. Edwin (1922), Mgr., Bartlett & Co., Inc., 1938 Market St., Philadelphia, and 209 Creswell St., Ridley Park, Pa.

BARTLEY, Fred C. (1919), Bartley, O'Neill Co., 224 3rd Ave., Pittsburgh, Pa.

BARTON, Royal Elton (1922), Engr., McLean & Cousins Co., Chandler and St. Charles Sts., Boston, and 4 Lyman Terrace, Dorchester, Mass.

BARWICK, Thomas (1920), (for mail) Consulting Engr., Buchman & Kahn, Archts., 49 W. 45th St., New York, and 668 Putnam Ave., Brooklyn, N. Y.

BASTEDO, Albert E. (1919), Mgr. and Treas., (for mail) Burnham Boiler Corp., Irvington-on-Hudson, and 12 Riverview Place, Hudson Heights, Hastings-on-Hudson, N. Y.

BATEMAN, William H., Jr. (1921), Heat Engr., C. J. Doyle, 2056 Pine St., and 2519 S. 19th St., Philadelphia, Pa.

BAUM, Albert L. (1916), Consulting Engr., Jaros & Baum, 116 W. 39th St., and (for mail) 99 Claremont Ave., New York, N. Y.

BEAHM, Robert B., 2nd (Associate 1919), Sales Engr., Egan & Beahm, Inc., 805 Stephen Girard Bldg., Philadelphia, and Haverford, Pa.

BEAR, Oliver L. (1917), 1120 Mulford St., Evanston, Ill.

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., A. L. Becker Heat & Vent. Co., 411 Long Ave., Cleveland, and 1142 Webb Rd., Lakewood, O.

BEEBE, Frederick E. W. (Associate 1915), Sales Engr., Johnson Service Co., 118 E. 28th St., New York, N. Y., and 543 Chilton St., Elizabeth, N. J.

BEECHER, Philip M. (1908), Mgr., Promotion and Sales, (for mail) Samuel Sloan & Co., 67 Exchange St., and 2634 Strathallan Park, Rochester, N. Y.

BEGGS, Douglas T. (1922), Secy., Walker Electric & Pbg. Co., 91 Peters St., Atlanta, and 612 W. College Ave., Decatur, Ga.

BENNETT, Charles A. (1917), Chargeman, Draftsman and Engr., 1850 E. Main St., Portland, Ore.

BENNETT, George E. (1918), Utilization Dept., Consolidated Gas Co., 130 E. 15th St., New York, N. Y.

BEHOIT, 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., Bentz Eng. Co., 90 West St., New York, N. Y.

BERG, A. Herman (1919), Mgr., (for mail) St. Louis Cent. & Sheet Metal Co., 1310 Ann Ave., and 4165 Walsh St., St. Louis, Mo.

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), Bergner Pbg., Heat & Supply Co., 1925 State St., and 2435 C St., Granite City, Ill.

BERMAN, Louis K. (1908), Secy., Raisler Heat Co., 129 Amsterdam Ave., New York, N. Y.

BEST, John H. (1921), Heat and Sanitary Engr., Martin C. Schwab, 116 S. Michigan Ave., and (for mail) 4109 Broadway, Chicago, Ill.

BEVERLEY, R. Carter (1905), Pres. and Treas., R. C. Beverley Heat Co., Inc., 9 N. 7th St., and (for mail) 3812 Chamberlayne Ave., Richmond, Va.

BIGGIN, Frank (1918), Director, Brightside Foundry Eng. Co., and Mgr., (for mail) Heat & Vent. Dept., Wicker Iron Works, Sheffield, England, and 19 Rupert Rd., Sheffield, England.

BINDER, Charles G. (1920), Mgr. Heat Dept., Warren Webster & Co., Point and Pearl Sts., Camden, and (for mail) 115 Oak Terrace, Merchantville, N. J.

BINDER, Irving (Junior 1920; 1922), Engr. and Estimator, Walker & Chambers, 222 E. 41st St., and 900 Riverside Drive, New York, N. Y.

BIRCH, Herbert R. (1922), Sales Engr., U. S. Radiator Corp., 101 Park Ave., and 875 W. 181st St., New York, N. Y.

BISHOP, Charles R. (1901), (Council 1916), Consulting Engr., 61 Broadway, New York, and (for mail) 413 Locust St., Lockport, N. Y.

BISHOP, Frederick R. (1921), Mgr. Heat Dept., Kelley-How-Thomson Co., and 519 N. 18th Ave., E. Duluth, Minn.

BLACK, Edgar Newbold (1922), Ch. Engr., Whitney MacDonal Co., 2320 E. Tioga St., and (for mail) 1533 Locust St., Philadelphia, Pa.

BLACK, Fred C. (1919), Mgr., M. H. Crane Estate, 28 N. Des Plaines 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 N. 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), Sales Engr., (for mail) McKellar & Blackhall, 228 St. Helens Ave., and 332 Waverley Rd., Toronto, Ont.

BLACKMAN, Alfred O. (1911), Supt. Power and Plant, (for mail) Yale & Towne Mfg. Co., and 43 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 5th Ave., New York, N. Y.)

BLACKWELL, C. H. (1921), Dis. Mgr., Warren Webster & Co., Room 7, Sec. E, Central Bldg., and 527 E. Lake Ave., Apt. 106, Seattle, Wash.

BLADON, James B. (1909), Ch. Engr., Darling Bros. Ltd., Montreal, Que.

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.

BLIZARD, John* (1921), Fuel Engr., U. S. Bureau of Mines, 4800 Forbes St., and (for mail) 1309 Richmond Ave., Swissvale, Pittsburgh, Pa.

BLOMFELDT, Allen A. (1914) Vice-Pres., Blomfeldt & Rapp Co., 108 N. Jefferson St., and 6523 Greenview Ave., Chicago, Ill.

BLOOM, Samuel C. (1915), Vice-Pres. and Research Engr., Atmospheric Conditioning Corp., 841 Monadnock Block, and (for mail) 7043 Clyde Ave., Chicago, Ill.

BOARDMAN, Wallace E. (1923), Heat and Vent. Engr., Stone & Webster, Inc., 147 Milk St., Boston, and (for mail) 54 Pleasant St., Wakefield, Mass.

BODTKE, Max (1921), Box, 24 R. F. D. No. 1, Berrien Springs, Mich.

BOGATY, Herman S. (1921), Ch. Engr., (for mail) Proctor & Schwartz, Inc., 7th and Tabor Rd., and 5243 N. 10th St., Philadelphia, Pa.

BOHN, R. G. (1921), Kallister & Bohn, 1015 Peoria Life Bldg., Peoria, Ill.

BOLLING, J. Esten* (Junior 1918; 1921), Publicity Engr., Carrier Eng. Corp., 750 Frelinghuysen Ave., Newark, N. J.

BOLSINGER, Raymond C. (1916), Secy., Fowler & Wolf Mfg. Co., 521 Bulletin Bldg., Philadelphia, Pa., and 238 E. Madison Ave., Collingswood, N. J.

BOLTON, James R. (1916), (for mail) James R. Bolton & Co., 17 W. Milwaukee Ave., Detroit, and 106 Waverly Ave., Highland Park, Mich.

BOLTON, Reginald P.* (1897), (Board of Governors, 1901; 2nd Vice-Pres., 1903; 1st Vice-Pres., 1905, 1910; Pres., 1911; Board of Governors, 1912, 1913). Pres., R. P. Bolton Co., 116 E. 19th St., and 638 W. 158th St., New York, N. Y.

BOON, George (1915), Engr., (for mail) Boon & Sample, 1708 Arch St., Philadelphia, and N.E. Cor. 36th and Hamilton Sts., W. 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), 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.

BORNEMANN, Walter A. (Junior 1923), Engr., Carrier Eng. Corp., 1402 Land Title Bldg., Philadelphia, Pa.

BOSTAIN, James C. (1923), Williamson Heater Co., 337 W. 5th St., Cincinnati, O.

BOSWIN, George A. (1917), Secy., (for mail) R. B. Hayward Co., 1714 Sheffield Ave., and 902 Diversey Parkway, Chicago, Ill.

BOURBONNIERE, J. A. (1921), Engr., Golden Gate Mfg. Co., 9 Youville St., Montreal, Que.

BOWERS, A. F. (Associate 1919), Industrial Heat. & Eng. Co., 143 Oneida St., Milwaukee, Wis.

BOWERS, J. S. (1921), Des. and Est. Engr., N. O. Nelson Mfg. Co., 10th and Chestnut Sts., and 2525a W. St. Louis Ave., St. Louis, Mo.

BOYD, D. Knickerbacker (1921), Otis Bldg., 112 S. 16th St., and Coronado Apts., 22nd and Chestnut Sts., Philadelphia, 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, Arthur W. (1918), Engr., 120 N. Franklin St., Chicago, and 1539 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), Co-partner and Mgr., 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. 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.

BRADY, B. W. (1919), Heat. Engr. and Contr., Pres. Brady & Co., 120 N. May St., and 5027 Washington Blvd., Chicago, Ill.

BRAEMER, William G. R. (1915), Consulting Engr., Grinnell Co., Inc., Ch. Engr., American Moistening Co., 260 W. Exchange St., Providence, and 181 Norwood Ave., Cranston, R. I.

BRANDELES, H. J. (1921), Pres. and Mgr., H. J. Brandeles Corp., 435 Lafayette St., Utica, N. Y.

BRASSINGTON, Arthur F. (Associate 1918), 507-9 W. 35th 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, Lester P. (1920), Prof. Mech. Engr. (Emeritus), (for mail) Mason Laboratory, 400 Temple St., New Haven, Conn.

BREDESON, Clarence R. (1921), Salesman, (for mail) American Radiator Co., 688 Hampden Ave., 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 (Junior 1923), Designer and Estimator, Haynes-Langenberg Mfg. Co., 4045 Forest Park Blvd., and (for mail) 1525a Melnickrodt St., St. Louis, Mo.

BRENDER, Peter E. (1920), Engr., Albert Kahn, Detroit, and (for mail) 204 S. Observatory St., Ann Arbor, Mich.

BRENNAN, Thomas P. (1914), Pres., Brennan, Moran, McGowan, Inc., 157 Columbus Ave., and 502 W. 141st St., New York, N. Y.

BRESNAHAN, James J. (1919), Pres. and Treas., James J. Bresnahan, Inc., 462 Elk St., and 135 Fordham Drive, Buffalo, N. Y.

BRIDGES, Frank G. (1919), Heat. Engr., Powers Regular Co., 1563 Reburn Rd., Cleveland, O.

BRINTON, J. W. (1920), Mgr., Boston Office, American Blower Co., 10 High St., Boston, Mass.

BRODERICK, Joseph F. (Junior 1914; 1918), Engr., S. H. Sweeney, 213-15 E. 44th St., New York, N. Y., and (for mail) 67 Sound View Ave., Stamford, 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), Brogan & Co., 810 Race St., Philadelphia, and 6142 Lebanon Ave., Overbrook, Pa.

BRONSON, Carlos E. (1919), Mech. Engr., Kewanee Boiler Co., Kewanee, Ill.

BRONSON, Ralph E. (Associate 1919), Mgr., (for mail) R. E. Bronson Co., 1830 St. Clair Ave., and 1597 Rosewood Ave., Cleveland, O.

BROOKS, Thos. C. (1923), Pres. and Treas., T. C. Brooks Co., 99-101 W. Dedam St., and 301 Shawmut Ave., Boston, Mass.

BROWN, Edwin H. (1920), (for mail) Hewitt & Brown, Archts. and Engrs., 1200 2nd Ave., S., Minneapolis, and Point Lookout, Wayzata, Minn.

BROWN, Edward R. (1920), (for mail) The Brown Co., 1053 Baltimore Ave., W., and 2290 La Mothe Ave., Detroit, Mich.

BROWN, Fred C. (Associate 1919), Supervisor of Bldgs., Bd. of Educ., 245 9th 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., and 5 Locust Ave., Troy, N. Y.

BROWN, Warren G. (1916), Mech. Supt., Smith, Hinchman & Grylls, 800 Marquette Bldg., Detroit, and 172 Avalon Ave., Highland Park, Mich.

BROWNE, Alfred L. (1923), Engr. and Sales Mgr., Illinois Eng. Co., 3514 Grand Central Terminal, New York, N. Y.

BROWNELL, Chester D. (1923), Gen. Mgr. and Engr., Reliable Pibg. & Heat. Co., 105 N. Walnut St., and (for mail) 307 White St., W., Champaign, Ill.

BRUEGGEMAN, Arthur R. (1920), Pres., The A. R. Brueggeman Co., Keith Bldg., and 3068 Huntington Rd., Shaker Heights, Cleveland, O.

BRUNT, T. Bayard (1917), Sales Engr., H. B. Smith Co., (for mail) 4939 Hazel Ave., Philadelphia, Pa.

BRYANT, Dr. Alice G. (1921), 502 Beacon St., Boston, Mass.

BRYANT, Percy J. (1915), Ch. Engr., U. S. Military Academy, West Point, and Newburgh, N. Y.

BRUCE, John W. (1918), The Bryce Heat. & Vent. Co., 415-18 Spitzer Bldg., Toledo, O.

BRUCE, Stephen D. (1921), Bryce Heat. & Vent. Co., 415 Spitzer Bldg., and 2907 Rockwood Place, Toledo, O.

BUCK, Frank W. (1920), Mech. Engr., The H. K. Ferguson Co., 8523 Euclid Ave., and 1861 E. 90th St., Cleveland, O.

BUCK, Mitchell S. (1922), Engr., (for mail) Vapor Heating Co., 215 S. 17th St., and 213 Rex Ave., Philadelphia, Pa.

BUDER, Charles G. (1919), 1441 Hamilton Ave., St. Louis, Mo.

BUEL, H. C. (1921), Salesman, Tilgham, Moyer Co., 814 Hamilton St., and (for mail) 1615½ Turner 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. St. Paul, Minn.

BUENSOD, Alfred C. (1918), Mech. Sales Engr., (for mail) Carrier Eng. Corp., 39 Cortlandt St., and 61 W. 10th St., New York, N. Y.

BUNNELL, Ercell, W. (Junior 1923), Sales Engr., C. A. Dunham Co., 2021½ 1st Ave., and 1806 10th Ave., S., Birmingham, Ala.

BUNTON, Fred L. (1919), Mgr., Kewanee Boiler Co., 945 Oliver Bldg., and 5514 Center Ave., Pittsburgh, Pa.

BURGER, John C. (1919), Contr., (for mail) Gallaher & Speck, 219 W. Congress St., and 7201 Champlain Ave., Chicago, Ill.

BURNAP, Chas. W. (Junior 1922), Herman Nelson Corp., 724 Commercial St., Emporia, Kans.

BURNETT, Earle S. (1920), Mech. Engr., Bureau of Mines, and (for mail) Old Colony Club, Hotel Raleigh, Washington, D. C.

BURNS, James J. (1919), Burns, Fleming & Co., 620 2nd Ave., and 6646 Ridgeway St., Pittsburgh, Pa.

BURNS, Richard D. (1915), 19th and Brown Sts., Philadelphia, Pa.

BURR, Ralph J. (Associate 1919), Heat. Contr., Standish, Mich.

BURRITT, Charles G. (Associate 1916), Mgr., Johnson Service Co., 308 3rd Ave., S., Minneapolis, Minn.

BURTON, Clarence A. (1919), Salesman, Kewanee Boiler Co., 2020 Wyandotte St., and 3534 Virginia Ave., Kansas City, Mo.

BUSHNELL, Carl D. (Associate 1921), Pres., Bushnell Machinery Co., 206 Wood St., Pittsburgh, and 94 Pilgrim Rd., Rosslyn Farms, Carnegie, Pa.

BUSHNELL, Clifford D. (1921), Supt. of Physical Plant, Purdue University, and 427 Russell St., W., LaFayette, Ind.

BUSHNELL, Thomas H., Jr. (1920), Engr., National Lamp Works, Nela Park, and 16019 Elderwood Ave., E. Cleveland, O.

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 Pibg., (for mail) 545 Broadway, and W. Erie and Madison Aves., Lorain, Ohio.

BYSON, Lealie 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 E. 26th St., New York, N. Y., and 11 Park Ave., Maplewood, N. J.

CADWELL, William H. (1916), Pres., The Beaton & Cadwell Mfg. Co., P. O. Box 1012, and 130 W. Main St., New Britain, Conn.

CALAHAN, John J. (1905), Supervising Engr., 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.

CALKINS, Lonson D. (Associate 1919), Asst. Mgr., Kewanee Boiler Co., 330 W. Washington St., and 6956 Normal Bldg., Chicago, Ill.

CALLAHAN, Michael J. (1914), Pres. and Treas., Peerless Vent. Ventilation Co., 437-39 W. 16th St., New York, N. Y.

CALVERT, Norman W. (1921), Engr., (for mail) The Detroit Edison Co., 2000 2nd 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), Pibg. and Heat. Contr., 306 Bleeker St., and 1302 Brinckerhoff Ave., Utica, N. Y.

CAPRON, Edmund F.* (1903), (Board of Governors 1907; 2nd Vice-Pres. 1912, 1913; 1st Vice-Pres. 1914), Secy.-Treas., (for mail) Lewis & Capron Co., 910 S. Michigan Ave., and 4442 Malden St., Chicago, Ill.

CARPENTER, B. Harold (Charter Member), (Board of Managers 1899, Board of Governors 1905), Pres., B. G. Carpenter Co., 508 S. Main St., and 65 W. Union St., Wilkes-Barre, Pa.

CARPENTER, R. H. (1921), Mgr., Nash Engr. Co., 350 Madison Ave., New York, and 10 1st St., White Plains, N. Y.

CARRIER, Willis H.* (1913), (Council 1923), Pres., Carrier Eng. Corp., 750 Frelinghuysen Ave., Newark, N. J., and (for mail) Rensselaer Rd., Essex Fells, N. J.

CARROLL, John M. (1919), United States Radiator Corp., 301 Niagara Life Bldg., Buffalo, and (for mail) P. O. Box 331, Avon, N. Y.

CARSTEN, Charles H. (1921), Salesman, The Ohio Plumbers Supply Co., 417 Jackson Ave., and (for mail) 2421 Hollywood Ave., Toledo, O.

CARSTENS, Emil (1922), H. B. Smith Co., 17th and Arch Sts., and (for mail) 512 W. Cornwall St., Philadelphia, Pa.

CARTLAND, Silas (Junior 1923), Engr. and Salesman, Johnson Fan & Blower Co., 115 S. Clinton St., Chicago, Ill., and Box 84, Pentwater, Mich.

CARY, Albert A.* (Charter Member), Board of Managers 1894; Council 1896; Board of Managers 1899, Consulting Engr., 95 Liberty St., New York, N. Y.

CASE, Edward W. (Associate 1916), Vice-Pres. and Secy., W. A. Case & Son Mfg. Co., 31 Main St., Buffalo, N. Y.

CASEY, Byron L. (1921), Sales Engr., Ilg Electric Vent. Co., 5 S. Wabash Ave., Chicago, and 501 Clifton Ave., Park Ridge, Ill.

CASSELL, Hiram H. (1920), Mech. Engr., (for mail) Smith, Hinchman & Grylls, 800 Marquette Bldg., and (for mail) 1447 Clairmount 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.

CAVILEER, James V. (Associate 1921), Office Mgr., Lewis, Robinson & Gant, 1303 Land Title Bldg., and 2938 N. 27th St., Philadelphia, Pa.

CHALLMAN, Samuel A. (1919), Comm. of School Bldg., State Dept. of Education, State Capitol, St. Paul, and (for mail) 1107 7th St., S.E., Minneapolis, Minn.

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), (Board of Governors 1913; Council 1914; 2nd Vice-Pres. 1915; 1st Vice-Pres. 1916), 84 Park St., Montclair, N. J.

CHASE, D. (1921), Providence Vent. Co., and 262 Doyle Ave., Providence, R. I.

CHASE, John M. (Associate 1916), 50 E. 42nd St., New York, N. Y.

CHATTERDON, B. W. (1921), Salesman, Ozone Pure Airifier Co., 1401 W. Jackson Blvd., Chicago, Ill., and 8409 Hough Ave., Cleveland, Ohio.

CHENOWETH, William H., Jr. (1911), Dist. Mgr., Warren Webster & Co., 549 W. Washington St., Chicago, and 256 Keystone Ave., River Forest, Ill.

CHEERY, Lester A. (1921), Industrial Planning Corp., 80 W. Genesee St., and 155 Euclid Ave., Station H., Buffalo, N. Y.

CHERVEN, Victor W. (Associate 1920), Heat. Engr., (for mail) Holland Furnace Co., and Maple Ave., Holland, Mich.

CHESTER, Thomas* (1917), Mgr., American Blower Co., 6004 Russell St., and 2487 Gladstone Ave., Detroit, Mich.

CHEW, Frank K.* (Associate 1895; 1897), (Board of Governors 1906-1908), Editor and Vice-Pres., Sheet Metal Worker, Edwin A. Scott Publishing Co., 15 E. 40th St., New York, N. Y., and 152 Roseville Ave., Newark, N. J.

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. 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). Mgr., Heat Dept., (for mail) Grinnell Co. Inc., N. Charlotte, and Myers Park, Charlotte, N. C.
CHUBB, John E. (Associate 1917). Sales Engr., Whitlock Coil Pipe Co., 343 S. Dearborn St., Chicago, and 806 Colfax St., Evanston, Ill.
CHURCH, Herbert John (1922). Mgr., Darling Bros., Ltd., 77 York St., Toronto, and Weston, Ont.
CLAFFEY, Edward J. (1913). Pres., E. J. Claffey Co., 10 W. Illinois St., and 439 Melrose St., Chicago, Ill.
CLARK, Homer J. (1919). Dist. Mgr., (for mail) B. F. Sturtevant Co., 436 Guardian Bldg., Cleveland, O.
CLARK, E. Harold (1922). American Blower Co., Sales Mgr., 1450 David Whitney Bldg., and 475 Peterboro, Detroit, Mich.
CLARK, Robert L. (Associate 1918). Mgr., The Clark-Fisher Co., 1893 E. 55th St., and 13521 Casper Rd., Cleveland, O.
CLARK, William C. (1918). Secy., Becker-Seidel Co., 324 Prospect Ave., N.W., and 1317 E. 10th St., Cleveland, 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 5th Ave., New York, and (for mail) 8613 110th St., Richmond Hill, N. Y.
CLARK, W. H. (1921). Anchor Sanitary Co., 123 3rd Ave., Pittsburgh, Pa.
CLARKE, Samuel S. (1909). Heat. and Vent. Engr., (for mail) Dominion Radiator Co., and Canadian Sirocco Co., 605 2nd St., W., and 603 2nd St., W., Calgary, Alberta.
CLARKSON, Robt. C., Jr. (1921). Asst. Engr., Turner Construction Co., 1713 Sansom St., and (for mail) The Clermont, 44th and Walnut Sts., Philadelphia, Pa.
CLARKSON, William B. (1919). Director of Research, King Vent. Co., and (for mail) 251 Broadway, Owatonna, Minn.
CLEGG, Carl (1922). Mgr., American Blower Co., 519 Mutual Bldg., and 1004 Armour Blvd., Kansas City, Mo.
CLIFTON, William A. (1919). Heat. Engr., State Dept. of Architecture, Albany, and (for mail) Round Lake, N. Y.
CLINE, Edgar A. (1914). Secy., General Heat Supply Co., R. 1, Reliance Bldg., and 4239 Forest Ave., Kansas City, Mo.
CLISE, Floyd W. (Associate 1920). Sales Engr., (for mail) Johns-Manville, Inc., 325 Jefferson Ave., W., and 1190 Ashland Ave., Detroit, Mich.
CLOUGH, Leslie (1922). Engr., H. P. & E. S. Stubbs, 9 Ash St., Boston, and 63A Mt. Auburn St., Watertown, Mass.
COCHRAN, Moncrieff M. (1908). Pres., Cochran-Sargent Co., 5th and Sibley Sts., and 400 Holly Ave., St. Paul, Minn.
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., Blower Systems Corp., 414 Orchard St., and 122 Penhurst Ave., Rochester, N. Y.
COE, Ralph T. (1917). (for mail) The R. T. Coe Companies, 5th floor, Cutler Bldg., and 235 Chili Ave., Rochester, N. Y.
COFFEY, John B. (Associate 1919). Plbg. and Heat. Contr., John B. Coffey & Brother, 1853 Grand River Ave., Detroit, Mich.
COFFIN, Robert K. (1921). Mgr., Southern Equipment Co., P. O. Box 296, and 524 Central Ave., Laurel, Miss.
COHAGEN, Chandler C. (1919). Archt., (for mail) Box 1305, 508 Elce Bldg., and 127 Wyoming Ave., Billings, Mont.

COLBY, Clyde W. (1915). Pres., The Colby-Merill Co., 706 Rose Bldg., 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., W. I. Collier & Co., 15 E. Fayette St., Baltimore, and Elliott City, Md.
COLLINS, Howard F. (1919). Mgr., Reading Heat & Vent. Co., 331 Calls Co., and 1503 N. 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, Charles J. (Junior 1920). Heat. Engr., C. J. Connor & Co., 1209 Harrison Bldg., Philadelphia, Pa.
CONNOR, Michael (Associate 1922). Mgr., Connor Bros. Plbg. & Heat. Co., 827 2nd Ave. S., and 1222 Knox Ave. N., 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). Designing Engr., 409 Interstate Bldg., Kansas City, and (for mail) Route 6, Box 452, Independence, Mo.
COOK, Chester D. (1921). Contr., D. F. Edwards Heat. Co., (for mail) 2340 Pine St., and 4923 Magnolia Ave., St. Louis, Mo.
COOLEY, Maxwell S. (1911). Bureau of Yards and Docks, Navy Dept., Washington, D. C., and 5 E. Irving St., Chevy Chase, Md.
COON, Thurlow E. (1916). Pres., The Coon-DeVisser Co., 1772 W. Lafayette Blvd., and (for mail) 826 Edison Ave., Detroit, Mich.
COOPER, Frank I. (1911). (Council 1914-1916). Pres., Frank Irving Cooper Corp., Archts. and Engrs., 172 Tremont St., Boston, and Concord Rd., Wayland, Mass.
COOPER, John W. (Junior 1921). Repr., Buffalo Forge Co., 515 Chemical Bldg., and 4305 Lindell Blvd., St. Louis, Mo.
COOPER, Michael A. (1920). Mgr., Heat. Dept., Mamin & Co., 624 Baronne St., and 2535 Gen. Pershing St., New Orleans, La.
COOPER, Thomas Winston (Associate 1922). Mgr., Utica Heater Co., 1712 Ludlow St., and 1918 Spring Garden 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., Hittings & Co., Cor. Spring and Louisa Sts., and 633 Madison Ave., Elizabeth, N. J.
COSGROVE, Wallace M. (1923). Br. Mgr., American Radiator Co., 104 W. 42nd St., New York, N. Y.
COWAN, Robt. A. (1921). Heat. and Vent. Engr., (for mail) 701 Rose Bldg., and 8110 Carnegie Ave., Cleveland, O.
COWARD, Herbert (1921). Mgr., Washington, D. C. Office, Buffalo Forge Co., 501 Washington Loan and Trust Bldg., Washington, D. C., and West Falls Church, Va.
COWELL, Robert J. (1922). Gordon & Co., Ltd., 110 Szechuen Rd., Shanghai, China.
COWLES, Benjamin E. (1919). Engr., (for mail) Kellogg-Mackay Co., 824 S. 4th St., and 1110 Hennepin Ave., Minneapolis, Minn.
COX, Christopher J. (1919). (for mail) C. J. Cox, Eng. Co., 28 Union St., Boston, and 1412 Commonwealth Ave., Brookline, Mass.
CRAIG, F. Broadhurst (1922). Dilworth & Carr, Ltd., Albion House, 5961 N. Oxford St., London, W. C. I., England.

CRAIGHEAD, Edward W. (Associate 1920). Heat. Engr., (for mail) A. D. Dennison Co., 2036 E. 105th St., and 1197 Brockley Ave., Cleveland, O.
CRANNELL, Chas. A. (1922). Secy.-Treas., Crannell-Beaton Co., 210 Hammond Bldg., and 1011 Park Place, Hammond, Ind.
CRAWFORD, W. B. (1921). Consulting Engr., 1753 Conway Bldg., and 1516 N. Mayfield Ave., N. 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.
CRISWELL, George A., 2nd (Junior 1920). Estimator, (for mail) Wayne Plbg. & Heat. Co., Wayne, Delaware Co., Pa., and 27 Locust St., Lockport, N. Y.
CROCKER, Robt. B. (1921). Heat. and Vent. Engr. and Heat. Mgr., Mrs. Nat'l Bank Bldg., Lynn, and (for mail) 104 Sycamore St., Waverly, Mass.
CRONE, Chas. E. (1922). Sales Engr., Mehring and Hanson Co., (for mail) 118-120 N. Franklin St. and 5432 Woodlawn Ave., Chicago, Ill.
CRONE, Thomas E. (1920). Dist. Mgr., Clarence O. Baring, Inc., 34 Park Place, R. 11, Newark, and (for mail) 595 William St., E. Orange, N. J.
CRUTCHLEY, Edward, Jr. (1920). Heat. and Vent. Engr., 1507 Avenue O, Brooklyn, N. Y.
CULBERT, Warren G. (Associate 1911). (for mail) 1503 Sansom St., Philadelphia, and Ridley Park, Pa.
CULLEN, Harry J. (1923). Heat. and Vent. Engr., Warren & Wetmore, 16 E. 47th St., New York, and (for mail) 15 Scott Place, Jamaica, N. Y.
CULLYFORD, Francis S. (1915). Pres. and Mgr., (for mail) Cullyford Plbg. & Heat. Co., 1210 California St., and 517 Josephine St., Denver, Col.
CUMMINGS, Gerald J. (1923). Pres., Minnesota Mech. Equip. Co., Farmers' Bank Bldg., and 913 10th Ave., S., St. Cloud, Minn.
CUMMINS, George H. (1919). Sales Engr., (for mail) Morgan-Gerrish Co., 501 S. 6th St., and 2300 Girard Ave., S., Apt. 8, Minneapolis, Minn.
CURRIER, Charles H. (1919). Vice-Pres., (for mail) Drying System, Inc., 11 S. Des Plaines St., Chicago, and 807 Monticello St., Evanston, Ill.
CUSTER, Allen E. (1921). Heat. Engr., C. W. Richards Co., 5-9 W. Commerce St., Bridgeton, N. J.
CUTLER, Joseph A. (1916). (Council 1920-1923). Mgr., Johnson Service Co., 177 N. Dearborn St., and Drake Hotel, Chicago, Ill.
CUTTER, Edward H. (Associate 1923). Special Distributor, Hoffman Steam Specialties, 139 N. Wells St., Chicago, Ill.
CUYLER, David H. (1917). Heat. Engr., Haines, Jones & Cadbury Co., P. O. Box 1282, Charlotte, N. C.

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DAILEY, James A. (Associate 1920). Heat. Contr., 374 W. Main St., and (for mail) 88½ Charlotte St., Rochester, N. Y.
DALY, John H. (1915). (Secy., Colorado Chapter). Pres. and Mgr., Daly Co., 230 15th St., and (for mail) Denver Athletic Club, Denver, Col.
DAMBLAY, A. Ernest (Junior 1921). Asst. H. B. Hackett, 505 Chestnut St., Philadelphia, and 4615 Wayne Ave., Germantown, 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 Elliott St., Buffalo, N. Y.
DARTS, John A. (1919). Sales Mgr., (for mail) Kewanee Boiler Co., Inc., 47 W. 42nd St., and 272 Manhattan Ave., New York, N. Y.
DAUCH, Emil O. (1921). Detroit Repr., Continental Heater Corp., and Marsh Valve Co., 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 (1916). Heat. and Vent. Engr., American Warming & Vent. Co., and 656 Reynolds St., Elmira, N. Y.
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., New York & New Jersey Bridge & Tunnel Commission, Hall of Records, Room 614, New York, and (for mail) 27 Argyle Rd., Brooklyn, N. Y.
DAVIS, Bert C. (1904). Pres. and Treas., (for mail) American Warming & Vent. Co., 317 Pennsylvania Ave., and 603 W. Church St., Elmira, N. Y.
DAVIS, C. E. (Associate 1917). Mgr., C. E. Davis & Sons Heat. & Plbg. Co., Atchison, Kans.
DAVIS, Frank R. (1920). Heat. & Vent. Engr., Room 1000, 12th St. Station, Illinois Central Railroad, Chicago, Ill.
DAVIS, Holyoke (1919). (for mail) Holyoke, Jennie & 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-Billings Corp., 92-20 150th St., and (for mail) 145-15 Hillside Ave., Jamaica, L. I., N. Y.
DAVIS, Rowland G. (1921). Salesman, Spohn Heat. & Vent. Co., 1775 E. 45th St., and 16800 Endora Rd., Cleveland, O.
DECKER, Edward M. (Associate 1917). Salesman, (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) Moutat Vapor Heat. Co., 1246 W. 4th St., Cleveland, and 4364 Riverside Drive, W. Park, U.
DEGAN, James E. (Associate 1916). Pres., (for mail) James E. Degan Co., 242-4 Larned St., W., and 2428 Baline Ave., Detroit, Mich.
DEGROOT, Leslie P. (1919). Br. Mgr., Bishop & Babcock Co., 418 Crozer Bldg., and (for mail) 4622 Hazel Ave., Philadelphia, Pa.
DEKRAKER, Russel E. (Junior 1920). Dist. Mgr., (for mail) Taplin Furnace Co., 307 Bridge St., and 215 W. Spruce St., Chippewa Falls, Wis.
DELONG, Harry B. (1915). H. B. DeLong Co., W. 409 1st Ave., and E. 231-24th Ave., Spokane, Wash.
DEMPSEY, Harry P. (1919). Consulting Mech. Engr., 34 Delaware Court, 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., and 5463 Delmar Ave., Apt. 222-B, St. Louis, Mo.
DENSON, Walter (1922). 19 E. 11th St., and 2205 St. Elmo Drive, Columbus, Ga.
DENSMORE, Edward D. (1906). Consulting Engr., Densmore & LeClear, 88 Broad St., Boston, Mass.
DERANLEAU, Raymond L. (Junior 1922). 914-18 Central Savings Bank Bldg., Denver, Col.
DEVENDORF, William F. (1910). Secy. and Treas., The Boiler & Rad. Corp., 154 East Ave., 409 Lafayette Bldg., Buffalo, and 33 Audubon St., Rochester, N. Y.
DEVEREUX, Leslie W. (Associate 1922). Met. Repr., Utica Heater Co., Room 5620 Grand Central Terminal, New York, and 421 W. 114th St., New York, N. Y.
DEVORE, Milton J. (1920). Heat. Engr., 54 Adeline Pl., N. Bergen, N. J.
DEWAR, John G. (1920). Dewar & Carrington, 153 N. Des Plaines St., Chicago, Ill.
DEWOLF, Roger D. (1915). Ch. Operating Engr., (for mail) Rochester Gas and Electric Corp., 24 Clinton Ave., N., and 15 Werner Park, Rochester, N. Y.

DEY, Charles (Associate 1918), 1723 Ludlow St., Philadelphia, and (for mail) 6327 Race St., Philadelphia, Pa.
DIBBLE, Albert B. (Associate 1922), Pres. and Mgr., S. E. Dibble & Son, Inc., 637 Grand Ave., P. O. Box 299X, and 869 Elm St., New Haven, Conn.
DIBBLE, Samuel E. (1917), (Council 1921-1923, 2nd Vice-Pres. 1922), Consulting Engr. & Prof. Heat. & 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, Hobart C. (1919), Ch. Div. Heat. and Thermometry Bureau of Standards, and 4629 30th St., N.W., Washington, D. C.
DICKSON, George P. (1919), (for mail) Pres., Kansas City Vent. & Sheet Metal Works, 1817 Grove St., and 3830 Park Ave., Kansas City, Mo.
DICKSON, Robert B. (1919), Sales Mgr., Kewanee Boiler Co., and 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.
DIETHER, Carl F. (Associate 1919), Mgr., Hart & Crouse Co., 909 Sweetland Bldg., and 2124 Stillman Rd., Cleveland, O.
DIGBY, Homer Evans (Junior 1922), Salesman, C. A. Dunham Co., 910 May Bldg., and 220 Meridian St., Pittsburgh, Pa.
DILL, H. O. (Associate 1922), Gen. Sales Mgr., Oil City Boiler Works, 501 5th Ave., and 243 Mt. Hope Pl., New York, N. Y.
DILL, Jay B. (1921), (Secy. Michigan Chapter), Sales Mgr., (for mail) American Blower Co., 1450 David Whitney Bldg., and 8771 Dexter Blvd., Detroit, Mich.
DILMAN, Ernest J. (1921), Engr., Research Dept., American Radiator Co., 1807 Elmwood Ave., and 1349 Hertel Ave., Buffalo, N. Y.
DISTEL, Frank, Jr. (1918), Distel Heat. Equip. Co., 515 Oakland Bldg., and 1011 Genessee St., W. Lansing, Mich.
DIX, Henry N., Jr. (1920), Advisory Engr. Adv. Dept., (for mail) American Radiator Co., 1807 Elmwood Ave., and 61 Sterling Ave., Buffalo, N. Y.
DOBBS, C. F. (Associate 1921), Boiler & Radiator Supply Co., 110 Walnut St., Philadelphia, Pa., and 72 Berlin Ave., Haddonfield, N. J.
DOBSON, George Gardner (1922), Mech. Engr., (for mail) Eastman Kodak Co., Kodak Park, and 200 Oriole St., Rochester, N. Y.
DODD, Samuel M. (1921), Consulting Engr., (for mail) Hoffman Specialty Co., Room 203 Fuller Bldg., 10 S. 18th St., Philadelphia, and Swarthmore, Pa.
DODDS, Forrest F. (1920), Asst. to Mgr., (for mail) American Radiator Co., 905 Davidson Bldg., and 3130 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 1262 Pratt Blvd., Chicago, Ill.
DOHERTY, John J. (1921), (for mail) P. C. Doherty Co., 112 Main St., and 26 Corlies Ave., Poughkeepsie, N. Y.
DOLAN, Raymond G. (Junior 1922), Secy., and Treas., (for mail) Tom Dolan Heat. Co., Inc., 711 N. Dewey St., and 2112 W. 20th St., Oklahoma City, Okla.
DOME, Walter R. (1920), Salesman, Abram Cox Stove Co., American and Dauphin Sts., and (for mail) 156 W. Hansburg St., Philadelphia, Pa.
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, Texas.
DONNELLY, Webster C. (Junior 1922), Repr., Donnelly Systems Co., 34 Trumbull St., New Haven, Conn.
DORNHEIM, G. A. (Junior 1906; 1912), Thompson-Starrett Co., 245 Hunters Point Ave., Long Island City, and (for mail) 715 W. 172nd St., New York, N. Y.
DORSEY, Francis C. (1920), Heat., Plbg. and Elect. Contr., Francis C. Dorsey, 110 Prospect Ave., Coland Park, Baltimore, Md.
DOUD, Malcolm P. (Associate 1921), Estimator and Salesman, Norristown Magnesia & Asbestos Co., and (for mail) 842 Smith St., Norristown, Pa.
DOUGHERTY, P. J.* (Associate 1912; 1918), International Heater Co., Utica, N. Y.
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. (1896), Administrator Compagnie Nationale Des Radiateurs, 149 Blvd. Haussman, Paris, France.
DOWNES, Nate W. (1917), Engr., School Dist. of Kansas City, 219 Library Bldg., and 1209 E. 45th St., Kansas City, Mo.
DOWNNEY, Frank E. (1921), Pres., 613 Clybourn St., and 502 Bellevue Pl., Milwaukee, Wis.
DOWNES, Edwin L. (1916), United States Radiator Corp., 135 E. Grand River, and (for mail) 10334 2nd 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., and (for mail) 1020 Delmonte Pl., 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), Instructor in App. Physiology, (for mail) Harvard Medical School, Boston, Mass., and 369 Cabot St., Newtonville, Mass.
DRINKWATER, Edgar L. (1919), Mech. Engr., E. J. Claffey Co., 10 W. Illinois St., and 147 N. Long Ave., Chicago, Ill.
DRISCOLL, William H.* (1904), (Council 1918-1921, 1922, Treas. 1923), 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.
DUDFIELD, Alvin (1920), Pres., Dudfield Mfg. Co., Sheet Metal & Furnace Work, 116 W. Kansas St., Liberty, Mo.
DUDLEY, Wm. Lyle (1922), Vice-Pres., Western Blower Co., 1800 9th Ave., S., and 2221 2nd Ave., W., Seattle, Wash.
DUFF, Kennedy (1915), Mgr., (for mail) Johnson Service Co., 118 E. 28th St., New York, N. Y., and 9 Park Ave., Maplewood, N. J.
DUFTY, Arthur (1919), Mech. Engr., Oberlin College, Oberlin, O.
DUGAN, Thomas M. (1920), Master Plumber, National Tube Co., 4th Ave. and Locust St., McKeesport, and 311 Washington Ave., Dravosburg, Pa.
DUNCAN, George M. (1922), Purdy, Mansell, Ltd., 63 Albert 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., J. H. Kitchen & Co., Delmain Bldg., and (for mail) 3924 Euclid Ave., Kansas City, Mo.
DURAND, William L.* (1921), (Pres. New York Chapter), Engr., Clark, McMullen & Riley, 101 Park Ave., New York, and 242 Lafayette Ave., Brooklyn, N. Y.

DUSOSSOIT, 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), 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 Vincent (Associate 1922), U. S. Radiator Corp., Dime Bank Bldg., Detroit, Mich.
DWYER, Thos. F. (1923), Bd. of Education, Concord St. and Flatbush Ave., Brooklyn, and (for mail) 338 E. 134th St., New York, N. Y.
DYER, Orville K. (1919), Sales Engr., Buffalo Forge Co., 490 Broadway, Buffalo, N. Y.

E

EADIE, John G. (1909), Consulting Engr., Eadie, Freund & Campbell, 7 W. 45th St., New York, N. Y.
EAGAN, George A. (1917), Pres., (for mail) Eagan & Beahm, Inc., 304-308 Stephen Girard Bldg., Philadelphia, Pa., and 17 Newton Ave., Woodbury, N. J.
EAGAR, Robert Francis (1922), Engr., Eagar, Coombs & Co., Ltd., 138 Lower Water St., Halifax and Bedford, Halifax, Co., 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., 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., 179 N. Michigan Ave., Chicago, and (for mail) 528 S. Grove Ave., Oak Park, Ill.
EBERT, William A. (1920), Engr. and Estimator, (for mail) A. H. Shafer, P. O. Box 1280, and 1004 Drexel Ave., San Antonio, Texas.
ECKART, Claude H. (1915), Secy.-Treas., Eckart Plbg. & Heat. Co., 320 Westlake Ave., N., Seattle, and Endolyn, Wash.
EDDY, Ernest J. (Associate 1919), Br. Mgr., Keasbey & Mattison Co., 17 Terrace, and 175 Dorchester Rd., Buffalo, N. Y.
EDELSTON, Samuel H. (Junior 1922), Estimator, W. L. Fleisher & Co., Inc., 31 Union Sq., W., New York, and 330 S. 12th St., Newark, N. J.
EDGAR, A. C. (Charter Member), (Council 1920), (for mail) Edgar Heat. Co., 1802 Chestnut St., Philadelphia, and Newton Sq., Delaware County, Pa.
EDWARDS, Daniel F. (1920), D. F. Edwards Heat. Co., 2340-42 Pine St., and 3000 Victor St., St. Louis, Mo.
EDWARDS, Paul A. (1919), Engr. and Estimator, The G. F. Higgins Co., 606 Wabash Bldg., and 1260 Mississippi Ave., S. Hills P. O., Pittsburgh, Pa.
EGGLESTON, Lewis W. (1921), Mgr., I. T. R. Specialties Dept., (for mail) American Radiator Co., 1807 Elmwood Ave., and 57 Tillinghast Pl., Buffalo, N. Y.
EHRlich, M. William (1916), Br. Mgr., Trane Co., R. 2332 Park Row Bldg., 15 Park Row, New York, N. Y., and (for mail) 56 Ridge Rd., Lyndhurst, N. J.
EICHBER, 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., 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 2nd Ave., S., Minneapolis, and 1710 Capitol Ave., St. Paul, Minn.
ELLIS, Earnest E. (1922), Mgr., Fred A. Ellis & Son, 840 Center St., and 998 Chatfield St., Winnetka, Ill.
ELLIS, Frederic R. (1913), Mgr. Heat. & Vent. Depts., B. F. Sturtevant Co., and 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 W. 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 105 S. Kensington Ave., La Grange, Ill.
ELLISON, J. Hüyer (1919), Secy., Ellison & Co., Inc., 211 W. 126th St., New York, and (for mail) 41 Wallace St., Freeport, N. Y.
EMERSON, Ralph R. (1922), Sales Engr., (for mail) Hoffman Specialty Co., 512 5th Ave., New York, and 660 59th St., Brooklyn, N. Y.
EMMERT, Luther D. (1919), Repr., (for mail) Buffalo Forge Co., 562 W. Washington Blvd., Chicago, and 1704 Himman Ave., Evanston, Ill.
EMPKEY, George J. (1919), Secy., The Schneider Plbg. 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.
ENGLE, Alfred (Associate 1923), Salesman, Jenkins Bros., 80 White St., New York, N. Y.
ENSGN, Ralph M. (1917), Pres., R. M. Ensign Co., 1704-64 W. Randolph St., and (for mail) 1002 Ansie St., Chicago, Ill.
ERICKSON, Harry A. (1917), Mgr. and Engr., Fitzpatrick & Hoefner Co., 63 E. Gay St., and 243 E. Gay St., Columbus, O.
ERTMAN, Bernard R. (1920), Heat. Engr. and Mgr., A. F. Ertman, 309 N. Main St., Herkimer, N. Y.
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 S. Bergman St., Corless Station, Pittsburgh, Pa.
EVANS, John (1919), Archt., 30 Water St., and 15 Ball Ave., Galt, Ont.
EVANS, Raymond Stanley (Junior 1920), Experimental Engr., (for mail) 3288 Washington Blvd., Chicago, Ill.
EVANS, William A. (1918), Mgr., (for mail) Whitlock Coil Pipe Co., 149 Broadway, New York, N. Y., and 24 Woodland Rd., Maplewood, N. J.
EVELETH, Charles F.* (1911), Ch. Engr., Heat. and Vent., Warren Webster & Co., Pearl and Point Sts., Camden, 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 Daniel (1922), Sales Engr., (for mail) Hester-Bradley Co., 4200 Forest Park Blvd., and 1286 Goodfellow Ave., St. Louis, Mo.
FARLEY, J. W. (Associate 1921), Mgr., Farley Sleeve & Hanger Co., 3748 E. 71st St., Cleveland, O.
FARNHAM, George D. (1907), Geo. D. Farnham & Co., 1630 Lakeland Ave., Cleveland, O.
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., Farnsworth Co., Conshohocken, and Germantown Pike and Centre St. Rd., Norristown, Pa.
FARRAR, Cecil W. (Associate 1918; 1920). (Pres. Western New York Chapter) Vice-Pres., Excelsior Specialty Works, Inc., 119 Clinton St., and 429, Norwood Ave., Buffalo, N. Y.
FEBREY, Ernest J. (1903). Heat. Contr., E. J. Febray & Co., 622 F St., N.W., Washington, D. C.
FEHLIG, John B. (1918). Pres. and Treas. (for mail) Excelsior Heat. Supply Co., 528 Delaware St., and 2927 Brooklyn Ave., Kansas City, Mo.
FEIGE, Henry W. (1922). Sales Mgr., Powers Regulator Co., 1206 Colonial Trust Bldg., Philadelphia, Pa., and Oaklyn, N. J.
FELDMAN, Abram M. (1903). Consulting Engr., 145 W. 45th St., New York, N. Y.
FELS, Arthur B. (1919). Pres., The Fels Co., 60 Union St., Portland, and Box 33, Yarmouth, Me.
FELTWELL, Robert Hall (1922). Heat. Engr., D. & T. Mfg. Co., and (for mail) 1040 S. Frazier St., Philadelphia, Pa.
FENSTERMAKER, Sidney E. (1909). Weinshank & Fenstermaker, 821 Hume-Mansur Bldg., and 3102 Washington Blvd., Indianapolis, Ind.
FERRERA, Frank F. (1920). Pres., Victor Piping Co., 1830 Calumet Ave., and 6747 Chappel Ave., Chicago, Ill.
FERRIS, Donald M. (1921). 19 S. Oxford St., Brooklyn, N. Y.
FERRIS, Thomas J. (1919). Mgr. Heat. and Vent. Depts., F. E. Newberg Elec. Co., Century Bldg., and (for mail) 4257 Westminster Pl., St. Louis, Mo.
FEST, Leon T. (1919). Salesman, Pierce, Butler & Pierce Mfg. Corp., 31st and Oxford Sts., and (for mail) 4722 N. 15th St., Philadelphia, Pa.
FIELDING, Howard H. (1904). (Council 1918-1919). Heat. and Vent. Engr., Warren Webster & Co., (for mail) 518 Boston Bldg., and Waldman Apts., Denver, Col.
FINAN, James J. (Associate 1920). Salesman, American Radiator Co., 413 S. 10th St., Omaha, and (for mail) 3001 F St., Lincoln, Neb.
FINAN, James J., Sr. (1923). Supv. Engr., Ch. Engrs. Dept. Bd. of Education, and (for mail) 7149 Euclid Ave., Chicago, Ill.
FIRESTONE, James F. (Junior 1914). Engr., Beckwith Co., and (for mail) 314 W. Telegraph St., Dowagiac, Mich.
FIRSCHING, Frank J. (1921). Heat. Engr., Warren Webster & Co., (for mail) 917 Empire Bldg., Pittsburgh, Pa., and 2731 N. Dover St., Philadelphia, Pa.
FISKE, T. Dumas (1922). Montgomery, Ward & Co., St. John and Belmont Sts., and 2917 E. 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.
FLEISHER, Walter Louis* (1914). Pres., (for mail) W. L. Fleisher & Co., Inc., 31 Union Sq., W., New York, N. Y.
FLEMING, Albert W. (Associate 1919). Br. Mgr., Kewanee Boiler Co., 509 Occidental Bldg., Indianapolis, Ind.
FLEMING, Thomas C. (1919). Sales Mgr., Crane Co., 245 Master St., and (for mail) 5239 N. 15th St., Philadelphia, Pa.
FLETCHER, Saxton W. (1923). W. L. Fleisher & Co., 31 Union Sq. W., New York, N. Y.
FLETT, Henry R. (Associate 1915; 1915). Mgr., Taylor-Forbes Co., Ltd., and Everlasting Valve Co., Ltd., 1088 King St. W., Toronto, Ont.
FLINT, Coll T. (1919). Boston Mgr., (for mail) H. B. Smith Co., 640 Main St., Cambridge, and 56 Brantwood Rd., Arlington, Mass.
FOGG, Oscar H. (1914). Secy.-Mgr., American Gas Association, 342 Madison Ave., New York, N. Y.
FOLEY, George E. (1920). Heat. Contr., Foley Plbg. & Heat. Co., 1115 E. 19th St., and 2134 Elmwood Ave., Kansas City, Mo.
FOLEY, Wm. J. (Associate 1923). Mgr. and Engr., Wm. J. Foley Heat. Service Co., 230 15th St., Denver, Colo.

FOOTE, Moses L. (1909). 705 Rose Bldg., and 1225 Cummington Rd., Cleveland, O.
FORD, J. A. (1921). Heat. Engr., (for mail) Loftis Plbg. Co., 42 Luckie St., and 17 W. Cain St., Atlanta, Ga.
FORFAR, Donald M. (1917). Mech. Engr., (for mail) Croft & Boerner, Inc., Archts. & Engrs., 1006 Marquette Ave., and 3140 Bryant Ave., S., Minneapolis, Minn.
FORGAN, Donald M. (Associate 1923). Mgr., American Radiator Co., 4201 Duncan Ave., and N. Denny Rd., St. Louis, Mo.
FORGE, Frederick A. (1919). Consulting Engr., 141 E. 29th St., New York, N. Y., and Ridgewood, N. J.
FORSBERG, William (1919). (for mail) Hopson & Chapin Mfg. Co., 231 State St., and 21 Brainerd St., New London, Conn.
FOSTER, Charles (1923). Consulting Engr., 512 Sellwood Bldg., and 2418 E. 3rd St., Duluth, Minn.
FOSTER, James M. (Associate 1920). Dist. Mgr., (for mail) Ilg Electric Ventilating Co., 1420 Syndicate Trust Bldg., and 7021 Lindell Blvd., St. Louis, Mo.
FOSTER, William M. (Associate 1914). Liggett-Doll-Foster Co., 16508 Woodward Ave., Highland Park, Mich.
FOUILHOUX, J. Andre (1915). Archt. and Consulting Engr., R. M. Hood and J. A. Foulhoux, 7 W. 42nd St., New York, N. Y., and (for mail) West Rd., Short Hills, N. J.
FOULDS, Powys A. J. (1916). Hollis French and Allen Hubbard, 210 South St., Boston, and (for mail) 33 Dakota Rd., Dorchester, Mass.
FRANCIS, Isaac Hathaway (1907). Consulting Engr., 1306 Otis 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., Frank and 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., and Howard Iron Works, 281 Chicago St., and 296 Norwalk Ave., Buffalo, N. Y.
FRANKLIN, Ralph S. (1919). Pres. and Treas., (for mail) Albert B. Franklin, Inc., 25 Haverhill St., Boston, and 320 Grove St., Melrose, Mass.
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). 601-602 Walton Bldg., Atlanta, Ga.
FRENCH, Bascom P. (Junior 1915). Olney Plbg. & Heat. Co., 106 W. Main St., Olney, Ill.
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). Engr., P. Gormly Co., 155 N. 10th St., Philadelphia, and (for mail) 828 W. Marshall St., Norristown, Pa.
FRUTCHY, Asel E. (Junior 1920). Vice-Pres., (for mail) Frutchy Barnes Co., Inc., Plbg. and Heat. Contrs., 104 W. 2nd St., and 414 Walnut St., Elmira, N. Y.
FRYER, Frederick G. (1918). Director, Rowntree & Co., Ltd., York, England.
FULLER, Charles A.* (1913). (Council 1917). Consulting Engr., 347 5th Ave., New York, and 501 E. 5th St., Mt. Vernon, N. Y.
FULLER, J. Lansing (Associate 1918). Western Sales Mgr., (for mail) Hart & Crouse Co., 315 E. Adams Ave., and 1745 Chicago Blvd., Detroit, Mich.
FULLER, Robt. K. (Associate 1922-1923). Archt. and Engr., (for mail) 310 Foster Bldg., and 627 Corona St., Denver, Colo.

FURMAN, Conrad W. (1915). Sales Engr., Savannah Supply Co., Jacksonville, Fla.
FURMAN, J. R. (1919). Mech. Engr., 1417 Railway Exchange, and (for mail) 5488 University Ave., Chicago, Ill.

G

GALE, Thomas J. C. (Associate 1920; 1921). (Secy. St. Louis Chapter), Standard Sanitary Mfg. Co., Heat. Dept., 4140 Forest Park Blvd., and (for mail) 6008 Bartner Ave., St. Louis, Mo.
GALLAHER, James E. (Junior 1923). Engr. and Estimator, J. H. Gallaher Co., 1946 N. Broadway, St. Louis, Mo.
GALLIGAN, Andrew B. (1921). Mgr., Galligan Bros., 716-718 S. 51st St., and 5231 Race St., Philadelphia, Pa.
GALLIGAN, John H. (1923). Haynes Selling Co., 1711 Sansom 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). Lewis, Robinson & Gant, Land Title Bldg., Philadelphia, Pa.
GARDNER, S. Franklin (1911). (for mail) Standard Eng. Co., 2129 I St., N.W., and Faulkstone Courts, 1401 Fairmont St., N.W., Washington, D. C.
GARDNER, Wm., Jr. (Associate 1921). Sales Mgr., Egan & Fife Co., (for mail) 152 McCormick Bldg., and 7829 S. Bishop St., Chicago, Ill.
GARRISON, James H. (1911). 708 Walton Ave., Watts, Cal.
GAUSMAN, C. E. (1923). Magney & Tusler, 126 S. 9th St., Minneapolis, and (for mail) 748 Margaret St., St. Paul, Minn.
GAUTHROP, Fred H. (1919). Pres.-Treas., (for mail) Gauthrop & Bro. Co., 705 Orange St., and 1110 Shawcross Ave., Wilmington, Del.
GAYLOR, William S. (1919). Heat. and Vent. Engr., Starrett & Van Vleck, 8 W. 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.
GEDEIST, Oliver (Associate 1920). Executive Asst., (for mail) Monitor Stove Co., Woodrow St., and 911 Vine St., Cincinnati, O.
GEIER, Bernard A. (Associate 1920). Sales Engr., 230 5th Ave., Pittsburgh, and (for mail) 225 S. Birmingham Ave., Avalon, 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., F. E. Geisler & Co., 422 1st Ave., and Saybrook Apts., Pittsburgh, Pa.
GEMENY, William J. (1919). Pres., W. J. Gemeny Co., 1050 W. Randolph St., and 7601 Normal St., Chicago, Ill.
GERRISH, Harry E. (1911). (Council 1919). Pres., (for mail) Morgan-Gerrish Co., 501 8th St., S., and 4534 S. Fremont Ave., Minneapolis, Minn.
GETSCHOW, George 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., Whitlock Coil Pipe Co., 726 Commercial Trust Bldg., Philadelphia, and Merion, Pa.

GIESECKE, F. E.* (1913). Prof. of Architectural Eng., Head of Eng. Research Division of the Bureau Economic Geology and Technology, Univ. of Texas, and 2400 Rio Grande, Austin, Texas.

GIFFORD, Robert L. (1908). Pres., Illinois Engineering Co., Chicago, Ill., and (for mail) 1231 S. El Molino Ave., Pasadena, Cal.
GIGUERE, George H. (1920). Mech. Engr., John Finn & Son, 7720 Plymouth Rd., and 14785 Saratoga Ave., Detroit, Mich.
GILBERT, Maxwell E. (Associate 1915). Mgr., (for mail) Richardson & Boynton Co., 1308 Arch St., Philadelphia, and Jenkintown, 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.
GILL, Michael J. (1919). Sanitary, Heat. & Vent. Engr., (for mail) 692 Newark Ave., and 33 Spruce St., Jersey City, N. J.
GILMORE, Frank P. (1923). Sales Engr., Peerless Unit Ventilation Co., Inc., Little Bldg., Boston, Mass.
GILLETT, Merriman C. (1916). Plant Mgr., Standard Heater Co., Walnut St., Williamsport, and 6600 Rising Sun Ave., Philadelphia, Pa.
GILLHAM, Walter E. (1917). 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.
GILSON, Howard J. (Associate 1915). 1818 Chapella St., Santa Barbara, Cal.
GLASSEY, J. Wilbur (1922). Mgr., (for mail) Vapor Heating Co., 215 S. 17th St., and Wyndmoor, Chestnut Hill, Philadelphia, Pa.
GLENNON, Charles (1917). Executive Secy., Master Steam and Hot Water Fitters Assn. of Chicago, 1214 Chamber of Commerce Bldg., Chicago, Ill.
GLORE, Ervin F. (Associate 1916). Secy. and Sales Mgr., Abram Cox Stove Co., American and Dauphin Sts., Philadelphia, Pa., and (for mail) 715 Riverside Drive, New York, N. Y.
GODFREY, Fokert 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., 706 Rose Bldg., and 850 E. 128th St., Cleveland, O.
GOLDSCHMIDT, Otto E. (1915). Consulting Engr., 116 W. 39th St., New York, N. Y.
GOLDSTEIN, A. M. (1923). Federal Heat. Co., 310 13th St., N.W., and 425 Irving St., N.W., Washington, D. C.
GOMBERS, Henry B. (Associate 1901). Secy., (for mail) Heat. and Piping Contrs. National Assn., 50 Union Sq., New York, N. Y., and 160 Halsted St., East Orange, N. J.
GOMERSALL, William H. (Associate 1921). Sales Engr., Sherman Eng. Co., 254 S. 15th St., and 7500 Limekiln Pike, Mt. Airy, Philadelphia, Pa.
GOOD, Macy S. (1921). Mgr., Chicago Territory C. A. Dunham Co., R. 230 E. Ohio St., and 6360 Greenwood Ave., Chicago, Ill.
GOODNOW, Wallace F. (1912). Special Repr., Pierce, Butler & Pierce Mfg. Corp., 41 E. 42nd St., New York, N. Y., and 680 Steamboat Rd., Greenwich, Conn.
GOODRICH, Charles F. (1919). Andrews & Goodrich, Inc., 88 Broad St., Boston, and 38 Clarendon St., Malden, Mass.
GORDON, Edward B., Jr. (1908). Chas. L. Pillsbury Co., Capital National Bank Bldg. St. Paul, and (for mail) 2915 Knox Ave., S., Minneapolis, Minn.
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 251 Crescent St., Brooklyn, N. Y.

GORTNER, John W. (1919), Heat, Vent. and Sanitary Plumber, (for mail) A. W. Gortner and Son, 318 Sunbury St., and 42 N. 6th St., Shamokin, Pa.

GOS, Matthew H. (1921), Estimator and Engr., The Brown Co., 1053 Baltimore Ave., W., and (for mail) 3022 Montclair Ave., Detroit, Mich.

GOTTWALD, C. (Associate 1916), Pres., Ric-Wil Co., Guardian Bldg., Cleveland, O.

GRAEFF, Richard J. (1920), Pres., R. J. Graeff, Inc., 1048 Beaubien St., and 1926 Euclid Ave., W., Apt. 6-A, Detroit, Mich.

GRASSLER, Edmund (Associate 1919), (for mail) Grassler & Gezelschap, 214 3rd St., and 750 Summit Ave., Milwaukee, Wis.

GRAVES, Willard B. (1906), Pres., (for mail) W. B. Graves Heating Co., 162 N. Des Plaines St., Chicago, and 254 Edgewood Place, River Forest, Ill.

GRAY, William E. (1922), National Dry Kiln Co., E. Maryland St., Indianapolis, Ind.

GREASON, Samuel L. (1915), Pres., Greason Mfg. Co., 108 W. 99th St., New York, and (for mail) 341 New York Ave., Brooklyn, N. Y.

GREBE, Henry W. (1919), Pres., (for mail) Central Asbestos & Magnesia Co., 214 W. Grand Ave., and 2560 Wilson Ave., Chicago, Ill.

GREEN, William C. (1906), Warren Webster & Co., 310 Provident Bank Bldg., Cincinnati, O.

GREENE, Walter C. (1921), Sales Engr., Strong, Carlisle, Hammond & Co., 336-344 Frankfort Ave., Cleveland, and 2400 Demington Drive, Cleveland Heights, O.

GRETZINGER, Franklin (1919), Mech. Engr., Land Title Bldg., and (for mail) 2124 N. 17th St., Philadelphia, Pa.

GRIER, William (1908), P. O. Box 75, Cincinnati, O.

GRIERSON, Ronald E. (1916), Ch. Engr., Provincial Cinematograph Theatres, Ltd., 80-82 Wardour St., London, W. 1, England.

GRIFFIN, Frank A., Jr. (1917), (for mail) Kellogg-Mackay Co., 2030 Walnut St., and 3930 S. Benton St., Kansas City, Mo.

GRIFFIN, John J. (Associate 1918; 1921), Pres., (for mail) International Eng. & Supply Co., 1308 Olive St., and 3662 Humphrey St., St. Louis, Mo.

GRIFFIN, W. H. (1922), Pres., 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, Clark, McMullen & Riley, 101 Park Ave., New York, and 90 Alter Ave., Dongan Hills, Staten Island, N. Y.

GRIMSHAW, George E. (Junior 1910; 1915), Asst. Mgr., Insulation Dept., Johns-Manville, Inc., Euclid Ave., and 46th St., Cleveland, O.

GROOM, Stanley L. (1920), Managing Director, Buffalo Forge Co., Ltd.; Carrier Eng. 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., 1869 E. 55th St., and 3323 E. Monmouth Rd., Cleveland, O.

GROSSMAN, Howard M. (1922), Dist. Mgr., Burnham Boiler Corp., Lancaster, Pa.

GROSVOLD, Fred E. (1917), Plbg. and Heat., 319 S. Farwell St., and 603 Main St., Eau Claire, Wis.

GROTZ, Arthur B. (1921), Pres., Linton Machine Co., Treas., Paterson Kelly Co., 101 Park Ave., New York, and (for mail) 17 Cambridge Pl., Brooklyn, N. Y.

GROWE, Andrew W. (1920), Heat. Engr., Warden & Co., 2450 Prospect Ave., Cleveland, O.

GRUMBEN, Irwin F. (1915), Pres., (for mail) National Heat. & Vent. Co., 736 Drexel Bldg., Philadelphia, and Lebanon, Pa.

GUEST, Peyton L. (1921), Pres., (for mail) Smith & Guest, Inc., 390 Peachtree St., and 247 McGindum St., Atlanta, Ga.

H

HAAS, William (1915), Pres. and Treas., (for mail) The William Haas Co., 429 E. 3rd St., and 1632 S. Wayne Ave., Dayton, O.

HACKETT, Charles P. (Associate 1921), Br. Mgr., (for mail) U. S. Radiator Corp., R. 206, Ludlow Bldg., 34 S. 16th St., and 61 W. Eagle Rd., P. O. Upper Darby Br., Philadelphia, 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. 5th St., and 1514 E. 7th St., Charlotte, N. C.

HADEN, George Nelson (Junior 1922), Consulting Engr., (for mail) 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, Indianapolis, Ind.

HAIGHT, Theodore (1919), Pres. and Gen. Mgr., Providence Eng. Co., 30 Church St., New York, and 328 Sterling Pl., Brooklyn, N. Y.

HAINES, John J. (1915), Vice-Pres. and Secy., The Haines Co., 1933 W. Lake St., Chicago, Ill.

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. 8th 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, Cal.

HALLER, Arthur L. (1920), Engr., (for mail) Hunt Heating Co., 810 Chestnut St., St. Louis, and 520 Fairview Ave., Webster Groves, Mo.

HALLETT, Edwin S.* (1918), (Council 1921-1923), Ch. Engr., (for mail) Board of Education, Bd. of Education Bldg., and 5156 Cabanne Ave., St. Louis, Mo.

HALLEY, W. H. (Junior 1923), Designer and Engr., Haynes-Langenberg Mfg. Co., 4045 Forest Park Blvd., and (for mail) 6134 W. Park Ave., St. Louis, Mo.

HAMILTON, Henry, Jr.* (Associate 1922), New York Mgr., Ozone Pure Airifier Co., 1455-57 W. Congress St., Chicago, Ill.

HAMLET, Francis A. (1922), Director, Castona Products, Ltd., 4 Harbour St., 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., 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.

HAND, William L. (1920), Mech. Engr., (for mail) 722-723 Oxford Bldg., 118 N. LaSalle St., and 4754 Vincennes Ave., Chicago, Ill.

HANES, J. W. E. (Junior 1922), Designer, D. S. Reynolds, Engr., 617 Homer Laughlin Bldg., and 1241 W. 47th St., Los Angeles, Cal.

HANKIN, Richard (1898) Vice-Pres., John Hankin & Bros., 228 Cherry St., New York, N. Y.

HANSEN, John (1921), Heat. Engr., Nilsson 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 Place, Pittsburgh, Pa.

HANSON, Henry A. (Associate 1923), Sales Mgr., Pierce, Butler & Pierce Mfg. Corp., 41 East 42nd St., New York, N. Y.

HANSON, Leon C. (Associate 1918), Bjorkman Bros., 712 S. 10th St., Minneapolis, Minn.

HARRISON, John E. (1920), Heat. Engr. and Contr., 211 1/2 Union St., and 1210 Union St., Schenectady, N. Y.

HARBUCK, John H. (1919), Vice-Pres. and Engr., (for mail) Moncrief Furnace Co., 130 S. Pryor St., and 156 McMillan St., Atlanta, Ga.

HARBULA, Michael G.* (1921), Atmospheric Conditioning Corp., 841 Monadnock Block, and 7126 Merrill Ave., Chicago, Ill.

HARDING, Louis A.* (1911), (Council 1922), Harding & Crea, White Bldg., Buffalo, N. Y.

HARDY, Arthur R. (1917), Archt., (for mail) Greenebaum, Hardy & Schumacher, 216 Scarritt Bldg., and 1111 E. Gillham Rd., Kansas City, Mo.

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), (Pres. Michigan Chapter), Heat. Contr., 515 S. Waterman Ave., Detroit, Mich.

HARRIGAN, Edward M. (1915), Pres., (for mail) Harrigan & Reid Co., 1705 1st St., and 7450 La Salle Blvd., Detroit, Mich.

HARRIS, Emory E. (1916), Vice-Pres., Pittelkow Heat. and Eng. Co., 312 W. Larned St., and 1492 Bewick Ave., Detroit, Mich.

HARRIS, Gordon D. (1913), (for mail) Industrial Dryer Corp., 60 W. 30th St., New York, and Islip, N. Y.

HARRIS, H. Archibald (Associate 1915; 1916), Archibald Harris & Co., Accts. and Engrs., 140 S. Dearborn St., Chicago, Ill.

HARRIS, H. Melvin (1918), 10309 Barrett Ave., Cleveland, O.

HARRIS, Jesse B. (1918), (for mail) Rose & Harris, 318 Auditorium Bldg., and 3620 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 E. 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.

HARTFORD, Claude (1917), Secy. and Gen. Sales Mgr., (for mail) Wilson Welder & Metals Co., Inc., 132 King St., New York, and 33 Argyle Rd., Brooklyn, N. Y.

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), 300 Builders' Exchange, and 2613 3rd Ave., S., Minneapolis, Minn.

HAUSER, Martin (1917), Pres. Engr., General Heat Supply Co., R. 1, Reliance Bldg., and 1316 E. 42nd St., Kansas City, Mo.

HAUSS, Charles F. (1922), Special Repr. for Far East, (for mail) American Radiator Co., 4 Yuen Ming Yuen Rd., Shanghai, China.

HAYES, James J. (1920), Sales Engr., Stannard Power Equipment Co., 1220 Monadnock Block, and 1423 E. 66th Pl., Chicago, Ill.

HAYES, Joseph G. (1908), Mgr. and Engr., Hayes Bros., Inc., 236 W. Vermont St., and 2849 N. Capitol Ave., Indianapolis, Ind.

HAYES, Patrick M. (Associate 1923), Asst. Mgr., K. C. Br., Dempster Mill Mfg. Co., 1307 W. 10th St., and Cortez Hotel, 417 E. 10 St., Kansas City, Mo.

HAYNES, Charles V. (1917), Vice-Pres. and Gen. Sales Mgr., Hoffman Specialty Co., 512 Fifth Ave., New York, N. Y., and 256 S. 45th St., Philadelphia, Pa.

HAYNES, William J. (1911), Vice-Pres., (for mail) Haynes-Langenberg Mfg. Co., 4519-33 N. Euclid Ave., and 5370 Pershing Ave., St. Louis, Mo.

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.

HEAP, Walter E. (1920), Mgr., Charles R. Heap & Son, 204 Bay St., Tomkinsville, and 412 Delafield Ave., W. New Brighton, N. Y.

HEAGLER, John M. (1922), Heat. and Vent. Engr., American Foundry & Furnace Co., 303 Pittsburgh Bldg., and 1783 Marshall Ave., St. Paul, Minn.

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., 45 W. 34th St., New York, and Crescent Athletic Club, 129 Pierpoint St., Brooklyn, N. Y.

HECK, George L., Jr. (Associate 1921), Sales Engr., Garden City Fan Co., 1842 McCormick Bldg., and 746 E. 49th St., Chicago, Ill.

HECKEL, Edmund P. (1918), Vice-Pres., Carrier Eng. Corp., 2169 Transportation Bldg., Chicago, and 314 Cuttriss Pl., Park Ridge, Ill.

HEDGES, Henry B. (1919), (Secy. Philadelphia Chapter), Mgr., (for mail) Kewanee Boiler Co., 510 Real Estate Trust Bldg., and 6525 N. Woodstock St., Philadelphia, Pa.

HEEBNER, Walter Morris (1923), Heat. and Vent. Engr., Warren Webster & Co., 15 W. 34th St., and (for mail) 129 W. 98th St., New York, N. Y.

HEIBEL, Walter E. (1921), Sales Engr., B. F. Sturtevant Co., 52 Vanderbilt Ave., New York, and 1045 Ocean Ave., Brooklyn, N. Y.

HEILES, Frederick C. (Junior 1914; 1920), Engr., George A. Fuller Co., of the Orient, Ltd., Dairen, Manchuria.

HEINLE, Earl L. (1920), The Kaine-Peterson-Heinle Co., 1304 E. 34th St., Cleveland, and (for mail) 2276 Grandview 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. W. B. Van Sickle, 318 Kealt Bldg., Beaumont, Texas.

HENDERSON, Thomas J., Jr. (1917), Heat. and Vent. Contr., 116 Peterson Bldg., and 424 E. 5th St., Flint, Mich.

HENION, Hudson D. (Associate 1923), Mgr., Young Pump Co., 310 Lister Bldg., Hamilton, Ont.

HENRICH, George A. (1914), Pres. and Treas., (for mail) Geo. A. Henrich Co., 5650 Broadway, and 1215 Elm Dale Ave., Chicago, Ill.

HENSCHEN, Laurence H. (1915), Henschel 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, Texas.

HERENDEEN, Frederick W. (1920), Secy., National Boiler & Radiator Mfrs. Assn., 815 S. Main St., and 29 Seneca St., Geneva, N. Y.

HERLIHY, George F. (1922), Vice-Pres., J. J. Herlihy, Inc., 751 W. Van Buren St., and 212 E. 109th St., Chicago, Ill.

HERLIHY, Jeremiah J. (1914), Pres., J. J. Herlihy, Inc., 751 W. Van Buren St., and 3634 N. Keeler Ave., Chicago, Ill.

HERING, John B. (Junior 1922), Philip Hering & Son, 409 Belgrade St., Philadelphia, Pa.

HERRICK, Daniel A. (1923), Factory Mgr., Julian D'Este Co., 26 Canal St., Boston, and (for mail) 27 Agassiz St., Cambridge, Mass.

HERRING, Edgar (1919), Managing Director, (for mail) J. Jeffreys & Co., Ltd., Barron's Place, 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 S. 16th St., Allentown, Pa.

HERSH, G. Willis (1917), Gen. Mgr., Hersh Bros. Co., 645 Mill St., Allentown, Pa.

HERSHEY, John C. (1919), Pres., Jas. Spear Stove & Heat Co., 1823 Market St., 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 N. 16th St., Philadelphia, Pa.

HIBBS, Frank C. (1917), Salesman, H. B. Smith Co., S. E., cor. 17th and Arch Sts., and (for mail) 3203 Columbia Ave., Philadelphia, Pa.

HIGGINS, John M. (1922), Salesman, H. B. Smith Co., 640 Main St., Cambridge 39, and (for mail) 16 Dearborn Rd., Medford 57, Mass.

HILDEBRANDT, Henry A. (1918), Supt. of Bldgs. and Grounds, (for mail) University of Minnesota, and 323 Church St., S.E., Minneapolis, Minn.

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, Charles H. (1917), Ch. Engr., State Normal School, Emporia, Kans.

HILL, Dr. E. Vernon* (Associate 1912; 1914), (Council 1915; 1917; 1921; 2nd Vice-Pres. 1918; 1st Vice-Pres. 1919; Pres. 1920), 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, Wm. A. (1921), Estimator, King Plbg. and Heat Co., 214 Columbia St., and Box 72-A, R. F. D. No. 7, Seattle, Wash.

HILLMAN, R. Ward (1919), Asst. Gen. Mgr. Sales, U. S. Radiator Corp., 135 E. Grand River Ave., and 2472 Euclid Ave., W., Detroit, Mich.

HINKLE, Edwin C. (1911), Pres., Atlantic Heat. & Eng. Co., 2nd National Bank Bldg., and 170 Franklin Ave., Hempstead, N. Y.

HITCHCOCK, Frederick P. (1917), Pres. H. & P. Sales Co., 1104 Republic 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. 3rd St., Dayton, O.

HOFFMAN, George D.* (1906), Hoffman Specialty Co., 512 5th 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., Purdue University, and 323 University St., W., Lafayette, Ind.

HOGAN, Edward L. (1911), Mgr., Air Conditioning Dept., (for mail) American Blower Co., 6004 Russel St., Detroit, Mich.

HOGUE, Carl T. (1922), Heat. & Vent. Engr., San Angela, Texas.

HOIER, William V. (1917), Mgr., (for mail) Wm. V. Hoier Co., 701 N. Wells St., and 1023 Thorndale Ave., Chicago, Ill.

HOLLOWAY, Robert B. (Junior 1923), Engr. and Salesman, Gurney Heater & Mfg. Co., 108 N. 17th St., Philadelphia, and 26 W. Rockland St., Germantown, Pa.

HOLMES, Joseph (1921), Pres. and Heat. Engr., The Holmes Landwehr Heat. Co., 1508 Adams St., and cor. Elizabeth and Vance Sts., Toledo, O.

HOMANN, Frederick A. (1918), Sales Repr., The Herman Nelson Corp., 3542 N. Broad St., 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.

HOOPER, Wyllys G. (1921), Mech. Engr., (for mail) Urbauer Atwood Co., 1450 S. 2nd St., and 4129 Shaw Ave., St. Louis, Mo.

HOOVER, H. Earl (Associate 1922), Vice-Pres. Hoover Co., 1411 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., Etablissements Arnould, Peking, China.

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.

HORNUNG, John C. (1914), Engr., 343 S. Dearborn St., Chicago, and Glencoe, Ill.

HOUGHTEN, Ferry C.* (1921), Heat. Engr., Research Laboratory, A. S. H. & V. E., R. 283, U. S. Bureau of Mines, Pittsburgh, Pa.

HOUP, 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.

HOWE, Willis W. (Associate 1919), Pres., (for mail) Willis W. Howe & Co., 3030 McGee Traffic Way, and 4122 Mercier St., Kansas City, Mo.

HOWELL, Frank B. (1920), Director, Dept. of Research, American Radiator Co., (for mail) 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. G., Jr. (Junior 1922), Salesman, 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., White-neville, 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, George W. (1911), Mech. Engr., (for mail) Graham, Anderson, Probst & White, 1417 Railway Exchange, Chicago, and 331 Bonnie Brae, River Forest, Ill.

HUBBARD, Nelson B. (1919), Consulting Engr., 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, Central Supply Co., 312 S. 3rd St., and 4037 Harriet Ave., Minneapolis, Minn.

HUCKEL, Frank, Jr. (1920), Mgr., Heat. Dept. Keystone Supply & Mfg. Co., 907 N. 9th 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.

HUGHES, John T. (Associate 1922), Sales Engr., (for mail) Brogan & Co., 810 Race St., Philadelphia, and 211 Dawson St., Wissickton, 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, Kans.

HUMPHREY, D. E. (1921), Heat. and Vent. Engr., (for mail) Goodyear Tire and Rubber Co., Akron, and 128 S. 4th St., Cuyahoga Falls, O.

HUMPHREYS, Aurelius E. (1911), Mgr., O'Mara Heat Co., 504 Victoria Bldg., St. Louis, Mo.

HUMPHREYS, Theodore F. (1915), Cleveland Mgr., H. B. Smith Co., and (for mail) 16108 Clifton Blvd., Cleveland, O.

HUNT, Phil M. (1922), Steam and Heat. Engr. Dept., Crane Co., Oklahoma City, Okla.

HUNT, Richard B. (1912), Mgr., (for mail) Gurney Heater Mfg. Co., 11 E. 42nd St., New York, and 414 S. 4th Ave., Mt. Vernon, N. Y.

HUNTER, Albert C. (1919), Salesman, Consolidated Sulphur Co., 428 Metropolitan Bank Bldg., and (for mail) 3900 Harriet Ave., Minneapolis, Minn.

HUNTER, Charles C. (Associate 1923), Salesman, Westinghouse Elect. & Mfg. Co., 165 Broadway, New York, and (for mail) 55 Hollywood Ave., East Orange, N. J.

HUNTER, Paul F. (Junior 1918), Engr., 249 9th Ave., N., and (for mail) 644 Huron St., S.E., Minneapolis, Minn.

HUNTLEY, Frank A. (Junior 1918), Salesman, Walworth Mfg. Co., Seattle, and (for mail) Box 1229, Yakima, Wash.

HURLEY, Joseph (1915), Pres., Petroleum Fuel Eng. Co., 7 S. 17th St., and 21 S. 61st St., Philadelphia, Pa.

HURXTHAL, Alpheus O. (1921), Ch. Engr., (for mail) Proctor & Schwartz, Inc., 7th St., and Tabor Rd., and 6214 Morton St., Philadelphia, Pa.

HUSBAND, Edward Woods (1922), Heat. Engr., Geo. Frederic Hall, Archt., 807 Union Trust Co. Bldg., and (for mail) 114 Corinth St., Providence, R. I.

HUTCHISON, J. E. (1921), Isaac Hathaway Francis, Otis Bldg., Philadelphia, Pa.

HUTCHISON, J. Howard (1919), (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) Hutzel & Co., 119 E. Washington St., and 722 W. Washington St., Ann Arbor, Mich.

HUTZEL, Hugo F. (1918), Engr., (for mail) American Radiator Co., 1807 Elmwood Ave., and 1160 Hertel Ave., Buffalo, N. Y.

HVOSLEF, F. Waldemar (Associate 1921), Engr., U. S. Radiator Corp., 133 E. Grand River Ave., Detroit, Mich.

HYMAN, Wallace M. (1920), Vice-Pres., (for mail) Reis & O'Donovan, 213 W. 28th St., and 302 W. 86th St., New York, N. Y.

HYNES, Lee P. (1919), Ch. Engr., Consolidated Car Heat Co., 413 N. Pearl St., Albany, N. Y.

ICKERINGILL, John (1923), Sales Engr., Haynes Selling Co., Inc., 1711 Sansom St., Philadelphia, and (for mail) 333 Rector St., Roxborough, Pa.

IDDLIS, Alfred (1921), Mech. Engr., (for mail) Day & Zimmermann, Inc., 611 Chestnut St., Philadelphia, and 304 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.

INCALLS, F. D. B. (1906), Heat. and Sales Engr., (for mail) 136 Federal St., Boston 9, and 25 Hartshorn St., Reading, Mass.

INGELS, Margaret M.* (Junior 1918), Research Engr., Research Laboratory, A. S. H. & V. E., R. 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.

IRELAND, Thomas H. (1923), Sales Engr., Crane Co., 19-25 W. 44th St., New York and 137 Pelham Rd., New Rochelle, N. Y.

ISSERTELL, Henry G.* (Associate 1912; 1913), Sales Engr., Bldg. Equip. Section, Gen. Elect. Co., 120 Broadway, and 825 W. 180th St., New York, N. Y.

JACKSON, Charles J. (Associate 1912), Local Mgr., Jenkins Bros., 646 W. Washington Blvd., Chicago, and 932 Oak St., Winnetka, Ill.

JACKSON, Marshall S. (1919), Heat. and Power Plant Equip., 232 Delaware Ave., and 356 Woodward Ave., 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 E. 15th St., and 365 W. 118th St., New York, N. Y.

JANES, Arthur (1919), Pres., (for mail) Arthur James Co., 138 E. 59th St., New York and 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.

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; Secretary 1898; Board of Managers 1899), Consulting and Constructing Engr., Pres., (for mail) Stewart A. Jellott Co., 1200 Locust St., and 6701 Lincoln Drive, Mount Airy, Philadelphia, Pa.

JENNINGS, Frederick W. (Associate 1905), Ashwell & Nesbit, Ltd., 12 Great James St., Bedford Row, London, W. C., England.

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.

JEWELL, George H. (1916), Sales Engr., Builders' Iron Foundry, 466 Peoples Gas Bldg., and 1435 Greenleaf Ave., Chicago, Ill.

JOHN, Benjamin F. (1920), Pres., (for mail) Benj. F. John Co., 1003 Race St., and 881 N. 24th St., Philadelphia, Pa.

JOHNSON, Carl W. (1912), Pres., (for mail) C. W. Johnson, Inc., 644 Washington Blvd., and 1809 Morse Ave., Chicago, Ill.

JOHNSON, Edward B. (1919), (Secretary New York Chapter), Sales Engr., American Radiator Co., 104 W. 42nd St., New York, and (for mail) 154 Wardwell Ave., W. New Brighton, N. Y.

JOHNSON, Fred W. (1916), Vice-Pres., (for mail) Johnson, Larsen & Co., 233 Monroe Ave., and 273 Chalmers Ave., Detroit, Mich.

JOHNSON, James A. (1919), (for mail) Esenwein & Johnson, 781 Elliott Sq., and 731 W. Delevan Ave., Buffalo, N. Y.

JOHNSON, Ralph B. (1922), Sales Engr., Johnson Service Co., 411 E. 10th St., and 3729 Summit St., Kansas City, Mo.

JOHNSTON, James A. (1912), Consulting Engr., Carneal & Johnston, Chamber of Commerce Bldg., 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), Bz. Mgr., (for mail) U. S. Radiator Corp., 712-16 Boyce Bldg., 500 N. Dearborn St., Chicago, Ill.

JONES, A. M. (1922), Mgr., Machinery Mfgs. Sect. Westinghouse Elect. & Mfg. Co., E. Pittsburgh, and 209 Biddle Ave., Wilkinsburg, Pa.
 JONES, David J. (1919), Mech. Asst., Illinois Cent. R. R. Co., R. 1000, Central Station, and (for mail) 425 E. 89th Pl., Chicago, Ill.
 JONES, Edwin A. (1919), Sales Engr., Williams Radiator Co., 620 Pacific Mutual Bldg., Los Angeles, and 1642 Ocean Ave., Santa Monica, Cal.
 JONES, Ernest F. (1923), Sales Engr., Kellogg-Mackay Co., 419 W. 18th St., Chicago, and (for mail) 440 W. Macon St., Decatur, 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, Louis T. (1921), Salesman, Richardson & Boynton Co., 1332 Arch St., and (for mail) 19 S. 43rd St., Philadelphia, Pa.
 JONES, Raymond E. (1919), Engr. and Salesman, 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 S. 48th St., Philadelphia, Pa.
 JONES, William T. (1915), 11 Rossmere St., Newtonville, Mass.
 JORDAN, Charles F. (1915), Ch. Engr., Board of Education, 1860 Kinney Ave., Cincinnati, O.
 JOYCE, Harry B. (1922), Ch. Engr., (for mail) Centrifugal Fan Co., 9-15 17th Ave., Newark, and 14 S. Munn Ave., East Orange, N. J.
 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 5th Ave., and (for mail) 75 W. 92nd St., New York, N. Y.
 KAMMAN, Amolel R. (Junior 1921), Engr., John W. Danforth Co., 72 Ellicott St., and (for mail) 441 Massachusetts Ave., Buffalo, N. Y.
 KANN, Louis J. (1919), Sixth City Sheet Metal Iron Works, 1830 St. Clair Ave., and 705 E. 109th St., Cleveland, O.
 KAPLAN, Joseph (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.
 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), 129 W. Main St., Belleville, Ill.
 KAUFFMAN, Rufus (1921), Heat. Engr. and Contr., 326 W. Seymour St., Germantown, 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), 2042 Rittenhouse St., and S.W. Cor. 44th and Pine Sts., Philadelphia, Pa.
 KEENAN, P. Frank (1921), Salesman, McNab & Harlin Mfg. Co., 110 William St., New York, and (for mail) 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), (for mail) 89 Franklin St., Boston, and 6 Hawthorne St., Waverley, Mass.

KELLOGG, Clarence V. (Associate 1900), Pres., (for mail) Kellogg-Mackay Co., 419 W. 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.
 KELLY, John C. (Associate 1919), Pibg. and Heat. Spec., 210 E. 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.
 KENNINGER, Albert H. (1918), Sales Engr., 4013 Woburn Ave., Cleveland, O.
 KERSJES, William (1922), Pres., Wheeler Blaney Co., 223 N. Burdick St., and (for mail) 728 Clinton Ave., Kalamazoo, Mich.
 KERSHAW, Melville G. (Junior 1921), Design. Engr., (for mail) Lewis, Robinson & Gant, 1303 Land Title Bldg., and 742 N. 40th St., Philadelphia, Pa.
 KEYES, Robert E. (1913), Const. Engr., (for mail) W. L. Fleisher & Co., Inc., 31 Union Sq., W., and 135 W. Kingsbridge Rd., New York, N. Y.
 KIEFER, Carl J. (1922), Consulting Engr., 810-15 4th National Bank Bldg., Cincinnati, O.
 KIEWITZ, Arthur A. (1912), Heat. Engr., Abram Cox Stove Co., 113 E. 34th St., New York, and 187 Academy St., Astoria, Long Island City, N. Y.
 KIEWITZ, Conway (1907), Engr., N. Y. Bd. of Education, Flatbush Ave., and Concord St., Brooklyn, and Floral Park, New York, N. Y.
 KILLIAN, Maurice A. (1922), Glanz & Killian Co., 427 Atwater St., E., Detroit, Mich.
 KIMBALL, Charles W. (1915), (Council 1918), 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 W. 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., 523 N. Charles St., and 2802 Garrison Ave., Baltimore, Md.
 KING, Thomson (1923), Sales Mgr., Gas Boiler Dept., Peerless Heater Co., 5602 Baum Blvd., Pittsburgh, Pa.
 KINGSBURY, William M. (1913), Heat. and Vent. Engr., (for mail) 705 Rose Bldg., Cleveland, O.
 KIPE, J. Morgan (1919), Philadelphia Mgr., Standard Heater Co., 609 Otis Bldg., and Homestead and Beck Aves., Beechwood Park, Philadelphia, Pa.
 KIRBY, William C. (1918), Contracting Engr., Grinnell Co., N. Charlotte, and (for mail) 2118 E. 7th St., Charlotte, N. C.
 KIRK, Charles D. (1909), Chas. D. Kirk Co., Box 1042, Winnipeg, Man.
 KIRK, George H. (1906), Engr. and Contr., 6711 Wentworth Ave., Chicago, Ill.
 KISSICK, J. J. (1918), Supt. of Bldgs., Board of Education, E. 6th and Rockwell Ave., and 1768 Wayside Rd., Cleveland, O.
 KITAURA, Shigeyuki (1918), Mech. Engr., Monopoly Bureau, Dept. of Finance, Tokyo, Japan.
 KITCHEN, Francis A. (Junior 1923), John H. Kitchen Co., 302 Delmain Bldg., and 1315 Valentine Rd., Kansas City, Mo.
 KITCHEN, John H. (1906), Heat. and Vent. Engr., (for mail) John H. Kitchen & Co., 302 Delmain Bldg., and 3759 Washington St., Kansas City, Mo.

KLAUS, Louis J. (Junior 1921), Heat. and Vent. Engr., Thompson-Starrett Co., 245 Hunters Point Ave., Long Island City, and Farmingdale, L. I., N. Y.
 KLAUS, Morris (Junior 1915), Michigan Chandler Co., 42 Broadway, and (for mail) 5814 Iroquois Ave., Detroit, Mich.
 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), Mgr., Heat. Dept. Thos. J. Sheehan Co., 2233 Olive St., 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 N. 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), Vice-Pres. and Gen. Mgr., M. A. Dame & Son, 27 Haymarket Sq., Boston, Mass.
 KNIGHT, Alvin B. (Associate 1916), Warren Webster & Co., 2123 Dime Bank Bldg., and 8818 Dexter Blvd., Detroit, Mich.
 KNOWLES, Arthur F. (Associate 1914), Knowles Mushroom Ventilator Co., 202 Franklin St., New York, N. Y., and 135 Hadden Pl., Upper Montclair, N. J.
 KNOWLES, Charles H. (1920), Technical Service, 210 Gazette Bldg., Champaign, and 709 W. Main St., Urbana, Ill.
 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.
 KOELLER, George T. (1923), Sales Engr., Richmond Radiator Co., 1480 Broadway, New York, N. Y., and (for mail) 1111 Market St., Harrisburg, Pa.
 KOEHLER, Julius B. (1920), Vice-Pres., Monitor Stove Co., Woodrow St., and (for mail) Elmhurst Pl., Cincinnati, O.
 KOENIG, Arnold C. (1919), Consulting Engr., Koenig, Hollister & Co., 401 Bankers Life Bldg., Lincoln, Neb.
 KOHLBRY, Edward G. (1920), Pres., (for mail) Kohlbry-Howlett Co., 63 W. Ontario St., Chicago, and 44 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., Herish Bros. Co., 645 Mill St., and (for mail) 1022 S. 8th St., Allentown, Pa.
 KOTTICAMP, Horace A. (1915), Pres. and Gen. Mgr., (for mail) Chambersburg Construction Co., Box 305, and 539 E. King St., Chambersburg, 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.
 KRETZ, William G. (1921), Pres., Caloric Furnace Co., 1408 Arrott Bldg., Pittsburgh, and (for mail) 651 Evergreen Ave., Millvale, Pa.
 KRIEBEL, Arthur E. (1920), Sales Engr., Vapor-Vacuum Heat. Co., 206 Otis Bldg., 16th and Sansom Sts., Philadelphia, and Berwyn, Chester Co., Pa.
 KRIEBEL, John H. (Associate 1921), Heat. Engr., Bridgman Co., 120 N. 30th St., and (for mail) 1638 N. 59th St., Philadelphia, Pa.
 KRIES, Henry A. (1901), Pres., (for mail) Henry A. Kries & Sons Co., 6 W. Lombard St., Baltimore, and Catonsville, Md.
 KRUEGER, Jas. I. (1921), Mech., Heat. and Vent. Engr., Repr., Illinois Eng. Co., 559 Pacific Bldg., and 775 Post Ave., San Francisco, Cal.

KUDER, Paul M. (Junior 1915), Pres., (for mail) General Heat. & Vent. Co., 188 Milwaukee St., and 675 Aator St., Milwaukee, Wis.
 KURKE, William F. (1922), Engr., (for mail) 211 Equity Bldg., and 820 12th St., Fargo, N. D.

L

LA BUNDY, Bert A. (Associate 1919), Heat. Engr., 2577 Oxford St., Memphis, Tenn.
 LA FOLLETTE, Byron E. (1916), (for mail) The Tarpenning-La Follette Co., Engrs., and Sheet Metal Contrs., 1030 Canal St., and 230 E. 47th St., Indianapolis, Ind.
 LAGODZINSKI, Harry J. (Junior 1920), Draftsman, Ilg Elec. Vent. Co., 2850 N. Crawford Ave., and (for mail) 3628 N. Tripp Ave., Chicago, Ill.
 LAMB, Foster W. (1906), F. W. Lamb Co., 24 E. Kinzie St., Chicago, Ill.
 LONDON, Archer A. (1920), Vice-Pres., American Radiator Co., 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 E. (1916), Pres. and Mgr., (for mail) Lane-Bowen Co., 647 Broadway, and 333 4th St., Lorain, O.
 LANGDON, Joseph D. (1920), Secy. and Treas., (for mail) Jos. A. Langdon & Sons Co., 2030 5th Ave., and 340 S. Fairmount Ave., Pittsburgh, Pa.
 LANGENBERG, Everett B. (1914), Secy. and Treas., Haynes-Langenberg Mfg. Co., 4525 N. Euclid Ave., and 7017 Kingsbury Pl., St. Louis, Mo.
 LAPERLE, Lorenzo G. (1923), Asst. Supt., George H. Drake, Inc., 218 Lexington Ave., Buffalo, N. Y.
 LARIMER, George B. (1915), Engr., (for mail) 1824 S. Hope St., and 6666 Selma Ave., Hollywood Sta., Los Angeles, Cal.
 LARIMER, Wm. McCoy (1922), Mgr. Heat. Dept., M. J. O'Fallon Supply Co., 1621 15th St., and 159 W. 2nd Ave., Denver, Col.
 LARSON, Gustav L. (1923), Professor of Steam and Gas Eng., (for mail) University of Wisconsin, and Route 7, Madison, Wis.
 LAURE, Robert J. (1917), Sales Engr., (for mail) Kellogg-Mackay Co., 204 Walnut St., and 3225 S. Benton St., Kansas City, Mo.
 LAUTENSCHLAGER, Fred (1915), Mgr. Heat. Dept., Brunswick-Kroeschell Co., 460 W. Erie St., and (for mail) 3846 Alta Vista Terrace, Chicago, Ill.
 LAVAN, P. J. (1921), Heat. Contr., 1319 8th Ave., and 4232 Bagley Ave., Seattle, Wash.
 LAWRENCE, Chas. E. (1922), N. Y. Sales Mgr., Massachusetts Blower Co., 5722 Grand Central Terminal, New York, and 52 Waldorf Court, Brooklyn, N. Y.
 LeBEAU, John F. (Junior 1921), Asst. Engr., (for mail) William H. Taylor & Co., 256 Hamilton St., and 148 N. 7th St., Allentown, Pa.
 LeCOMPTE, William G. (Associate 1914), Sales Engr., Jenkins Bros., 80 White St., New York, N. Y., and 57 Harrison St., East Orange, N. J.
 LEEK, Walter (1903), Leek & Co., 1090 Homer St., Vancouver, B. C.
 LEES, Chas. C. (Associate 1922), Salesman, Standard Heater Co., 609 Otis Bldg., and (for mail) 4817 Warrington Ave., Philadelphia, Pa.
 LEES, Herbert K. (Junior 1912), Estimator, William Lees, 548 W. Washington Blvd., Chicago, Ill.
 LEILICH, Roger L. (1922), Vice-Pres. and Mgr., Baltimore Heat. Corp., 425 St. Paul Pl., and 2810 Elsinor Ave., Baltimore, Md.
 LEITCH, Arthur S. (1908), (Secretary Ontario Chapter), Mgr. Toronto Office, Sheldons Ltd., 1002 Kent Bldg., and 444 Walmer Rd., Toronto, Ont.
 LELAND, William E. (1915), Consulting Engr., 58 Sutter St., San Francisco, Cal.
 LENNOX, Frederick J. (1912), Heat. Engr., 6 Grove St., Elmwood, Conn.
 LENONE, Jose M. (1919), 5109 Cornell Ave., Chicago, Ill.

ROLL OF MEMBERSHIP

LEONHARD, Frederick (1921), Sales Engr. and Mgr., Jas. P. Marsh & Co., 536 E. 123rd St., Cleveland, O.

LEWIS, George C. (1919), Vice-Pres. and Gen. Mgr., (for mail) Solar Eng. Corp., 200 N. 15th St., Philadelphia, and 812 Summit Grove Ave., Bryn Mawr, 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, Pres. Philadelphia Chapter), Vice-Pres. and Gen. Mgr., (for mail) York Heat and Vent. Co., 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, Charles P. (1920), Heat. Engr., (for mail) C. A. Dunham Co., 2121 1/2 1st Ave., and 1011 Tuscaloosa Ave., Birmingham, Ala.

LIDE, Martin J. (1911), Consulting and Constructing Engr., (for mail) 1009 Woodward Bldg., and 1920 16th Ave., S. Birmingham, Ala.

LIND, Clarence C. (Junior 1921), C. C. Lind Heat. Eng. & Contr., 314 Pine St., and (for mail) 1169 Vanhook St., Camden, N. J.

LINDEMAN, Reinhold F. (1916), Mgr. Vent. Dept., Robt. Garden, Inc., 1355 W. Washington Blvd., and (for mail) 2642 Eastwood Ave., Chicago, Ill.

LINER, John J. (Associate 1916), Pres., Philadelphia Asbestos Co., 422-26 Callowhill St., Philadelphia, Pa., and 539 Trenton Ave., Camden, N. J.

LINHARD, Howard V. (Associate 1921), Dist. Mgr., U. Hiter Co., 1265 Griswold St., and (for mail) 7238 Webb Ave., Detroit, Mich.

LINN, Homer R. (1917), Industrial Engr., American Radiator Co., 816 S. Michigan Ave., Chicago, and (for mail) 321 S. Ashland Ave., La Grange, Ill.

LIPKEMAN, Henry (1915), Mgr., Peerless Heater Co., 1476 Broadway, New York, N. Y.

LIPPE, Ernest V. (1922), Heat. and Vent. Engr., Haines Co., 1933 W. Lake St., and (for mail) 4521 N. Rockwell St., Chicago, Ill.

LIPPMAN, Orville S. (Associate 1920), Sales Mgr., The Kellogg-Mackay Co., 419 W. 18th St., and 7251 Princeton Ave., Chicago, Ill.

LISSAUER, Adolph W.* (1918), Vice-Pres., (for mail) W. L. Fleisher & Co., Inc., 31 Union Sq., W., New York, and Philpse Manor, N. Tarrytown, N. Y.

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 1463 Lawrence Ave., Detroit, Mich.

LOCKE, Hiram W. (1920), Heat. Engr. and Sheet Metal Worker, 1942 N. 20th St., Philadelphia, Pa.

LOCKER, Charles W. (1916), Mgr., (for mail) C. A. Dunham Co., R. 202, 3000 Grand River Ave., Detroit, and R. F. D. 2, Farmington, Mich.

LOCKETT, John W. (1922), Mgr., (for mail) Fitzgibbon Boiler Co., Oswego, N. Y.

LOCKHART, George L. (1919), Archt., 1353-55 University Ave., St. Paul, Minn.

LOCKWOOD, Edwin H.* (1915), Asst. Prof. Mech. Eng., Sheffield Scientific School, Yale University, 51 Sheldon Terrace, New Haven, Conn.

LOEFFLER, Frank X. (1914), F. Loeffler Supply Co., 320 W. 28th St., Oklahoma City, Okla.

LOEHR, J. R. (Associate 1921), Special Repr., D. & T. Mfg. Co., 3001 LaSalle St., 610 Wrigley Bldg., and 4553 Sheridan Rd., Chicago, Ill.

LOHMAN, 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), Pres. and Mech. Engr., (for mail) S. Faith Co., Inc., 2427 Pennsylvania Ave., and 8283 W. Chester Pike, Philadelphia, Pa.

LONG, John, Jr. (1919), Mech. Engr., 5425 Diamond St., Philadelphia, Pa.

LONGENECKER, Howard J. (1917), Pres. and Gen. Mgr., (for mail) York Heat & Vent. Co., 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., and 112 W. Johnson St., Germantown, Philadelphia, Pa.

LOUGHLIN, Frank J. (1918), Engr. and Estimator, Baker, Smith & Co., 576 Greenwich St., and 135 E. 119th St., New York, N. Y.

LOVE, Clarence H. (1919), Mfr. Agent, Nash Eng. Co., 840 Elliott St., and (for mail) 297 Parkdale Ave., Buffalo, N. Y.

LOVELACE, James A. (1920), R. L. Spitzley meat Co., 246 Larned St., W. Detroit, Mich.

LOWNSBERY, Benjamin F. (1920), Heat. Engr., Benjamin F. Shaw Co., 2nd and Lombard Sts., and 21 S. Sycamore St., Wilmington, Del.

LUCE, George D., Jr. (1919), Asst. Mech. Engr., 1417 Railway Exchange Bldg., and (for mail) 3633 N. Harding Ave., Chicago, Ill.

LUCK, Alexander W.* (1919), Pres. and Gen. Mgr., (for mail) Reading Heater & Supply Co., Church and Woodward Sts., Reading, Pa.

LUNN, W. R. (1921), Ch. Engr., Austin-Gorham-McIlvaine (Asso.), 1816 Ludlow St., Philadelphia, and Spruce and Hamel Ave., N. Glenside, Pa.

LUTTS, Conrad West (1922), Heat. and Vent. Engr., Hersh Bros. Co., 645 Mill St., and (for mail) 1023 S. 7th 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 Frelinghuysen Ave., Newark, and 1200 W. 7th St., Plainfield, N. J.

LYND, Roy E.* (Junior 1908; 1910), Pres., Kensington-Davis Corp., 144 Kensington Ave., and 373 Huntington Ave., Buffalo, N. Y.

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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, Concord St. and Flatbush Ave., Brooklyn, and 292 W. 92nd St., New York, N. Y.

McCARTHY, Charles J. (1919), Contr., 4511 Lancaster Ave., and (for mail) 533 S. 55th St., Philadelphia, Pa.

McCARTHY, Thos. (1921), Heat. Contr., (for mail) McCarthy & Crandall Plbg. and Heat. Co., 529 Cascade Ave., and 444 W. Yampa St., Colorado Springs, Colo.

McCAULEY, James H., Jr. (1921), Estimator, W. J. Genney Co., 1050 W. Randolph St., and (for mail) 3831 Lexington St., Chicago, Ill.

McCLELLAN, James E. (1922), Mgr. Denver Office, (for mail) American Blower Co., 523 Boston Bldg., and 1060 Emerson St., Apt. No. 5, Denver, Colo.

McCLINTOCK, Alexander, Sr. (1917), A. McClintock & Sons, 1937 Ridge Ave., and 121 Rochelle Ave., Wissahickon, Philadelphia, Pa.

McCLINTOCK, Alexander, Jr. (Junior 1920), Heat. Engr., (for mail) 1937 Ridge Ave., and 121 Rochelle Ave., Wissahickon, Philadelphia, Pa.

McCLINTOCK, John L. (1917), Heat. Engr., 1937 Ridge Ave., and 121 Rochelle Ave., Wissahickon, Philadelphia, Pa.

McCLYMONT, Bryce W. (Associate 1920), Asst. Secy., (for mail) Penberthy Injector Co., 360 Holden Ave., and 905 Virginia Park, Detroit, Mich.

McCOLL, Jay R.* (1916), 2nd Vice-Pres. 1920; 1st Vice-Pres. 1921; Pres. 1922; Council 1923) Dean of Eng., University of Detroit, and Consulting Engr., McColl, Snyder & McLean, 2348 Penobscot Bldg., and 825 Chicago Blvd., Detroit, Mich.

McCONNOR, Charles R. (Junior 1922), Mgr. Industrial Dept., (for mail) Clarge Fan Co., 111 W. Washington St., and 754 Bittersweet Pl., Chicago, Ill.

McCORMICK, Edward T. (Associate 1923), Br. Mgr., Pierce, Butler & Pierce Mfg. Corp., 600 2nd Ave., Pittsburgh, and (for mail) 2210 S. Hobson St., Philadelphia, Pa.

McCREA, Lester W. (1920), (for mail) Jas. McCre & Son, 19 N. Carrollton Ave., and 504 University Apt., University Parkway, Baltimore, Md.

McCREERY, Hugh Joseph (1922), Dist. Mgr., Canadian Sirocco Co., Ltd., 24 King St., W., and 29 Gormley Ave., Toronto, Ont.

McCULLY, David E. (Associate 1917), Pres. and Treas., (for mail) D. E. McCully 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., U. S. Radiator Corp., R. 517, Dime Savings Bank Bldg., Detroit, Mich.

McELWEE, Hugh J., Jr. (1920), 2029 E. Huntington St., Philadelphia, Pa.

McEVOY, William J. (1917), Western Mgr., Buckeye Blower Co., 324 Monadnock Block, and (for mail) 6718 Lakewood Ave., Chicago, Ill.

McGINNESS, J. E. (1903), Pres., McGinness Co., 527 1st Ave., and 142 Bellefield 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., Western Heat. Co., 815 S. Claremont Ave., and 652 Waveland Ave., Chicago, Ill.

McGUIGAN, L. A. (Associate 1919), Salesman, National Radiator Co., 215 Wood St., and 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), Ch. Engr., (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, William N. (1917), Ch. Engr. and Gen. Supt., A. Holtman Heat. Co., 1927 Montgall, Kansas City, Mo.

McKEIGHAN, Edward E. (1920), Engr. and Mgr., Eng. Sales Co., 1314 McGee St., and 3130 Olive St., Kansas City, Mo.

McKENNA, William N. (1912), Treas., Wm. N. McKenna Co., 79 Chestnut St., and 99 Revere St., Boston, Mass.

McKERNAN, John C., Jr. (Associate 1921), Sales Engr., Monitor Bi-Loop Radiator Co., 408 Finance Bldg., and (for mail) 1838 N. Croskey St., Philadelphia, Pa.

McKIEVER, William H.* (Junior 1896; 1897), Consulting and Contr. Engr., 247 W. 13th St., New York, and 479 8th 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) 335 Curtin St., So., Williamsport, Pa.

McLEAN, Dermid (1917), McColl, Snyder & McLean, Consulting Engrs., 2348 Penobscot Bldg., and 5140 Ridgewood Ave., Detroit, Mich.

McLELLAND, H. Burton (Associate 1912), Jenkins Bros., 646 W. Washington Blvd., Chicago, Ill.

McMILLAN, Luther B.* (1918), Consulting Engr., Johns-Manville, Inc., Madison Ave. and 41st St., New York, and Larchmont, N. Y.

McMORAN, Francis J. (1917), American Blower Co., 1221 Boatman's Bank Bldg., St. Louis, Mo.

McMURRAY, John (1920), Pres., Iron City Heat. Co., 843 Jackson St., N.S., Pittsburgh, Pa.

McNAIR, Edward E. (1905), (Council 1921-1922; 2nd Vice Pres. 1923; Vice-Pres., (for mail) U. S. Radiator Corp., 133 E. Grand River Ave., and Detroit Athletic Club, Detroit, Mich.

McNEAL, William R. (1921), Supt., Bldgs. and Grounds, Seattle School District, 810 Dexter Ave., and (for mail) 4110 Densmore Ave., Seattle, Wash.

McPHERSON, Charles J. (1903), W. G. McPherson Co., 19th and Wilson Sts., Portland, Ore.

McQUILLAN, James A. (1919), Heat. and Sanitary Engr. and Estimator, McQuillan Bros., 415 Selby Ave., St. Paul, Minn.

McSORLEY, Clarence M. (1916), Mgr., L. J. Mueller Furnace Co., 426 Jefferson Ave., E., and 1970 Gladstone Ave., Detroit, Mich.

McVEHIL, Earl W. (1923), Mgr., McVehil Plbg. Co., 40 E. Wheeling St., Washington, Pa.

M

MacDONALD, J. W. (1920), Mech. Engr., Parks-Kramer Co., 1102 Old South Bldg., Boston, and (for mail) 119 Brooks St., Brighton, Mass.

MacDOUGALL, Burgess W. (1923), Heat. Engr., W. G. Rover, 510 Stuyvesant Ave., and (for mail) 134 Hoffman Ave., Trenton, N. J.

MacK, John A. (1921), Heat. Engr., (for mail) 207 Main St., and 209 Church St., Greenwood, Miss.

MACKENSEN, Wm. H. (1923), Estimator and Designer, Huffman-Wolfe Co., 669 N. High St., Columbus, O.

MACKENZIE, George A. (1913), Western Foundry & Metal Co., 3830 7th St., S.W., Elbow Park, Calgary, Alberta.

MACKIE, James (1917), Pres. and Mgr., James Mackie Co., Ltd., 357 Langside St., and 254 Montrose St., Winnipeg, Man.

McKINNON, C. W. (1920), 348 Thacher St., Milton, Mass.

MACON, William W.* (1908), (Secretary 1911, 1912; Board of Governors 1913; Council 1914), Editor (for mail) "Iron Age," 239 W. 39th St., New York, and 711 Ave. J, Brooklyn, N. Y.

MAGINN, Peter F. (1908), P. F. Maginn & Co., 207 Fulton Bldg., Pittsburgh, Pa.

MAHADY, Thomas C. (1918), Philadelphia Repr., International Heater Co., 1613 Filbert St., Philadelphia, and 127 Bailey Rd., Lansdowne, Pa.

MAHAFFY, R. M. (1921), Mgr. Heat. and Engr. Dept., Pacific Pipe and Supply Co., 1002 Santa Fe Ave., and 1526 W. 47th St., Los Angeles, Cal.

MAIER, George M. (1921), Engr., Bronx Laboratory, American Radiator Co., E. 149th St. and Harlem Pier, New York, and Apt. 54, Pelham Court, Pelham, N. Y.

MALLIS, William (1914), Archt. and Engr., 409 Lyon Bldg., Seattle, Wash.

MAILORY, Harry C. (1903), 32 W. 40th St., New York, N. Y.

MANDEVILLE, Edgar W. (1914), Treas., E. W. Mandeville, Inc., 655 Rogers Ave., and (for mail) 1171 E. 37th St., Brooklyn, N. Y.

MANNING, A. J. (1921), 156 W. Peachtree St., Atlanta, Ga.

MANSELL, P.-C. (1921), Vice-Pres., (for mail) Purdy-Mansell, Ltd., 63 Albert St., and 26 Grassmere Rd., Toronto, Can.

MANSFIELD, F. A. (Associate 1920), Dist. Mgr., 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., Public Service Co. of Northern Illinois, 114 N. Oak Park Ave., and 210 S. Kenilworth Ave., Oak Park, Ill.

MARINE, John Deputy (Junior 1920), Heat. Engr., Bourse Bldg., and 1937 Church Lane, Philadelphia, Pa.

MARSHALL, H. Hall (1923), Consulting Engr., 370 Lexington Ave., New York, and (for mail) 63 Pine St., Garden City, N. Y.

MARTENIS, John V. (1918), Associate Prof. of Mech. Eng., Mech. Eng. Dept., Univ. of Minnesota, and (for mail) 131 Orlin Ave., S.E., Minneapolis, Minn.

MARTIN, Albert B. (1917), Dist. Sales Mgr., (for mail) Kewanee Boiler Co., 822 W. Washington Blvd., Chicago, and 997 Vine St., Winnetka, Ill.

MARTIN, George W. (1911), Pres., (for mail) New York Service Co., 141 E. 29th St., New York, N. Y., and 314 Prospect St., Ridgewood, N. Y.

MARTIN, J. Howard (1923), Estimator, Austin Eng. Co., 121 W. 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), (Pres., Ohio Chapter), Dist. Sales Mgr., Utica Heater Co., 707 Union Bldg., Euclid Ave., and (for mail) 1325 E. 141st St., Cleveland, O.

MASON, Orion Augustus (Associate 1922), Br. Mgr., (for mail) Pierce, Butler & Pierce Mfg. Corp., 312 Congress St., Boston, and 686 Webster St., Needham, Mass.

MATHEY, Nicholas J. (1915), Heat. and Vent. Engr., Mathey Plbg. Co., 17 3rd Ave., N.E., Lemars, Ia.

MATHIS, Eugene (1922), Secy. 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 W. 71st St., Chicago, Ill.

MATHIS, Julien W. (Associate 1921), Pres., New York Blower Co., 2248 S. Halsted St., and (for mail) 6613 Eberhart Ave., Chicago, Ill.

MATTHEWS, John K. (1923), Morgan Heat. & Plbg. Co., Box 843, Charleston, W. Va.

MATZEN, Harry B. (1919), Sales Engr., Carrier Eng. Corp., 2169 Transportation Bldg., Chicago, and Park Ridge, 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), Maurer Bros Co., 8600 Detroit Ave., Cleveland, and (for mail) 1527 Maronoc, Lakewood, O.

MAY, Edwin A. (1906), 171 N. Kenilworth Ave., Oak Park, Ill.

MAYER, Robert J. (Junior 1915; 1915), Mayer, Valentine & Cameron, R. 204, Erie Bldg., and 3355 W. 95th St., Cleveland, O.

MAYER, Robert S. (1911), Br. Sales Mgr., (for mail) Chicago Pump Co., 319 Plymouth Bldg., and 9327 Amesbury Ave., Cleveland, O.

MEAGHER, John F. (Associate 1921), Mgr., (for mail) General Boilers Co., 608 Fullerton Bldg., and 4716 McPherson Ave., St. Louis, Mo.

MEDENWALD, Arthur L. (1918), Draftsman, P. O. Box 278, San Pedro, Cal.

MEDWAY, Fred J. (Associate 1919), Mgr., 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), (Board of Governors 1903), Pres., Mehling & Hanson Co., 118 N. Franklin St., Chicago, Ill.

MEIER, Konrad (1916), Consulting Engr., Tachlisbrunnen Str., 12, Winterthur, Switzerland.

MELLON, James T. J. (1911), (Council 1915), Walters, Purks & Mellon, 4419 Ludlow St., Philadelphia, Pa.

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 Frankfort Ave., Philadelphia, Pa.

MERRILL, Carle 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.

MERRY, Fred D. (1917), Amer. Warm. & Vent. Co., 1017 Summit St., Toledo, O.

MERTZ, Walter A. (1919), Secy., Kehm Bros. Co., 51 E. Grand Ave., and 3753 N. Keeler Ave., Chicago, Ill.

MERVINE, Thos. R. (1922), Mervine Bros., 208 S. 7th St., and (for mail) 5852 N. 5th St., Philadelphia, Pa.

MEYER, Henry C., Jr. (1898), (Council 1915, 1916), Consulting Engr., 101 Park Ave., New York, N. Y.

MEYER, Hans J. (1919), (Council 1922), Pres., Chas. L. Pillsbury Co., 1200 2nd Ave., S., and 2738 Hennipin Ave., Minneapolis, Minn.

MEYER, John S. (1920), Mgr., L. J. Mueller Furnace Co., 69 E. Lake St., Chicago, Ill.

MEYER, John W., Jr. (1921), Engr., American Blower Co., 6004 Russell St., Detroit, Mich., and 410 18th St., W. New York, N. Y.

MEYER, Paul F. (Associate 1920), Supt., Geo. J. Meyer & Son, 3223 Kennett Sq., and (for mail) 6714 McPherson Blvd., Pittsburgh, Pa.

MEYRING, Archer S. (1922), Heat. and Vent. Engr., (for mail) Br. Mgr., C. A. Dunham Co., 600-4 Citizens National Bank Bldg., and 317 33rd St., Cheyenne, Wyo.

MICHAEL, J. Paul (1920), Ch. Engr., Stanton Heater Co., Sheets St., Martins Ferry, O.

MICHAEL, L. E. (1921), Heat. and Vent. Engr., (for mail) 407 Bank Block, and 2264 Holly St., Denver, Col.

MILES, James C. (1914), Sales Engr., American Warming & Vent. Co., 1869 E. 55th St., and Cleveland Athletic Club, Cleveland, O.

MILLER, Charles A. (Associate 1917), Salesman (for mail) H. B. Smith Co., 10 E. 39th St., and 2178 University Ave., New York, N. Y.

MILLER, Charles W. (Junior 1908; 1919), (Pres., Wisconsin Chapter), Sales Engr., Herman Nelson Corp., 209 Grand Ave., and 383 24th Ave., Milwaukee, 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 1290 Stowell Ave., Milwaukee, Wis.

MILLER, Harvey N. (1921), Mgr., (for mail) Peerless Plbg. and Heat. Co., 1010 Main St., and 1010 1/2 Main St., Mt. Vernon, Ill.

MILLER, James E. (Junior 1912; 1914), Vice-Pres., (for mail) C. W. Johnson, Inc., 644 Washington Blvd., Chicago, and 2210 Colfax Ave., Evanston, Ill.

MILLER, John F. G. (1916), Vice-Pres. and Treas., American Blower Co., 6004 Russell St., Detroit, Mich.

MILLER, M. E. (1921), Ch. Mech. Engr., Construction Service Q. M. C. R. 1315, Munitions Bldg., 20th and B Sts., and 5514 8th St., N.W., Washington, D. C.

MILLER, Robert B. (1922), Pres., Miller & Brady, Inc., 210 E. 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.

MILLER, W. Lloyd (Associate 1913; 1918), Heat. and Vent. Engr., 539 Main St., Poughkeepsie, N. Y.

MILLIGAN, Rockwell M. (1919), Commissioner of School Bldgs., Bd. of Education, St. Louis, Mo.

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., U. S. Radiator Corp., 4004 Duncan Ave., St. Louis, and 434 Lee Ave., Webster Groves, Mo.

MINNICH, Harry S. (1921), Sales Engr., Richmond Radiator Co., (for mail) 4526 Walnut St., Philadelphia, Pa.

MOFFETT, William S. (1907), Consulting and Constructing Engr., Staunton, Va.

MOLBY, Edgar C.* (1915), Vice-Pres. and Sales Mgr., Molby Boiler Co., Inc., 41 E. 42nd St., R. 1800, New York, and 5 Devon Pl., Forest Hills, L. I., N. Y.

MOLO, Harold E. (1922), Mgr., (for mail) Linehan & Molo, 472 Main St., and 305 W. Locust St., Dubuque, Iowa.

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), Clargate Fan Co., Kalamazoo, Mich.

MOODY, Lawrence E. (1919), Engr., (for mail) Isaac H. Francis, 1306 Otis Bldg., Philadelphia, Pa., and 237 Jefferson Ave., Haddonfield, N. J.

MOON, L. Walter (1915), Heat. Engr., Bradley Heat. Co., 3834 Olive St., St. Louis, Mo.

MOORE, H. Lee (1919), Dist. Mgr., Buffalo Forge Co., 917 Union Arcade, Pittsburgh, Pa.

MOORE, James A. (Junior 1920), 825 Morris St., Philadelphia, Pa.

MOORE, Joseph C. (1921), Consulting Mech. Engr., Aero Alarm Co., 725 Central Bldg., and (for mail) 2409 E. Prospect St., Seattle, Wash.

MOORMAN, Theodore A. (Associate 1921), Designer and Estimator, N. O. Nelson Mfg. Co., 10th and Chestnut Sts., and (for mail) 2303 University St., St. Louis, Mo.

MOORMAN, William G. (1920), Dist. Mgr., Sarco Co., Inc., 325 Ellicott Sq., Buffalo, N. Y.

MORAN, Francis N. (1916), Augusta Plbg. and Heat. Co., 128 W. Main St., Staunton, Va.

MORAN, Frank E. (1922), Pres., Ben Rigby, Inc., 551 W. Lake St., Chicago, and 543 S. Lombard Ave., Oak Park, Ill.

MORGAN, C. Stanley (Associate 1919), (for mail) 429 Wayne St., and 14595 Harbor Ave., Detroit, Mich.

MORGAN, Francis H. (1912), Heat. and Vent. Engr., 66 Munroe St., Lynn, Mass.

MORGAN, Glenn C. (1911), Vice-Pres. and Secy., (for mail) Morgan-Gerrish Co., 501 S. 6th St., and 1219 W. 24th St., Minneapolis, Minn.

MORGAN, J. Scott (Associate 1922), Mgr., Morgan Bros., 7227 Tioga St., and 7031 Hamilton Ave., Pittsburgh, Pa.

MORGAN, Richard H. (1918), Heat. Engr., (for mail) The Chapel-Warren Co., 1830 St. Clair Ave., and 523 E. 124th St., Cleveland, O.

MORGAN, Robert C. (1915), Ch. Engr., (for mail) Stewart A. Jellett Co., 1200 Locust St., and 314 W. Seymour St., Philadelphia, Pa.

MORGAN, Sherman H. (1918), Heat. Contr. and Engr., (for mail) 526 Randolph St., and 175 Marlborough Ave., Detroit, Mich.

MORITZ, Carl J. (1921), Engr., Sodemann Heat. & Power Co., 2308 Morgan St., and (for mail) 6923 S. Garner Ave., St. Louis, Mo.

MORRIS, C. Raymond (1921), 55 Lexington Ave., Passaic, and 381 20th Ave., Paterson, N. J.

MORRIS, Edward A. (1919), Treas., Merrimack Valley Supply Co., Lowell, and (for mail) 7 Sheffield West, Winchester, Mass.

MORROW, Charles F. (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.

MORTON, John (1915), Almirall & Co., Inc., 1 Dominick St., New York, and (for mail) 432 72nd St., Brooklyn, N. Y.

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 & Budeberg Mfg. Co., and American Steam Gauge & Valve Mfg. Co., Div., (for mail) 423 Ashland Ave., Buffalo, N. Y.

MOSS, Edward (1920), Supervisor Plbg. and Heat., (for mail) New York Consolidated R. R. Co., 1130 Atlantic Ave., and 231 94th St., Brooklyn, N. Y.

MOTEJL, J. A. (1917), Archt. and Engr., (for mail) Bd. of Education, and 1121 S. 2nd St., Cedar Rapids, Ia.

MOTT, Abram C. (1897), (Board of Managers 1898), 1329 N. Broad St., Philadelphia, 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., Mouat Vapor Heat. Co., 1246 W. 4th St., and 360 E. 105th St., Cleveland, O.

MOULDER, Albert Wm. (1917), Ch. Engr., H. P. & I. P. Sub. Div., (for mail) Grinnell Co., Inc., Dana and Paige Ave., and 74 Roosevelt Ave., Warren, O.

MUELLER, Ben H. (1923), Mfgs. Agt., 1887 Railway Exchange Bldg., and 4117 Magnolia Ave., St. Louis, Mo.

MUELLER, Eugene F.* (1919), Assoc. Physicist, (for mail) Bureau of Standards, and 3914 Huntington St., Washington, D. C.

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 234 S. Scoville Ave., Oak Park, Ill.

MULLEN, Frank J. (1921), Mgr., Heat. Dept., Standard Sanitary Mfg. Co., 311 Erie St., and 755 Dearborn Ave., Toledo, O.

MUNIER, Leon L. (Junior 1915; 1919), Secy. and Treas., 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.

MUNRO, Edward K. (1904), Mech. Engr., U. S. Veterans Bureau, Munitions Bldg., Washington, D. C., and 5924 Bellona Ave., Baltimore, Md.

MURPHY, Edward T. (1915), Vice-Pres., and Phila. Mgr., Carrier Eng. Corp., 1402 Land Title Bldg., Philadelphia, Pa.

MURPHY, William R. (1911), Pres., American Heat. & Vent. Co., Inc., 804 Times Dispatch Bldg., and 2805 Monument Ave., Richmond, Va.

MURRAY, James M. (1922), Engr. and Estimator, City Heat. Co., 2047 Ellis Ave., Pittsburgh, Pa.

MURRAY, Thos. E. (1923), Heat. and Vent. Engr., State Archt., Albany, and (for mail) 51 S. Portland Ave., Brooklyn, N. Y.

MUSSELMAN, Joseph F. (1917), Consulting Engr., 101 Park Ave., New York, N. Y.

MUTH, Herbert (1912), Pres. and Treas., Muth Heat. and Eng. Co., 4544 N. Western Ave., and (for mail) 4217 N. Hermitage Ave., Ravenswood Station, 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.

MYRICK, James W. H. (1909), New England Air Conditioning Co., 53 Devonshire St., and 1521 Washington St., Boston, Mass.

NACEY, Harry M. (1908), Pres. and Gen. Mgr., (for mail) P. Nacey Co., 927 S. State St., and 229 Lake Shore Drive, Chicago, Ill.

NADER, John H. (1919). Engr. (for mail) Crane Co., 30 S. 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. (Associate 1920). Mgr., Water Heater Dept., Schley & Nash Co., Columbia Bank Bldg., and 5850 Douglas Ave., Pittsburgh, Pa.

NATKIN, Benjamin (Junior 1907; 1909). Mgr. (for mail) Natkin Eng. Co., 208 Mutual Bldg., and 3725 Tracy Ave., Kansas City, Mo.

NEILER, Samuel G. (1898). Neiler, Rich & Co., 431 S. Dearborn St., Chicago, and 737 N. Oak Park Ave., Oak Park, Ill.

NEITZEL, Carl Wm. (1921). Ch. Mech. Supt., Bd. of Education, Cleveland, and (for mail) 3240 Washington Blvd., Cleveland Heights, O.

NELSON, Benjamin (1914). (Pres., Illinois Chapter), Sales Mgr., 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, Herman W. (1909). Pres., Herman Nelson Corp., 1824 3rd Ave., and The Le Claire, Moline, Ill.

NELSON, Ralph L. (Junior 1913; 1917). Engr. and Mfrs. Agt., 110 N. Augusta St., Spokane, Wash.

NESBIT, David M.* (1895). (Board of Governors 1900), Ashwell Lodge, Barkly Lane, Leicester, England.

NESBITT, A. J. (Junior 1921). 213 N. Vermont Ave., and 212 Victoria Ave., Atlantic City, N. J.

NESDAHL, Ellert (1915). Ch. Engr. (for mail) Atmospheric Conditioning Corp., 920 Lafayette Bldg., Philadelphia, Pa., and 811 York St., Camden, N. J.

NEUFERT, E. A. (Associate 1921). Walworth Mfg. Co., 12th and Everett Sts., Portland, Ore.

NEVINS, J. R. (1921). Archt. and Engr., 1708 Hoge Bldg., Seattle, Wash.

NEUBERG, Harold O. (Junior 1919). Heat. and Vent. Engr., International Harvester Co., and (for mail) 1943 Foster Ave., Chicago, Ill.

NEWPORT, Charles F.* (1906). Treas., Newport Boiler Co., 105 S. Dearborn St., and (for mail) 1001 Longwood Drive, Chicago, Ill.

NICHOLS, George B. (1915). (Council 1919-1920). Consulting Engr., 300 Madison Ave., New York, N. Y.

NICHOLLS, Percy* (1920). Research Laboratory, A. S. H. & V. E., U. S. Bureau of Mines, Pittsburgh, Pa.

NIESTRATH, W. H. (1921). Jas. P. Marsh & Co., 3324 S. Jefferson Ave., St. Louis, Mo.

NILSON, Andrew (1917). (for mail) 3222 N. Halsted St., and 5407 Wayne Ave., Chicago, Ill.

NOBBS, Walter W. (1919). 50 Fairhazel Gardens, London, N.W., 6, England.

NOBIS, H. M. (1914). Heat. Engr. (for mail) Weiss Heat. and Pibg. Co., 5604 Cedar Ave., Cleveland, and 1827 Stanwood Rd., E. Cleveland, O.

NOLAND, Lloyd O. (1915). Pres., Noland-Clifford Co., Inc., 322 28th St., and 319 54th St., Newport News, Va.

NOLAND, Ralph W. (1914). Prof. of Heat. and Vent., Purdue University, and 221 Waldron St., W. Lafayette, Ind.

NORDINE, Louis F. (1914). Sales Engr., Herman Nelson Corp., and (for mail) 1170 26th 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. Eng., R. 309, Pierce Hall, Harvard University, Cambridge, Mass.

NORTON, Frederick W. (Junior 1922). Engr., John C. Williams, Inc., R. 850, Woolworth Bldg., New York, and 126 Park Ave., Port Richmond, S. I., N. Y.

NORTON, Thos. (1921). Pres., Bay Ridge 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 South Bales, Kansas City, Mo.

NULSEN, Carl A. (1919). Heat. and Vent. Engr., W. G. Cornell Co., 232 E. Erie St., Chicago, Ill.

NUNAN, John F. (Junior 1921). Foreman, Jas. Spear Stove & Heat. Co., 1823 Market St., and 238 W. Highland Ave., Chestnut Hill, Philadelphia, Pa.

NUSBAUM, Lee* (1915). Engr., 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., 104 W. 42nd St., New York, N. Y., and 13 Russell Pl., Summit, N. J.

OBERT, Casin W. (1916). (Secretary 1916-1923). Secy., A.S.H. & V. E., 29 W. 39th St., New York, and (for mail) 155 Archer Ave., Mt. Vernon, N. Y.

O'BRIEN, Vincent R. (Associate 1919). Vice-Pres., Cochrane-Sargent Co., 5th and Sibley Sts., and 90 Crocus Pl., St. Paul, Minn.

O'CONNELL, Presly M. (1916). Heat. Engr. (for mail) Perkins & McWayne, Archts., 322 Paulton Block, and 1216 Norton Ave., Sioux Falls, S. D.

ODELL, Nathaniel M. (1919). Sanitary and Heat. Engr., Martin Metal Mfg. Co., Mosley and 2nd Sts., and 1023 S. Wichita St., Wichita, Kan.

O'DONNELL, Thomas J. (1920). Heat. and Vent. Engr., Wm. H. McKiever, 247 W. 13th St., and 140 Vernum Ave., New York, N. Y.

OFFER, Louis A. (1917). Mech. Engr., Ford Motor Co., Highland Park, and (for mail) 300 Westminster Ave., Detroit, Mich.

OFFICER, H. S. (Associate 1923). Crane Co., 245 Master St., Philadelphia, Pa.

OFFNER, Alfred J. (1922). Consulting Engr., 1182 Broadway, New York, N. Y.

OGELSBY, William P. (1923). Sales Mgr., Oil City Boiler Works, 1043 Real Estate Trust Bldg., Philadelphia, Pa.

OHMES, Arthur K.* (1913). (Council 1915; 2nd Vice-Pres. 1916; 1st Vice-Pres. 1917). Consulting Engr., 101 Park Ave., New York, N. Y.

OLSEN, Carlton F. (Junior 1920). Sales Engr., Kewanee Boiler Co., 710 Builders' Exchange Bldg., and 1302 Linden Ave., Apt. 110, Minneapolis, Minn.

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 3rd Ave., Pittsburgh, Pa.

ORR, Merrill J. (1917). Pres. and Mgr., Orr Co., 513 Jackson St., and 1815 Jackson St., Sioux City, Ia.

ORTH, John W. (1919). Pres. (for mail) Orth Pibg. Co., 509 Columbia St., and 1930 Kossuth St., Lafayette, Ind.

OSBORNE, G. H. (1922). Gen. Mgr., The Vent. & Blow Pipe Co., Ltd., 144 Inspector St., and 926 Tupper St., Apartment 12, Montreal, Que.

OSMON, Thomas R. (1916). Heat. and Vent. Engr., Spohn Heat. & Vent. Co., 1775 E. 45th St., and (for mail) 851 Faxon 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). (for mail) Sales Engr., Crane Co., 23 W. 44th St., New York, and 611 S. Columbus Ave., Mt. Vernon, N. Y.

OTIS, Gerald Earle (1922). Ch. Engr., Herman Nelson Corp., and 1921 23rd Ave., Moline, Ill.

OTTO, Robert W. (1912). Ch. Engr., Andrews Heat. Co., 2529 University Ave., S.E., Minneapolis, and (for mail) 2147 Carroll Ave., St. Paul, Minn.

OWENS, Charles Beland (1921). Secy. and Mgr., Canadian Powers Regulators Co., Ltd., 106 Lombard St., and 25 High Park Blvd., Toronto, Ont.

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., American Blower Co., 1450 David Whitney Bldg., and 5849 Cass Ave., Detroit, Mich.

PAGE, Harry W. (1923). Asst. Mgr., B. F. Sturtevant Co., Hyde Park, Boston, Mass.

PAINE, Leonard G. (1920). Mgr. (for mail) C. A. Dunham Co., Otis Bldg., 112 S. 16th St., and 5915 Carpenter St., Philadelphia, Pa.

PALMER, Dr. George T.* (1915). Epidemiologist, (for mail) American Child Health Assn., 370 7th Ave., New York, N. Y.

PARKER, Philip (1915). Engr. Dept., Braman Dow & Co., 239 Causeway St., Boston, and (for mail) 8 Middle St., Woburn, Mass.

PARKHILL, David (1915). Supt., (for mail) The Graft 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., 1306 W. 8th St., 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 W. 172nd St., New York, N. Y.

PARTLAN, James W. (1916). (for mail) 1255 Park Pl., and 478 Algonquin Ave., Detroit, Mich.

PATERSON, James S. (1922). Heat. Engr., Bd. of Education, 155 College St., and 23 Norton Ave., Toronto, Ont.

PATERSON, William B. (Junior 1920; 1921). Asst., H. H. Angus, Consulting Engr., 217 Continental Life Bldg., and 71 Falcon St., Toronto, Ont.

PATTINSON, R. L. (1922). Pres., Central Pipe Line Co., Ltd., Chatham, Ont.

PATTISON, George B. (1920). Sales Engr., 605 Empire Bldg., and (for mail) 2138 Hudson Ave., Detroit, Mich.

PATTON, H. T. (1921). Bishop & Babcock Co., 537 Real Estate Trust Bldg., Philadelphia, Pa.

PEABODY, Ernest H. (1920). Pres., Peabody Eng. Corp., (for mail) 110 E. 42nd St., New York, and 557 Pelham Manor Rd., Pelham Manor, N. Y.

PEACOCK, Jas. K. (1921). Mgr., New York Br., Hoffman Specialty Co., 512 5th Ave., New York, and 498 Manor Lane, Pelham Manor, N. Y.

PEARCE, C. E. (1911). Ch. Engr., Guilbert & Betelle, Archts., Chamber of Commerce Bldg., Brantford, Ont., Newark, and (for mail) 1255 Clinton Pl., Elizabeth, N. J.

PEARSON, Harry D. (1917). Pres. and Treas., (for mail) Michigan Warm. and Vent. Co., 202-3 Aldrich Bldg., Grand Rapids, Mich.

PEASE, Harrison H. (Associate 1922). Commercial Trust Bldg., and 5239 Wissahickon Ave., Germantown, Philadelphia, Pa.

PEASE, John G. (1917). 2020 Wyandotte St., Kansas City, Mo.

PECKHAM, Randolph R. (1919). Supt., 650 W. 44th Ave., and 3018 Hogarth Ave., Detroit, Mich.

PEGRAM, William A. (1920). Engr. (for mail) Hanley & Co., 3444 Forest Ave., and 7018 S. Park Ave., Chicago, Ill.

PERHAM, Stanley H. (1920). Associate Engr., Charles R. Ammerman, 529 Occidental Bldg., and 4507 Carrollton Ave., Indianapolis, Ind.

PETERKIN, Stuart MacG. (1922). Engr., C. A. Dunham Co., 229 College St., and (for mail) 550 Bathurst St., Apartment 4, Toronto, Ont.

PETERMAN, Robert M. (1917). Engr., School Dist. of Philadelphia, 19th St., above Chestnut, Philadelphia, and (for mail) 205 Lauriston St., Wissahickon, Pa.

PETERSEN, Gustave (Associate 1916). Secy. and Treas., Heat. and Vent. Magazine, 1123 Broadway, New York, N. Y., and 216 11th St., Hoboken, N. J.

PETHERICK, David H. (Associate 1916). Special Repr., U. S. Radiator Corp., 517 Dime Bank Bldg., and 2278 Blaine Ave., Detroit, Mich.

PFEIFFER, Jos. F. (1921). Jos. F. Pfeiffer Steam & Hot Water Heat. Co., 1140 California St., and 663 Cook St., Denver, Col.

PHEGLEY, Frank G. (1913). (Council 1918-1919) Engr., Hart & Crouse Co., 1312 Fulton Bldg., Pittsburgh, Pa.

PHILLIPS, Frank T. (1919). Sales Engr., American Radiator Co., 115 N. Broad St., Philadelphia, Pa.

PHILLIPS, Frederic W., Jr. (1921). Engr. (for mail) E. W. Mandeville, Inc., 655 Rogers Ave., and 825 E. 38th St., Brooklyn, N. Y.

PHILLIPS, Lee (1920). 610 Ferguson Bldg., Pittsburgh, and Terrace Ave., Carnegie, Pa.

PICKUP, Harry (1920). 46-48 Goswell Rd., and 46 Regents Park Rd., London, England.

PIERCE, Edward R. (1919). 41 Strathmore Rd., Brookline, Mass.

PIERCE, Frank J. (1921). Mgr., Heat. Dept., 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 E. 47th St., New York, and (for mail) 113 Schley St., Glendale, Long Island, N. Y.

PINDER, Percy H. (1919). Treas., Standard Steam Specialty Co., 366 3rd Ave., New York, N. Y., and 12 Forest Rd., Ridgewood, N. Y.

PINES, Sidney (1920). (Secy., Kansas City Chapter), Asst. Mgr., (for mail) Natkin Eng. Co., 208 Mutual Bldg., and 3725 Tracy Ave., Kansas City, Mo.

PIPER, Albert (1920). Pibg. and Heat. Contr., Piper Bros., 340-346 N. Broad St., Trenton, and 192 Roseville Ave., Newark, N. J.

PIPER, Edmund R. W. (Associate 1920). Pibg. 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.

PITTELKOW, 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.

PLEWES, Stanley E. (1917). Br. Mgr., (for mail) Johnson Service Co., 285 S. Van Pelt St., and 803 Duncannon Ave., Philadelphia, Pa.

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 S. (1919). Supt., Belden; Porter, Gray Co., 65 N. 17th St., Minneapolis, Minn.

POSEY, James (1919). Consulting Engr., (for mail) 11 E. Pleasant St., and 4005 Liberty Heights Ave., Baltimore, Md.

POTTINGER, Charles T. (1917). Mgr., American Blower Co., 1027 Empire 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 5th Ave., and 321 Bedford Park Blvd., New York, N. Y.

PREBLE, J. Jarvis (1919), Sales Engr., Spray Eng. Co., 60 High St., Boston, and 58 Howard St., Waltham, Mass.

PRESTON, Bruce B. (1919), Pres., Ideal Heat Equipment Co., 1897 E. 90th St., Cleveland, O.

PRICE, Frank E. (Associate 1922), Mgr. Heat Dept., Hedges Atkins Supply Co., 1730 Blake St., Denver, Col.

PROBST, Alfred H. (1919), Sales Engr., Morgan-Gerrish Co., 501 6th St., S., and 2902 James Ave., S., Minneapolis, Minn.

PROX, Robert E. (Junior 1922), Vice-Pres., Frank Prox Co., and 1608 S. 4th St., Terre Haute, Ind.

PRYOR, Frederick L. (1913), Prof. Exp. Eng., Stevens Inst. of Technology, Hoboken, and National Silk Dyeing Co., 5 Colt St., Paterson, N. J.

PRYOR, Robert W., Jr.* (1913), (Council 1919, 1920), Mech. Engr., Koithan & Pryor, 39 Cortlandt St., New York, N. Y., and 199 Roseville Ave., Newark, N. J.

PUGH, Earl C. (1921), Heat. and Vent. Engr., Fulton, Taylor & Cahill, Archts., 8120 Euclid Ave., Cleveland, and 1311 Lakeland Ave., Lakewood, Cleveland, O.

PURCELL, Arthur J. (1914), Heat., Pibg. and Steam Spec. Repr., 631 New Britain Ave., Hartford, Conn.

PURCELL, Robert E. (1916), Heat., Vent. and Pibg. Contr., 1735 Willis Ave., W., and 128 Avery Ave., Detroit, Mich.

PURDY, Alexander K. (1922), Pres., (for mail) Purdy, Mansell, Ltd., 63 Albert St., and 30 Glenrose Ave., Toronto, Ont.

PURSELL, H. E. (1919), 514 Boston Bldg., Denver, Col.

PYLE, John W. (1919), Supt., (for mail) Peru Heat Co., 30 W. Canal St., and 227 W. 2nd St., Peru, Ind.

QUAY, D. M.* (Charter Member), (2nd Vice-Pres. 1895; 1st Vice-Pres. 1896, 1899; Pres. 1900) Mgr., W. G. Cornell Co., 639 Leader News Bldg., and 1352 E. 84th St., Cleveland, O.

QUENTIN, Edward H. (Associate 1919), Mgr., (for mail) Johnson Heat Regulating Co., 14 N. 12th St., and 3259 Geyer Ave., St. Louis, Mo.

QUIGLEY, William J. (1920), Salesman, Gurney Heater Mfg. Co., (for mail) P. O. Box 164, Buffalo, and 27 Knowlton Ave., Kenmore, N. Y.

QUIRK, Clinton H. (Junior 1915; 1916), Vent. and Mech. Engr., (for mail) Howard & Morse, 45 Fulton St., New York, and 8557 110th St., Richmond Hill, Long Island, N. Y.

R

RAINE, John J. (1912), G. S. Blodgett Co., Burlington, Vt.

RAISLER, Samuel (1921), Pres., Raisler Heat & Sprinkler Co., 129 Amsterdam Ave., and (for mail) 202 Riverside Drive, New York, N. Y.

RATHER, Max F. (1919), Mgr., Cleveland Office, (for mail) Johnson Service Co., 2028 E. 22nd St., Cleveland, and 2135 Renrock Rd., Cleveland, Heights, O.

REARDON, J. Albert (1921), Pres., Reardon Bros. Co., Mfgs. National Bank, 341 Union St., and 202 Washington St., Lynn, Mass.

RECK, Anders B.* (1899), Pres., (for mail) Reck Heat Co., Ltd., 15 Esromgade, Copenhagen, and Christiansavei 16, Hellerup, Denmark.

REDER, Benedict S. (1922), Mgr., (for mail) B. S. Reder & Co., 513 Arrott Bldg., and 1515 Rockland Ave., Pittsburgh, Pa.

REED, William Dick (1919), (for mail) W. D. Reed Co., 622 Benton Bldg., 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), Sales Engr., Hoffman Specialty Co., 512 5th Ave., New York, N. Y., and (for mail) 204 E. Oklahoma Ave., Knoxville, Tenn.

REES, Rhea (1916), Pres., Sanitary Heat. & Pibg. Co., 467 Boyce-Greely Bldg., and 628 W. 13th St., Sioux Falls, S. D.

REESE, Henry L. (1923), Supt., Hersh Bros. Co., Allentown, and 521 Elm St., Emaus, Pa.

REEVES, Charles G. (1916), Gen. Supt., H. Courty Richards, Archts., 608 Chestnut St., Philadelphia, and (for mail) 257 W. Clapier St., Germantown, Philadelphia, Pa.

REGAN, William A. (1919), Contr., Keystone Heat. and Equip. Co., 1321 S. Juniper St., Philadelphia, Pa.

REINHARD, E. L. (1919), Br. Mgr., (for mail) American Radiator Co., 414 Jackson Bldg., and 506 Linwood St., Buffalo, N. Y.

REPP, Harry Leroy (1922), Br. Mgr., U. S. Radiator Corp., 908 N. Senate Ave., and 824 E. 42nd St., Indianapolis, Ind.

REUTER, Albert C. (1922), Sales Engr., Bishop & Babcock Co., 1724 Lawrence St., and (for mail) 712 S. Corona St., Denver, Col.

REUSS, Edward H., Jr. (Associate 1918; 1921), Heat. Contr., 30th and Race Sts., and 52nd St., above Wynnefield Ave., Philadelphia, Pa.

REYNOLDS, Henry M. (1915), Vice-Pres., General Boilers Co., Waukegan, Ill.

REYNOLDS, Thurlow W. (1922), Asst. Engr., N. Y. Central Lines, R. 2416, Grand Central Term., and (for mail) 601 W. 191st St., New York, N. Y.

RHODES, Solomon V. (1921), Supt. of Heat., Farrell Heat. & Pibg. 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, Edmund T. (1920), Heat. and Vent. Engr., Jas. Spear Stove & Heat Co., 1523 Market St., and 589 S. 56th St., Philadelphia, Pa.

RICE, William W. (1915), Engr., Walters, Purks & Mellon, 4419 Ludlow St., and (for mail) 1437 N. Redfield St., Philadelphia, Pa.

RICHARDS, Frank A. (1920), Sales Engr., Herman Nelson Corp., 219 New First National Bank Bldg., and 2612 Glen Echo Drive, Columbus, O.

RICHARDS, Samuel F. (1915), Mgr., Heat Dept., Anchor Sanitary Co., 123 3rd 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., 171 W. Lake St., and 1302 Ritchie Court, Chicago, Ill.

RICHARDSON, Clifford B. (1917), Mgr., Drake Avery Co., Ltd., 210 State St., Detroit, Mich.

RICHARDSON, D. Rait* (1915), Pres., Richardson & Boynton Co., 258 5th Ave., New York, N. Y.

RICHARDSON, Frank J. (1921), Heat. and Vent. Insp., Dept. of Education, 131 Livingston St., and (for mail) 467 1st St., Brooklyn, N. Y.

RIDLER, Harry C. (1919), Pibg. Heat. and Vent. Engr., (for mail) 310 W. 33rd St., and 3248 Pleasant Ave., Minneapolis, Minn.

RIELLEY, Edward P. (Junior 1921), Sales Engr., James P. Marsh & Co., 118 S. Clinton St., and 5224 Montrose Ave., Chicago, Ill.

RILEY, Albert H. (1919), Supt. Heat. and Vent. (for mail) Bd. of Education, 9th and Locust Sts., and 6235 Dowler Ave., St. Louis, Mo.

RILEY, Champain L.* (1906), (Council 1918-1922; 1st Vice-Pres. 1920; Pres. 1921), Clark MacMullen & Riley, 101 Park Ave., New York, N. Y., and (for mail) Plainfield, N. J.

RILEY, DeWitt H. (1921), Ch. Draftsman, Research Dept., American Radiator Co., 1807 Elmwood Ave., and 815 Tonawanda St., Buffalo, N. Y.

RITCHIE, Edmund John (1923), (for mail) Sales Mgr., Sarco Co., Inc., Woolworth Bldg., New York, and 140 E. 9th St., Brooklyn, N. Y.

RITCHIE, William (1909), Vice-Pres., Boynton Furnace Co., 58 W. 40th St., New York, N. Y., and 17 Van Reipen Ave., Jersey City, N. J.

RITTER, Arthur (1911), N. Y. Mgr., American Blower Co., 50 Church St., New York, and 699 Ocean Ave., Brooklyn, N. Y.

ROBB, John M.* (1913), Heat. Engr., 1513 Columbia Terrace, Peoria, Ill.

ROBBINS, Loring G. (1907), Robbins, Gamwell & Co., 68 West St., Pittsfield, Mass.

ROBERTS, Henry L. (1916), Engr. and Contr., 228 N. 16th St., Philadelphia, Pa.

ROBERTSON, George A. (1902), Acting Supv. Heat. and Vent. Inspector, Bd. of Education, Bureau of Plant Operation, Flatbush Ave., and Concord St., and 1081 E. 39th St., Brooklyn, 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 Pibg. and Heat Co., 115 N. 3rd St., and 1501 Frances St., St. Joseph, Mo.

ROCKART, Edward R. (1921), Ch. Mech. Engr., Minneapolis Bd. of Education, 245 9th 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 Richford Hotel, Rochester, N. Y.

ROGERS, A. Carl (1921), Consulting Engr., Power Plants Heat. and Vent., 752 Euclid Ave., Toledo, O.

ROGERS, C. W. (1921), Secy., New York 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), (Secy., Ohio Chapter), Br. Mgr., U. S. Radiator Corp., 523 Cleveland Discount Bldg., and 1418 Kenilworth Ave., Cleveland, O.

ROLLINS, Lewis M. (1916), Master Mechanic, Morris & Co., Union Stock Yards, and (for mail) 5927 Rockwell Ave., Chicago, Ill.

RONEY, Thomas G. (1916), T. G. Roney Heat Co., 3461 Fort St., W., and 748 25th St., Detroit, Mich.

ROONEY, Martin A. (1918), Hart & Crouse Co., 301 Turner St., Utica, N. Y.

ROSEBROUGH, Robert M. (1920), Mgr., L. J. Mueller Furnace Co., 1409 Olive St., St. Louis, Mo.

ROSENBACH, 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 E. 42nd St., New York, and Colonial Heights, Tuckahoe, N. Y.

ROSSMAN, Vincent D. (1919), (Pres., St. Louis Chapter), Secy., (for mail) Modern Heat Co., 3935 Olive St., and 2365 Klemm St., St. Louis, Mo.

ROTHROCK, John T. (1920), Supt. Mech. Eng., Thompson-Starrett Co., 15 N. 9th St., Minneapolis, Minn.

ROTZ, John M. (1918), Consulting Engr., Snider & Rotz, 703 Merchants Bank Bldg., and 3930 Broadway, Indianapolis, Ind.

ROW, Oliver M. (1912), Director, Royles, Ltd., Heat Specialists, Irlam, near Manchester, England.

ROWE, W. A. (1921), Ch. Engr., American Blower Co., and 8159 La Salle Blvd., Detroit, Mich.

ROWLEY, Frank B.* (1918), (Pres., Minn. Chapter), Prof. of Mech. Eng. and Director of Experimental Eng. Laboratories, University of Minnesota, and (for mail) 63 Barton Ave., S.E., Minneapolis, Minn.

RUCKEL, John B. (Associate 1919), Pres., (for mail) J. H. Ruckel & Son, 81-83 Main St., and 183 Cleveland Ave., Buffalo, N. Y.

RUDELL, Wm. H. (1921), Mgr., West Coast Heat Co., Inc., 1627 4th Ave., and 308 Newton St., Seattle, Wash.

RUDIO, H. M. (1921), Salesman, (for mail) Carrier Eng. Corp., 39 Cortlandt St., New York, and 142 Winspear Ave., Buffalo, N. Y.

RUFF, DeWitt Clinton, 2nd (1922), (for mail) Healy-Ruff Co., 502 Plymouth Bldg., Minneapolis, and 727 Portland Ave., St. Paul, Minn.

RUPEL, Richard L. (1911), Consulting Engr., 32 W. 40th St., New York, N. Y., and (for mail) Meriden Rd., Waterbury, Conn.

RUSSELL, Hugh C. (1911), Supv. Archts. Office, U. S. Treas. Dept., and 3349 18th St., N.W., Washington, D. C.

RUSSELL, Joseph N. (1899), Mgr., Rosser & Russell, Ltd., 37 Duke St., Oxford St., London, W. 1, England.

RUSSELL, Willard E. (1921), Mgr., C. A. Dunham Co., 210 Broad St. Bank Bldg., Trenton, N. J.

RUSSELL, William Arthur (1918), 70 E. 45th St., New York, N. Y.

RUSSELL, William A. (1921), Mgr., Kansas City Br., U. S. Radiator Corp., 1412 W. 12th St., Kansas City, Mo.

RYAN, Harry J. (1922), Sales Engr., 91 Elm St., Albany, N. Y.

RYAN, Henry B. (1920), Vice-Pres., Barry, Byrne & Ryan Co., 104 S. Michigan Ave., Chicago, and 170 Fuller Lane, Winnetka, Ill.

RYAN, Thomas P. (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.

SANBORN, Edward N. (1923), Engr., Mensing & Co., 928 Mensing Bldg., Philadelphia, Pa.

SANFORD, Arthur L. (1915), (Secy., Minn. Chapter), Mech. Engr., (for mail) Bd. of Education, 245 9th Ave., N., and 301 E. 48th St., Minneapolis, Minn.

SANTMYER, W. J. (1921), Supt., Steam Heat Div., Puget Sound Power and Light Co., Electric Bldg., 7th 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, 58 Lafayette Blvd., and (for mail) 2025 Virginia Park, Detroit, Mich.

SAWADE, Carl A. (Associate 1920), Mgr. Boiler Sales, (for mail) Continental Heater Corp., and 721 Washington Ave., Dunkirk, N. Y.

SAWDON, William M. (1920), Prof., Exp. Eng., Cornell University, and 1018 E. State St., Ithaca, N. Y.

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., R. 1156, 38 S. Dearborn St., and 4626 N. Kilbourn Ave., Chicago, Ill.

SCHELLHAMMER, Alfred L. (1919), Schellhammer & Co., Warren, Pa.

SCHILDMILLER, George H. (1922), Asst. Br. Mgr., American Radiator Corp., Barlum Bldg., Grand River and Broadway Ave., and 2206 Pennsylvania Ave., Detroit, Mich.

SCHILLING, Clarence L. (1921), Treas. and Mgr., Atlanta Sheet Metal Works, P. O. Box 1022, Atlanta, Ga.

SCHLEMMER, Oliver H. (1906), 8442 Curzon Ave., Hartwell, Cincinnati, O.

SCHLEY, Arthur A. (1920), Mgr. Heat. Dept., Schley & Nash Co., 903 Arrott Bldg., Pittsburgh, Pa.

SCHLOSS, Newton L. (1913), Consulting Engr., 105 W. 40th St., and 546 W. 147th St., New York, N. Y.

SCHLUTER, H. (Associate 1921), Ames Iron Sales, R. 1010, 41 E. 42nd St., New York, N. Y.

SCHMIDT, George G. (Junior 1912; 1914), Carrier Eng. Corp., 39 Cortlandt St., and 6063 Broadway, New York, N. Y.

SCHNEIDER, Paul W. (1919), 16 Pearl St., Utica, N. Y.

SCHOENJAHN, Robert P. (1919), Consulting Engr., (for mail) Industrial Trust Bldg., 10th and Shipley Sts., and 7 Crawford Circle, Wilmington, Del.

SCHOEPLIN, Paul H. (1920), Pres., (for mail) Niagara Blower Co., Ontario St. at New York Central Tracks, and 56 Ardmore Place, Buffalo, N. Y.

SCHOPP, Walter J. (1922), Mgr., (for mail) General Eng. & Const. Co., 10 S. 18th St., and 146 Lauriston St., Philadelphia, 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., (for mail) Hester-Bradley Co., 4200 Forest Park Blvd., and 4499 Forest Park Blvd., St. Louis, Mo.

SCIPPO, 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., (for mail) Vapor Heat Co., 597 5th Ave., New York, N. Y., and S. Norwalk, Conn.

SCOTT, Edwin A. (1912), (Secretary 1913), Editor, Sheet Metal Worker, Edwin A. Scott Publishing Co., 15 E. 40th St., and 3207 Park Ave., New York, N. Y.

SCOTT, Francis H. (Junior 1920), Consulting Engr., 54 S. 17th St., Philadelphia, Pa.

SCOTT, George M. (1915), Child & Scott Co., 108 Wooster St., New York, N. Y.

SEABRIGHT, Louis C. (1920), Engr., c/o C. W. Bates, 77 12th St., Wheeling, W. Va.

SEARS, William H. (1919), Archt. and Structural Eng., 1102-3-4 James Bldg., Chattanooga, and 623 Hanover St., N. Chattanooga, Tenn.

SEIPPEL, John H. (Associate 1920; 1921), Repr., Haynes Selling Co., and Standard Heater Co., (for mail) 847 Equitable Bldg., and 208 E. 34th St., Baltimore, Md.

SEKIDO, Kunisuke (1903), Nakano, Tokio Suburb, Japan.

SELLARS, Fred J. (1917), Pres., Sell-Orr Heat Co., 311 N. Penn Ave., and 619 N. 9th St., Independence, Kans.

SELLERS, Reuben F. (1922), Owner, R. F. Sellers Eng. Co., 216 E. 2nd 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., American Radiator Co., 401 Pennway Bldg., and (for mail) 3206 College Ave., Indianapolis, Ind.

SETZER, Walter C. (Junior 1922), Mech. Engr., H. B. Smith Co., 17th and Arch Sts., and (for mail) 3915 N. 8th St., Philadelphia, Pa.

SEWARD, Percival H.* (Charter Member), Vice-Pres., Richmond Radiator Co., 1480 Broadway, New York, and (for mail) 369 Washington Ave., Brooklyn, N. Y.

SEWELL, John M. (1919), Consulting Engr., 1711 Sansom St., Philadelphia, and (for mail) Warren Ave., Berwyn, Pa.

SHANKLIN, John R. (1899), Pres. and Gen. Mgr., West Virginia Heat & Pblg. Co., 233 Hale St., and 1507 Quarrier St., Charleston, W. Va.

SHAW, Clinton E. (1921), Instructor, Northeast High School, 8th and Lehigh Ave., and 6412 N. 11th St., Philadelphia, Pa.

SHAW, Raymond E. (1921), Mgr., New England Sales, B. F. Sturtevant Co., R. 555 Massachusetts Trust Bldg., and Boston Athletic Assn., Boston, Mass.

SHEA, M. B. (1921), Mgr., American Radiator Co., 417 S. 10th St., and 3616 Lincoln Blvd., Omaha, Nebr.

SHEARS, Matthew W. (1922), Heat Engr., C. A. Dunham Co. Ltd., 1523-41 Davenport Rd., Toronto, and Lansing P. O., Ont.

SHEFFIELD, Edward B. (1921), Asst. Engr., Melvern F. Thomas, 229 College St., Toronto, and 25 Government Rd., Lambton Mills, Ont.

SHEFFLER, Morris (1921), Sheffer-Gross Co., 205-207 Drexel Bldg., and 224 S. 59th St., Philadelphia, Pa.

SHEPPARD, Frank A. (1918), Johnson Service Co., 411 E. 10th St., Kansas City, Mo.

SHEPPARD, William G. (1922), Heat and Vent. Engr., Sheppard & Abbott, 119 Harbord St., and 479 Dovercourt Rd., Toronto, Ont.

SHERIFFS, Walter A. (1918), Mehring & Hanson Co., 118 N. Franklin St., Chicago, Ill.

SHODRON, John G. (1921), Research Engr., James Mfg. Co., and (for mail) 411 E. Milwaukee Ave., Ft. Atkinson, Wis.

SHORB, Will A. (1909), Treas., Field & Shorb Co., 133 W. William St., and (for mail) 3 Lincoln Pl., Decatur, Ill.

SHOZO, Saito (1923), Managing Director, Saito Shozo Tokyo Office, Nichi Bei Shintaku Bldg., Kyobashi, and (for mail) 12, 2 Chome, Atago Cho., Tokyo, Japan.

SHUELL, Frank W. (Associate 1921), Pres., (for mail) The Ever-Hot Heater Co., 214 W. Woodbridge St., and 5229 Cass Ave., Detroit, Mich.

SHULTZ, Earle (Associate 1919), Vice-Pres., Illinois Maintenance Co., R. 1136, Edison Bldg., and 5818 Magnolia Ave., Chicago, Ill.

SIEGEL, John F. (Associate 1915), Newport Boiler Co., 101 Park Ave., New York, and Mt. Vernon, N. Y.

SIMMONDS, Philip R. (Associate 1921), Gen. Sales Mgr., John Call Co., 122 N. Franklin St., Philadelphia, Pa., and 301 Chadwick Ave., Newark, N. J.

SIMONSEN, Lawrence A. (1920), Estimator and Engr., E. J. Clafey Co., 10 W. Illinois St., and (for mail) 6224 S. Park 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., Detroit, Mich., and Cloquet, Minn.

SKELLY, John F. (1921), Heat and Vent. Engr., M. J. Daly & Sons, 543 Bank St., and (for mail) 148 Chipman St., Waterbury, Conn.

SKINNER, Henry W. (1920), Mech. Engr., Heat and Pblg. Dept., Atlas Supply Co., and 612 Jefferson St., Muskogee, Okla.

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, Delbert C. (Associate 1919), 333 State St., Detroit, and 150 Hawthorne Ave., Royal Oak, Mich.

SMITH, Edward C. (1918), Supervising Engr., (for mail) Bd. of Education, 340 N. Water St., and 1053 Mathewson Ave., Wichita, Kans.

SMITH, George P. (1922), Sales Repr., (for mail) Herman Nelson Corp., 122 Michigan Ave., R. 437, Chicago, and 500 Western Ave., Joliet, Ill.

SMITH, Leslie L. (1919), Mech. Engr., (for mail) Smith, Hinchman & Grylls, 800 Marquette Bldg., and 1931 Delaware Ave., Detroit, Mich.

SMITH, Milton S. (1919), Production Mgr., Carrier Engr. Corp., 750 Frelinghuysen Ave., Newark, and (for mail) 13 North Terrace, Maplewood, N. J.

SMITH, Wilbur F. (1920), Mech. Engr., W. M. Anderson, (for mail) 600 Schuylkill 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 3987 Martindale Ave., Detroit, Mich.

SODEMANN, Paul (Junior 1920), Sales Engr., Fischer Heat Co., 367-369 Adams St., and (for mail) 206 Garland Place, 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, Wm. (1923), Estimator and Engr., Reis & O'Donoghue, Inc., 253 W. 28th St., New York, and (for mail) 198 Floyd St., Brooklyn, N. Y.

SOMMER, Louis J., Jr. (1922), Pblg. and Heat. Contr., (for mail) Sommer & Son, 6021 Clifford Terrace, and 2436 Brown St., Philadelphia, Pa.

SOPER, Horace A. (1916), Vice-Pres., American Foundry & Furnace Co., and 1122 E. Monroe St., Bloomington, Ill.

SOPER, Ira N. (1919), Sales Engr., (for mail) Warren Webster & Co., 549 W. Washington Blvd., and 7214 Prairie Ave., Chicago, Ill.

SOULE, Lawrence C. (1908), Carrier Eng. Corp., 750 Frelinghuysen Ave., Newark, N. J.

SOVER, Paul E. (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.

SPEAKMAN, William (Associate 1918), 7813 Kelly St., Pittsburgh, Pa.

SPECKMAN, Charles H. (1918), (for mail) R. 902, Stephen Girard Bldg., Philadelphia, Pa.

SPELLER, Frank N.* (1908), Metallurgical Engr., National Tube Co., 1802 Frick Bldg., and 6411 Darlington Rd., Pittsburgh, Pa.

SPEZZEL, 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), Mgr., (for mail) R. L. Spitzley Heat Co., 246 W. Larned St., and 1050 Yorkshire Rd., Grosse Pointe, Detroit, Mich.

SPOONER, Harold R. (1921), Engr. and Estimator, Jarcho Bros., Inc., 358 W. 31st St., New York, and (for mail) 33 Woodhull Ave., Hollis, L. I., N. Y.

SPRIGGS, Walter J. (Junior 1920), (for mail) F. J. Spriggs, 43 W. 4th St., and 183 S. Chatsworth St., St. Paul, Minn.

SPOULL, Howard E. (1920), Dist. Mgr., American Blower Co., 1151 Consolidated Bldg., Indianapolis, and Bedford, Ind.

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. (Associate 1908; 1919), (Pres., Kansas City Chapter), (for mail) Mgr., American Radiator Co., 906 Davidson Bldg., and 314 W. Armour Blvd., Kansas City, Mo.

STAMMER, Edward L.* (1919), Heat and Vent. Supt., Bd. of Education, 9th and Locust Sts., St. Louis, Mo.

STANFORD, Leland E. (1921), Mgr., Forbes-Stanford Co., 758 Upson St., and (for mail) 120 E. Cuyahoga Falls Ave., Akron, O.

STANGER, Ralph B. (1920), Sales Engr., Robinson & Stanger, Empire Bldg., Pittsburgh, Pa.

STANGLAND, B. F. (Charter Member), (Board of Managers 1895; Council 1896, 1897; Board of Managers 1899; Board of Governors 1905-1906; 2nd Vice-Pres. 1908; Board of Governors 1909), Morton, N. Y.

STANNARD, James M.* (1906), (Board of Governors 1913; Council 1914, 1917), Pres., Stannard Power Equipment Co., 1220 Monadnock Block, Chicago, Ill.

STARK, Edward A. (Associate 1914; 1916), Br. Mgr., U. S. Radiator Corp., 1248 1st Ave., S., and 2338 Broadway, N., Seattle, Wash.

STARK, Ira S. (Junior 1920), Sales Engr., E. Vernon/Hill Co., 64 W. Randolph St., Chicago, Ill.

STARKS, Verne E. (1921), Dist. Mgr., (for mail) Ilg Elec. Vent. Co., 1314 Schofield Bldg., Cleveland, and 1678 Hower Ave., E. Cleveland, O.

STEDMAN, C. N. (1921), Dist. Sales Mgr., (for mail) Fulton Co., 610 Wrigley Bldg., and 2309 E. 69th St., Chicago, Ill.

STEIM, Charles J., Jr. (1923), Sales Engr., (for mail) Samuel Sloan & Co., 67 Exchange St., and 100 Laburnum Crescent, Rochester, N. Y.

STEINER, John G. (Associate 1922), Utica Heater Co., 1708 Broadway, and 1368 Elizabeth St., Denver, Col.

STEINHORST, Theodore F. (1919), Engr. and Estimator, Emil Steinhorst & Sons, 1158 Mohawk St. and West Shore R. R., and 1642 Brinckerhoff Ave., Utica, N. Y.

STEPHANY, Erwin J. (Junior 1920), Supt. of Sales Dept., Equitable Gas Co., 435 6th 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 E. 13th St., and 2712 Benton Blvd., Kansas City, Mo.

STERN, H. Richard (1923), Johnson & Morris, 538 W. 23rd St., New York, N. Y.

TESTSON, 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 S. 51st St., Philadelphia, Pa.

STEWART, Earl A. (1922), Assoc. Prof. Agr. Physics, Univ. of Minnesota, University Farm, St. Paul, Minn.

STEWART, Harry D. (1920), Salesman, Pierce, Butler & Pierce Mfg. Corp., Broad and Race St., and (for mail) 5604 Spruce St., Philadelphia, Pa.

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), (Secy., Pittsburgh Chapter), Mgr., (for mail) U. S. Radiator Corp., 607 Arrott Bldg., and 1535 Fairlawn Ave., Dormont, Pittsburgh, Pa.

STITT, Howard B. (Associate 1922), Heat. Engr., (for mail) Onarga Pblg. & Heat. Co., Onarga, Ill.

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., Johnson Service Co., 177 N. Dearborn St., 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.

STOLTENBERG, Thomas R. (1922), Sales Rep. Heat. and Vent. Engr., (for mail) Box 1168, and Kenmark Hotel, Denver, Col.
STONE, Eugene R. (1913), Pres., Stone-Underhill Heat. & Vent. Co., 171 Harrison Ave., Boston, Mass.
STONE, George F. (1918), 4520 N. Carlisle St., and 1320 Olive 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, N. Y.
STRANDWITZ, William J. (1919), Secy. and Treas., Strandwitz & Scott, Inc., 537-39 S. 2nd St., Camden, and Hawthorne Ave., Haddonfield, N. J.
STRÖM, William H. (1921), Mgr., Heat. Dept., Bridgman Co., 120 S. 30th St., and (for mail) 5405 Chestnut St., Apartment A, Philadelphia, Pa.
STRONG, Ralph C. (1919), Salesman, Pierce, Butler & Pierce Mfg. Corp., 31st and Oxford Sts., and (for mail) 4522 Walnut St., 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. (1923), Mgr., Hoffman Specialty Co., 136 Federal St., Boston, Mass.
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.
SUTTER, George (1921), Heat. Contr., (for mail) 210 E. 2nd St., and 1842 Barrett Ave., Sedalia, Mo.
SUTTERLEY, W. W. (1919), 503 N. 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. Weadock Ave., Saginaw, Mich.
SWEENEY, Sylvester H. (1915), Engr. and Contr., 213-215 E. 44th St., New York, N. Y.
SZEKELY, Ernest (1920), Consulting Mech. Engr., 500 B. R. T. Bldg., 820 W. Superior Ave., and (for mail) 1435 Ridgewood Ave., Cleveland, O.

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TAGGART, Ralph C. (1912), Ch. Engr., Dept. of Archt., and (for mail) 14 Lyon Ave., Menands, Albany, N. Y.
TAIT, George M. (1909), Heat., Vent. and San. Engr., 76 S. Walnut St., Mansfield, O.
TALIAFERRO, R. Ryland (1919), Carrier Eng. Corp., 1402 Land Title Bldg., and Beechwood Park, Philadelphia, Pa.
TALLMAN, D. Stephen (1920), D. S. Tallman & Co., 3637 Boulevard, Jersey City, and 11 E. Gouverneur Ave., Rutherford, N. J.
TANGEMAN, Bruno W. (Associate 1919), Mgr., A. Y. McDonald Mfg. Co., 221 3rd St., N., and 2716 Aldrich Ave., S., Minneapolis, Minn.
TAPLIN, Neal W. (Associate 1915; 1921), Pres., (for mail) Taplin Furnace Co., 21 N. Sheldon Ave., and 145 Cherry St., S.E., Grand Rapids, Mich.
TAYLER, Theron C. (1917), Pres. and Gen. Mgr., Sand Lime Products Co., and (for mail) 2436 W. Grand Blvd., Detroit, Mich.
TAYLOR, Fred K. (1919), (for mail) Sales Dept., Taylor Instrument Cos., 95 Ames St., and 111 Trafalgar St., Rochester, N. Y.
TAYLOR, Reginald F. (1915), Consulting Engr., 1106 Western Indemnity Bldg., and 5742 Richmond Ave., Dallas, Tex.
TAYLOR, Thomas Smith (1921), Westinghouse Elec. & Mfg. Co., Westinghouse Research Bldg., E. Pittsburgh, and Forest Hills Rd., Forest Hills, Wilkesburg, Pa.
TAZELAAR, Peter (Junior 1916), Sales Engr., Commonwealth Brass Corp., 48 E. 41st St., New York, N. Y., and 43 Fulton St., Bloomfield, N. J.

TEMLIN, Charles L. (1921), Engr., American Heat. & Vent. Co., 804 Times Dispatch Bldg., and (for mail) 810 N. Blvd., Richmond, Va.
TENKONOHY, Rudolph J. (1923), Sales Engr., American Blower Co., 2136 Oliver Bldg., Pittsburgh, Pa., and 37 Stevens Ave., Highland Park, Mich.
TERAN, Cesar* (1902), Pres., Teran-Lange, Inc., Grand Central Terminal, New York, and Milburn St., Bronxville, N. Y.
TERRELL, Herbert A. (1915), Secy. and Treas., Atmospheric Conditioning Corp., 921 Lafayette Bldg., Philadelphia, Pa., and (for mail) Wenonah, N. J.
THATCHER, George S. (1919), Pres., (for mail) Thatcher Heat. Co., 46 S. Broadway, and 140 Morningside Drive, Akron, O.
THEISEN, Edwin F. (1922), Pres. and Heat. Engr., Industrial Pblg. and Heat. Co., 606 2nd 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., C. A. Dunham Co., 230 E. Ohio St., and 1721 Humboldt Blvd., Chicago, Ill.
THOMAS, Bernard A. (Junior 1923), Estimator, Mechanical Trade Co., Ltd., 64 University Ave., and (for mail) 162 Howard Park Ave., Toronto, Ont.
THOMAS, Glegge (1923), Br. Mgr., B. F. Sturtevant Co., 900 F 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), (Pres., Ontario Chapter), Consulting Engr., (for mail) R. 30-34, 229 College St., and 80 Indian Rd., Toronto, Ont.
THOMAS, R. H. (1920), Pres., (for mail) Economy Pumping Machinery Co., 122-124 N. Curtis St., Chicago, and Pres., Inland Iron Works, Joliet, 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), International Eng. & Supply Co., 1308 Olive St., 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), Heat. and Vent. Engr., Bd. of Education, Concord St. and Flatbush Ave., Brooklyn, and 44 E. 87th St., New York, N. Y.
TIBBETS, John C. (1920), Heat. & Vent. Engr., B. & O. R. Co., 1303 B. & O. Central Bldg., Baltimore, and (for mail) Elliott City, Howard County, Md.
TIMM, William H. (1915), Consulting Engr. and Archt., 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 427 Ella St., Wilkesburg, Pa.

TIMMIS, Pierce (1920), Mech. Engr., (for mail) Dwight P. Robinson Co., 125 E. 46th St., New York, and 9440 86th Ave., Woodhaven, N. Y.
TIMMIS, Walter S.* (1911), (Council 1916, 1917, 1920; 1st Vice-Pres. 1918; Pres. 1919), Consulting Engr., 315 8th Ave., New York, and Hillsdale and Homer Lee Aves., Jamaica, N. Y.
TINKER, Wm. E. (Associate 1922), National Radiator Co., Juniper and Arch Sts., Philadelphia, Pa.
TISNOWER, William (1923), Heat. Engr., Bd. of Education, Concord St. and Flatbush Ave., Brooklyn, and 640 Academy St., Astoria, N. Y.
TITZEL, J. Edgar (1923), Mgr., Eastern Dist. Sales Office, Gen. Boilers Co., 101 Park Ave., and (for mail) 132 W. 88th St., New York, N. Y.
TJERSLAND, Alf. (Junior 1906; 1916), E. Sundt & Co., Christiania, Norway.
TOBIN, George J. (1901), Contracting Engr., 187-91 North Ave., and 510 Grant Ave., Plainfield, N. J.
TODD, James (1922), Pres., Sterling Varnish Co., 528 Fulton Bldg., Pittsburgh, and Sewickley, Pa.
TOENNIGES, George C. (1915), Sales Engr., Dewar & Carrington, 153 N. Desplains St., Chicago, Ill.
TOOKER, Charles C. (1918), Heat. Engr., 113 N. 27th St., and (for mail) 208 Terry Ave., Billings, Mont.
TOWSON, William W., Jr. (Associate 1918), 1220 New York Ave., N.W., Washington, D. C.
TRANE, Reuben N. (1915), Pres., Trane Co., 127 S. 6th St., and 1720 Cass St., LaCrosse, 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), 3317 R St., N. W., Washington, D. C.
TRUITT, Joseph E. (Associate 1911; 1920), Pres., Autovent Fan & Blower Co., 730-738 W. Monroe St., Chicago, Ill.
TURNO, Walter G. W. (Associate 1912; 1917), Engr. and Estimator, 71 Lafayette Ave., East Orange, N. J.
TUSCH, Walter (1917), Heat. and Vent. Engr., (for mail) Tenney & Ohmes, 101 Park Ave., New York, and 881 Sterling Pl., Brooklyn, N. Y.
TUTTLE, J. Frank (1913), (Pres., Massachusetts Chapter), Mgr., Warren Webster & Co., 220 Devonshire St., Boston, and Winchester, Mass.
TWEED, Carleton F. (1916), Consulting Engr., Tweed & Kerr, Metropolitan Bank Bldg., Minneapolis, and Sellwood Bldg., Duluth, Minn.
TWIST, Charles F. (1921), Ashwell & Twist, 2127 1st Ave., Seattle, Wash.
TYLER, Frank T. (1922), Mgr. Estimating Dept., Herman Nelson Corp., and 1615 8th Ave., Moline, Ill.

U

UHL, Willard F. (1918), Sales Engr., (for mail) Uhl Co., 305 Metropolitan Bank Bldg., and 4716 Lyndale Ave., S., Minneapolis, Minn.
UHLHORN, W. J. (1920), Sales Engr., Drying Systems, Inc., 11 S. Desplains St., and (for mail) 5950 W. Lake St., Chicago, 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., American Blower Co., 50 Church St., New York, and (for mail) 770 Greene Ave., Brooklyn, N. Y.

V

VAILE, Rawson (1921), American Blower Co., Detroit, Mich.
VALENTINE, Floyd H.* (1912), Heat. and Vent. Engr., Mayer, Valentine and Cameron, R. 204, Erie Bldg., and 3019 Edgehill Rd., Cleveland, O.
VANCE, Louis G. (1919), Dist. Mgr., (for mail) Warren Webster & Co., Gunther Bldg., and 3601 Garrison Ave., Baltimore, Md.

VAN INWAGEN, Frank (1916), Vice-Pres., Illinois Eng. Co., Racine Ave. at 21st St., Chicago, and 151 County Line Rd., Hinsdale, Ill.
VAN SICKLE, William B. (1915), Pres., 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), Mgr., (for mail) John H. Van Zandt Co., Mfrs. Agt., 809 Southwestern Life Bldg., and 4504 Live Oak St., Dallas, Tex.
VAUX, Frederick J. (1919), Vice-Pres. and Gen. Mgr., Monitor Bi-Loop Radiator Co., 538 Woolworth Bldg., and (for mail) 834 Marietta Ave., Lancaster, Pa.
VAUX, Noble (Associate 1923), Heat. Engr., R. T. Vaux & Son, 12 Fawcett St., and (for mail) 11 Holmecland Park St., Sunderland, England.
VERNER, William F.* (1913), (for mail) Verner, Wilhelm & Molby, 603 Book Bldg., Detroit, and 908 Lincoln Ave., Ann Arbor, Mich.
VIVARTTAS, Eugene A. (1910), Consulting Engr., 10 1st St., Troy, N. Y.
VOGEL, Adolph H. (1920), Heat. and Vent. Engr., Urtaner-Atwood Co., 1446 S. 2nd St., and (for mail) 3512a Humphrey St., St. Louis, Mo.
VOICT, Charles O. (1921), Buffalo Forge Co., 1720 California St., and 2073 S. Clayton St., Denver, Col.
VOORHEES, Guy A. (1922), Engr., Century Heat. Service Co., 32-36 W. 10th St., and (for mail) 3451 Broadway, Indianapolis, Ind.

W

WACHTER, John A. (1914), Engr., Cuyler & Mohler, 611 William St., Baltimore, Md.
WADDINGTON, Bertram C. (1922), Dist. Mgr., Natin Eng. Co., 706 World-Herald Bldg., and 105 Turner St., Omaha, Nebr.
WADDINGTON, Earle C. (1917), Sales Engr., (for mail) Natin Eng. Co., 208 Mutual Bldg., and 3230 Tracy Ave., Kansas City, Mo.
WADLEY, Calvin P. (1919), Pres., (for mail) Excelso Specialty Works, Inc., 119 Clinton St., and 136 Goulding Ave., Buffalo, N. Y.
WAGENER, Robert N. (Junior 1915), Wagener Steam Pump Co., Canton, O.
WAGNER, A. M. (Associate 1921), Mgr., American Radiator Co., 688 Hampden Ave., St. Paul, and 1828 W. 25th St., Minneapolis, Minn.
WAGNER, John P. (Associate 1921), Pres. and Gen. Mgr., Success Heater & Mfg. Co., 1015 Murphy St., and 4333 Grand Ave., Des Moines, Ia.
WALKER, James B. (1919), Secy. and Treas., (for mail) Pittsburgh Heat. Co., 8 Wood St., and 202 Iquois Apt., Pittsburgh, Pa.
WALKER, James H.* (1916), Supt., Central Heat., (for mail) Detroit Edison Co., 2000 2nd Ave., and 1520 Virginia Park, Detroit, Mich.
WALLACE, Albert (1921), Mfrs. Repr., Frank Prox Boilers & Heat. Specialties, 401 Jacobson Bldg., and (for mail) 2971 Irving St., Denver, Col.
WALLACE, John F. (1921), Secy., Treas. and Mgr., Wallace Pblg. Co., 1509 Tremont Pl., and (for mail) 1320 S. Josephine St., Denver, Col.
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. Engr., 2242 E. 75th St., and 7536 S. Shore Drive, Chicago, Ill.
WALSH, Joseph G. (1919), Sales Engr., (for mail) McAlear Mfg. Co., 409 Reliance Bldg., and 4406 Main St., Kansas City, Mo.
WALTERS, William T. (1917), Engr., Illinois Eng. Co., W. 21st St. and Racine Ave., and (for mail) 9036 Cottage Grove Ave., Chicago, Ill.

WALTERTHUM, John J. (Associate 1922), Supt., Arthur Janes Co., 138 E. 59th St., New York, N. Y., and (for mail) 834 Grand St., Jersey City, N. J.

WALTHER, Harry J. (1919), (for mail) Mgr. Heat. Dept., Henry B. Pancost Co., 946-62 N. Front St., and 1125 Lindley Ave., Philadelphia, Pa.

WALTHER, Owen N. (1919), Treas., (for mail) York Heat & Vent. 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, Jerry J. (Associate 1921), (for mail) Wenzler & Ward, 2705 First Ave., and 615 Federal Ave., Seattle, Wash.

WARD, Oscar G. (1919), Dist. Mgr., (for mail) Johnson Service Co., 517 Boston Bldg., and 303 Waldman Apts., Denver, Col.

WARNKE, Fred E. (Associate 1921), Sales Mgr. Spencer Turbine Co., 2848 Prospect 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 E. 48th St., Indianapolis, Ind.

WATKINS, James A. (1919), Asst. Ch. Engr., American Blower Co., 6004 Russell St., and 9121 3rd Ave., Detroit, Mich.

WATERS, Peter J. (1921), Mgr., John Watters, 67 Richmond Ave., and (for mail) 52 Ann St., Port Richmond, Staten Island, N. Y.

WEACER, T. A. (1920), Mgr., Buffalo Forge Co., Kirby Bldg., Cleveland, and 3124 Berkshire Rd., Cleveland Heights, O.

WEBB, John S. (1920), 68 Devonshire St., Boston, Mass.

WEBER, Erwin L. (1921), Consulting Engr., 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.

WEBSTER, E. Kessler (1915), Secy. and Asst. Gen. Mgr., Warren Webster & Co., Point and Pearl Sts., and 418 N. 5th St., Camden, N. J.

WEBSTER, Warren (Associate 1899; 1906), Pres. and Gen. Mgr., Warren Webster & Co., Point and Pearl Sts., Camden, N. J.

WEGMANN, Albert (1918), Blower & Vent. Engr., A. & W. Wegmann, 2207 N. 27th St., and (for mail) 2842 N. Bonhall St., Philadelphia, Pa.

WEIBERT, Chas. J. (1921), (for mail) Weibert & Chapman, 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.

WEISS, Irwin I. (Junior 1921), (for mail) Weiss Heat. and Plbg. Co., 5604 Cedar Ave., and 9906 Pierpont Ave., Cleveland, O.

WELAMB, Victor N. (1918), Contr. Muench, Welamb Co., 135 N. 22nd St., and (for mail) 1741 N. 33rd St., Philadelphia, Pa.

WELKER, Arthur E. (1918), Price & Welker, 707 Canal Rd., Cleveland, and 1299 Hall Ave., Lakewood, O.

WELSH, Harry S.* (1906), Pres. and Mgr., Boiler & Radiator Corp., David 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. Eng., Catholic University of America, and Consulting Engr., 303 Mills Bldg., and (for mail) 1243 Monroe St., N. E. Washington, D. C.

WEST, Perry (1911), (Council 1920-1923), Executive Engr. and Secy., (for mail) Anti-Corrosion Eng. Co., 117 W. 54th St., New York, N. Y., 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), Wheeler & Sons, 1a Victoria Gardens, Notting Hill, London, W. 11, and 88 Hanover Court, St. Johns Wood, London, N.W. 8, England.

WHEELER, Otto J. (1923), Mgr. and Secy., Samuel A. Esswein Heat. & Plbg. Co., 96 W. Broad St., and (for mail) 504 Linwood Ave., Columbus, O.

WHELOCK, Harry C. (1919), 118 College St., Burlington, Vt.

WHEELER, Harry S. (1916), Vice-Pres., L. J. Wing Mfg. Co., 352 W. 13th St., New York, N. Y., and (for mail) 230 Stiles St., Elizabeth, N. J.

WHITBY, Stephen S. (Associate 1922), Salesman, Chicago Pump Co., and Gillis & Geoghegan, 1503 Sansom St., and (for mail) 127 E. Upsal St., Philadelphia, Pa.

WHITE, Everett A. (1921), Mgr. Heat. Dept., (for mail) Crane Co., 30 S. 16th St., and 3115a Nebraska Ave., St. Louis, Mo.

WHITE, Elwood S. (1921), Pres. and Treas., Thermal Appliance Co., Inc., 342 Madison Ave., New York, and 18 North Lane, Glen Cove, N. Y.

WHITELEY, James (1919), Consulting Engr., Whiteley and Sanders, 406 Marquette Bldg., and (for mail) 1166 E. Lawn Ave., Detroit, Mich.

WHITEMAN, W. R. (Associate 1921), Salesman, Ozone 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) Chamberlin Metal Weather Strip Co., 619 E. 13th Ave., and 1031 Harrison St., Denver, Col.

WHITTLESEY, Grant (1919), Power Plant Specialties, (for mail) 844 Ellicott Sq., and 458 Parkside Ave., Buffalo, N. Y.

WHY, H. Berkeley (1919), Construction Engr., (for mail) 312 Earlhams Terrace, Germantown, Philadelphia, 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.

WILBUR, Edwin R. (1921), Salesman, Morgan-Gerrish Co., 501 6th St., S., and 2902 James Ave., S., Minneapolis, Minn.

WILCOX, Oscar H. (Associate 1917), Salesman, Ideal Furnace Co., 530 Jefferson Ave., and 2545 Canton Ave., Detroit, Mich.

WILCOX, William (1916), Dist. Engr., (for mail) Whitlock Oil Pipe Co., 50 Congress St., Boston, Mass.

WILD, Walter H. (Associate 1921), Mfr. Agt., (for mail) General Boilers Co., 1525 Land Title Bldg., Philadelphia, and 122 Cynwyd Rd., Cynwyd, Pa.

WILDE, Ray S. M. (1916), Consulting Engr., (for mail) 305 Hume Bldg., Detroit, and 194 Connecticut Ave., Highland Park, Mich.

WILDER, Edward L. (1915), Elec. and Mech. Engr., Rochester Gas & Electric Corp., 34 Clinton Ave., N., 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.

WILHELM, Dean B. (1914), Oxford Acres, Clyde, Mich.

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 Plbg. Co., 332 E. State St., Ithaca, N. Y.

WILLIAMSON, Arthur H. (Associate 1915), Mgr., American Radiator Co., Broadway and Grand River Ave., Barium 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. 4th St., and (for mail) 360 E. 106th St., Cleveland, O.

WILLIS, F. H. (1921), (Pres., Colorado Chapter), Ch. Engr., Heat. and Vent. Div., Wm. N. Bowman Co., R. 914, Central Savings Bank Bldg., 1111 Jackson St., Denver, Col.

WILMOT, Charles S. (1919), Research Engr. and Works, Mgr., Monitor Bi-Loop Radiator Co., Harrisburg Ave., Lancaster, Pa., and (for mail) 203 2nd 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) 846 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.

WILSON, Eugene K. (1919), (for mail) Wilson & Co., 1017 Duke St., and 12 Lafayette Blvd., Norfolk, Va.

WILSON, Frederick A. (1910), Sales Engr., Heat. and Vent. Dept., Wm. Highton & Sons Co., and (for mail) 3 Tyler St., Nashua, N. H.

WILSON, Harry A. (1903), Moosup, Conn.

WILSON, J. J. (Charter Member), Consulting Engr., 5514 Paschall Ave., Philadelphia, Pa.

WILSON, Lewis H., Jr. (Junior 1921), Crane Co., 245 Master St., Philadelphia, Pa., and (for mail) 302 Linden St., Camden, N. J.

WINSBOROUGH, William C. (Associate 1920), Dist. Boiler Sales Repr., Abram Cox Stove Co., 1412 Syndicate Trust Bldg., St. Louis, Mo.

WINTER, Frank M. (1921), Sales Repr., Hugo Mfg. Co. of Duluth, Minn., 2231 W. Washington St., Los Angeles, and 7353 Jasmine Ave., Palms, Cal.

WINTERBOTTOM, John W. (1915), Vice-Pres. and Engr., Inland Supply Co., 4630 W. Augusta St., Chicago, Ill.

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., 5th and Sibley Sts., and 690 Randolph St., St. Paul, Minn.

WINTERER, Raymond J. (1919), Mgr., Heat. Dept., Crane & Orway Co., 5th 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.

WITKOWSKY, Fred A. (1920), Salesman, U. S. Radiator Corp., 523 Discount Bldg., and (for mail) 13712 Chautauqua Ave., N.E., Cleveland, O.

WIX, William H. (1921), Sales Engr., Hart & Crouse Co., R. 603, Hoffman Bldg., Baltimore, Md.

WOLFE, Roy (1923), Vice-Pres. and Engr., Huffman-Wolfe Co., 669 N. High St., Columbus, O.

WOLFF, Richard A. (Junior 1915; 1919), Pres., Wolff & Munier, Inc., 405 Lexington Ave., and 606 W. 115th St., New York, 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), Engr., Bowers Bros. & Co., 2015 Sansom St., and 4815 N. 12th St., Philadelphia, Pa.

WORSHAM, Herman (Junior 1918), Sales Engr., (for mail) Carrier Eng. Corp., 1144 Prudential Bldg., and 37 Manchester Pl., Buffalo, N. Y.

WORTHINGTON, Thomas (1922), Heat. Engr., Dominion Radiator Co., Toronto, and 141 Albany Ave., Toronto, Ont.

WRIGHT, Harris H. (1917), Mgr., C. A. Dunham Co., 1627 Main St., and 1214 E. Gillham St., Kansas City, Mo.

WRIGHT, K. (1921), Mgr., Johnson Service Co., 319 Gwynne Bldg., Cincinnati, O.

WYLIE, Howard M. (Junior 1917), Sales Mgr., Nash Eng. Co., S. Norwalk, Conn.

Y

YAGER, John J. (1921), Secy., Goergen-Mack-wirth Co., Inc., 817 Sycamore St., and (for mail) 272 Carlton St., Buffalo, N. Y.

YARDLEY, Ralph W. (1920), Superv. Engr., Memphis Municipal Auditorium Commission, and 865 Washington Ave., Memphis, Tenn.

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.

ZIMMER, George J. (1921), Engr., (for mail) Bryce Heat. & Vent. Co., 415 Spitzer Bldg., and 2221 Maplewood Ave., Toledo, O.

ZIRHUT, George A. (Associate 1922), Onarga Plbg. & Heat. Co., P. O. Box 33, Onarga, Ill.

ZOKELT, C. G. (1921), Ch. Draftsman, Dept. Bldg. & Grounds, Seattle School Dist. No. 1, 510 Dexter Ave., and (for mail) 2355 16th Ave., S., Seattle, Wash.

Summary of Membership

UNITED STATES

Alabama.....	3	Nebraska.....	5
California.....	11	New Hampshire.....	1
Colorado.....	23	New Jersey.....	44
Connecticut.....	19	New York.....	315
Delaware.....	3	North Carolina.....	6
District of Columbia.....	20	Ohio.....	114
Florida.....	1	Oklahoma.....	4
Georgia.....	13	Oregon.....	4
Illinois.....	206	Pennsylvania.....	285
Indiana.....	24	Rhode Island.....	7
Iowa.....	6	South Dakota.....	2
Kansas.....	8	Tennessee.....	5
Kentucky.....	1	Texas.....	10
Louisiana.....	1	Utah.....	1
Maine.....	2	Vermont.....	3
Maryland.....	17	Virginia.....	14
Massachusetts.....	69	Washington.....	23
Michigan.....	113	West Virginia.....	4
Minnesota.....	60	Wisconsin.....	19
Mississippi.....	2	Wyoming.....	1
Missouri.....	105		
Montana.....	5		1,579

FOREIGN COUNTRIES

Canada.....	45	New Zealand.....	1
China.....	6	Norway.....	1
Denmark.....	2	Sweden.....	1
England.....	23	Switzerland.....	1
France.....	2	Turkey.....	1
Germany.....	1		88
Ireland.....	1		
Japan.....	3	Total Membership.....	1,667

SUMMARY OF MEMBERSHIP BY GRADES

Honorary Members.....	2
Members.....	1,387
Associate Members.....	192
Junior Members.....	86
	1,667

LIST OF MEMBERS Arranged Geographically

UNITED STATES

ALABAMA	Libby, L. R.	FLORIDA	Chubb, J. E.
Birmingham—	Purcell, A. J.	Jacksonville—	Claffey, E. J.
Bunnell, E. W.		Furman, C. W.	Crawford, W. B.
Lichty, C. P.			Crone, C. E.
Lide, M. J.		GEORGIA	Currier, C. H.
CALIFORNIA		Atlanta—	Cutler, J. A.
Los Angeles—		Alger, R. W.	Cutter, E. H.
Hanes, J. W. E.		Baker, I. C.	Davis, F. R.
Jones, E. A.		Beggs, D. T.	Dewar, J. G.
Larimer, G. B.		Ford, J. A.	Diebold, C. M. L.
Mahaffey, R. M.		Frederick, L. M.	Doherty, J.
Winter, F. M.		Guest, P. L.	Douglass, T. C.
San Francisco—		Harbuck, J. H.	Drinkwater, E. L.
Haley, H. S.		Klein, E. W.	Dunham, C. A.
Krueger, J. I.		Manning, A. J.	Eaton, B. K.
Leland, W. E.		Pottinger, C. T.	Ellis, W. C.
San Pedro—		Rhodes, S. V.	Emmert, L. D.
Medenwald, A. L.		Schilling, C. L.	Ensign, R. M.
Santa Barbara—		Columbus—	Evans, C. E.
Blackman, A. O.		Denson, W.	Evans, R. S.
Gilson, H. J.			Ferreira, F. F.
Watts—		ILLINOIS	Finan, J. J., Sr.
Garrison, J. H.		Bellefonte—	Frank, J. M.
COLORADO		Karr, T., Jr.	Furman, J. R.
Colorado Springs—		Bloomington—	Gardner, W., Jr.
McCarthy, T.		Howell, L.	Gemeny, W. J.
Denver—		Soper, H. A.	Getschow, G. M.
Bradbury, G. L.		Champaign—	Gifford, R. L.
Cullyford, F. S.		Brownell, C. D.	Glennon, C.
Daly, J. H.		Knowles, C. H.	Good, M. C.
Deranleau, R. L.		DELAWARE	Graves, W. B.
Fielding, H. H.		Wilmington—	Grebe, H. W.
Foley, W. J.		Gawthorp, F. H.	Griffin, W. H.
Fuller, R. K.		Lownsbery, B. F.	Haines, J. J.
Larimer, W. M.		Schoenijahn, R. P.	Hamilton, H., Jr.
McClellan, J. E.		DISTRICT OF COLUMBIA	Hand, W. L.
Michael, L. A.		Washington—	Hansen, J.
Pfeiffer, J. F.		Bradbury, C. R.	Harbula, M. G.
Price, F. E.		Burnett, E. S.	Harris, H. A.
Pursell, H. E.		Cooley, M. S.	Harrison, B. S.
Reuter, A. G.		Coward, H. T.	Hart, H. M.
Steiner, J. G.		Dickinson, H. C.	Hayes, J. J.
Stoltenberg, T. R.		Febrey, E. J.	Hayward, R. B.
Voigt, C. O.		Gardner, S. F.	Heck, G. L., Jr.
Wallace, A.		Goldstein, A. M.	Heckel, E. F.
Wallace, J. F.		Miller, M. E.	Henrich, G. A.
Ward, O. G.		Mueller, E. F.	Herlihy, G. F.
Whitten, H. W.		Munro, E. A.	Herlihy, J. J.
Willis, F. H.		Munro, E. K.	Hill, Dr. E. V.
CONNECTICUT		Myers, D. R.	Hoier, W. V.
Hartford—		Russell, H. C.	Hoover, H. E.
Anderson, H. J.		Stock, E. L.	Hornung, J. C.
Lennox, F. J.		Thomas, G.	Howatt, J.
(Elmwood)		Thompson, N. S.	Hubbard, G. W.
		Towson, W. W., Jr.	Impey, P. F.
		Tripp, L. H.	Jackson, C. J.
		Weschler, G. A.	Jensen, J. S.
			Jewell, G. H.
			Johnson, C. W.
			Jolliffe, A. H.
			Jones, D. J.
			Jones, E. F.

ROLL OF MEMBERSHIP

Keeney, F. P.
Kehm, A.
Kellogg, C. V.
Kimbrough, H. C.
Kirk, G. H.
Kohlbray, E. G.
Lagodzinski, H. J.
Lamb, F. W.
Lautenschlager, F.
Leas, H. K.
Lenone, J. M.
Lewis, S. R.
Lindeman, R. F.
Linn, H. R.
Lippe, E. V.
Lippman, O. S.
Loehr, J. R.
Lohman, W. J.
Luce, G. D., Jr.
McCauley, J. H., Jr.
McConnor, C. R.
McEvoy, W. J.
McGregor, C. H.
McLeland, H. B.
Martin, A. B.
Mathis, E.
Mathis, H.
Mathis, J. W.
Matzen, H. B.
Mauer, W. J.
Mehring, G.
Menk, R. W.
Mertz, W. A.
Meyer, J. S.
Miller, F. A.
Miller, J. E.
Monaghan, T. H.
Moran, F. E.
Muir, G. A.
Muth, H.
Nacey, H. M.
Narowetz, L. L., Jr.
Neiler, S. G.
Nelson, B.
Newberg, H. O.
Newport, C. F.
Nilson, A.
Nulsen, C. A.
Pegram, W. A.
Pittsford, W. A.
Pope, S. A.
Pope, W. A.
Powers, F. W.
Richardson, A. H.
Rielley, E. P.
Rogers, C. W.
Rollins, L. M.
Rosenbach, R. G.
Ryan, H. B.
Scheidecker, D. B.
Sheriffs, W. A.
Shultz, E.
Simonsen, L. A.
Small, J. D.
Smith, G. P.
Soper, I. N.
Spielman, G. P.
Stannard, J. M.
Stark, I. S.
Stedman, C. N.
Stockenberg, R.
Storm, E. S.
Sutcliffe, A. G.
Thinn, C. A.
Thomas, H. G.
Thomas, R. H.
Toenniges, G. C.
Truitt, J. E.
Uhlhorn, W. J.
Van Inwagen, F.
Walsh, A. F.
Walters, W. T.
Whiteman, W. R.
Widdicombe, R. A.
Winterbottom, J. W.
Winterbottom, R. F.

Decatur—
Shorb, W. A.

Edwardsville—
Blackmore, F. H.

Elmhurst—
McKinnon, D.

Evanston—
Bear, O. L.

Granite City—
Bergner, W. G.

Joliet—
Henschen, L. H.

Kewanee—
Baker, E. E.
Bronson, C. E.
Dickson, R. B.

Moline—
Nelson, H. W.
Nordine, L. F.
Otis, G. E.
Tyler, F. T.

Mt. Vernon—
Miller, H. N.

Oak Park—
Alexander, A. D.
March, R. C.
May, E. A.

Olney—
French, B. P.

Onarga—
Stitt, H. B.
Zirhut, G. A.

Peoria—
Bohn, R. G.
Robb, J. M.

Urbana—
Willard, A. C.

Waukegan—
Reynolds, H. M.

Winnetka—
Ellis, E. E.

INDIANA

Hammond—
Crannell, C. A.

Indianapolis—
Ammerman, C. R.
Cones, B.
Fenstermaker, S. E.
Fleming, A. W.
Gray, W. E.
Hagedorn, C. H.
Hayes, J. G.
LaFollette, B. E.
Perham, S. H.
Repp, H. L.
Rotz, J. M.
Seltzer, A. P.
Sproull, H. E.
Voorhees, G. A.
Warren, C. N.
Weinshank, T.

LaFayette—
Bushnell, C. D.
Hoffman, J. D.
Noland, R. W.
Orth, J. W.

Michigan City—
Stockwell, W. R.

Peru—
Pyle, J. W.
Thrush, H. A.

Terre Haute—
Prox, R. E.

IOWA

Cedar Rapids—
Motejl, J. A.

Des Moines—
Wagner, J. P.

Dubuque—
Molo, H. E.

Ft. Madison—
Theisen, E. F.

LeMars—
Mathew, N. J.

Sioux City—
Orr, M. J.

KANSAS

Atchison—
Davis, C. E.

Emporia—
Burnap, C. W.
Hill, C. H.

Independence—
Sellars, F. J.

Manhattan—
Hull, B. R.

Wichita—
Odell, N.
Smith, E. C.
Threlfall, W. R.

KENTUCKY

Louisville—
Lewis, J. C.

LOUISIANA

New Orleans—
Cooper, M. A.

MAINE

Portland—
Fels, A. B.
Merrill, C. J.

MARYLAND

Baltimore—
Adams, H.
Berger, C. D.
Collier, W. I.
Dorsey, F. C.
Eisert, H.
King, C. T.
Kries, H. A.
Lelich, R. L.
McCrea, L. W.
Posey, J.
Reeder, C. L.
Rogers, G. H.
Seippel, J. H.
Tibbetts, J. C.
Vance, L. G.
Wachter, J. A.
Wix, W. H.

ROLL OF MEMBERSHIP

Pittsfield—
Robbins, L. G.

Somerville—
Swaney, C. R.

Watertown—
Bartlett, A. C.

MICHIGAN

Ann Arbor—
Backus, T. H. L.
Emswiler, J. E.
Hutzel, A. F.

Berrien Springs—
Bodtke, M.

Clyde—
Wilhelm, D. B.

Detroit—
(Cambridge)
Addy, R.
Arnold, R. S.
Ballenger, D. P.
Bolton, J. R.
Brender, P. E.
Brown, E. R.
Brown, W. G.
Calvert, N. W.
Cassell, H. H.
Chester, T.
Clark, E. H.
Clise, F. W.
Cockburn, L. S.
Coffey, J. B.
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.
Downs, E. L.
Dwyer, J. V.
Foster, W. M.
Fuller, J. L.
Giguere, G. H.
Goss, M. H.
Graeff, R. J.
Hamlin, H. A.
Harms, W. T.
Harrigan, E. M.
Harris, E. E.
Hill, N. J.
Hillman, R. W.
Hogan, E. L.
Hubbard, N. B.
Hvoslef, F. W.
Johnson, F. W.
Johnston, W. B.
Kaplan, J.
Killian, M. A.
Klaus, M.
Knight, A. B.
Linhard, H. V.
Little, C. W.
Little, E. R.
Locker, C. W.
Lovelace, J. A.
McClintock, B. W.
McColl, J. R.
McDonald, J. C.
McIntire, J. F.
McLean, D.
McNair, E. E.
McSorley, C. M.
Marty, E. O.
Meyer, J. W., Jr.
Miller, J. F. G.
Morgan, C. S.
Morgan, S. H.
Morse, C. T.

Offer, L. A.
Paetz, H. E.
Parrott, L. G.
Partlan, J. W.
Pattison, G. B.
Peckham, R. R.
Petherick, D. H.
Pittelkow, A. G.
Purcell, R. E.
Richardson, C. B.
Roney, T. G.
Rowe, W. A.
Saulson, S.
Schildmiller, G. H.
Shuell, F. W.
Skagerberg, R.
Smith, D. C.
Smith, L. L.
Snell, E.
Snyder, J. W.
Soderberg, C. H.
Spitzley, R. L.
Taylor, T. C.
Vaile, R.
Verner, W. F.
Walker, J. H.
Wallich, A. C.
Walton, H. L.
Watkins, J. A.
Whitley, J.
Wilcox, O. H.
Wilde, R. S. M.
Williamson, A. H.
Wooley, T. R.

Dowagiac—
Firestone, J. F.

Flint—
Henderson, T. J.

Grand Rapids—
Pearson, H. D.
Taplin, N. W.

Holland—
Cheryen, V. W.

Kalamazoo—
Blaney, C. A.
Kersjes, W.
Monroe, L. O.

Lansing—
Distel, F. Jr.

Saginaw—
Swartwout, J. D.

Standish—
Burr, R. J.

MINNESOTA

Duluth—
Bishop, F. R.
Foster, C.

Minneapolis—
Brown, E. H.
Brown, F. C.
Brown, J. H.
Burritt, C. G.
Connor, M.
Cowles, B. E.
Cummins, G. H.
Elliott, A. D.
Fitts, C. D.
Forfar, D. M.
Gausman, C. E.
Gaylord, F. H.
Gerrish, H. E.
Hanson, L. E.
Harris, J. B.
Hasey, C. E.
Hildebrandt, H. A.

Huch, A. J.
Hunter, A. C.
Hunter, P. F.
Jaynes, E. L.
Martens, J. V.
Meyer, H. J.
Morgan, G. C.
Olson, C. F.
Otto, R. W.
Porter, R. S.
Probst, A. H.
Ridler, H. C.
Rockart, E. R.
Rothrock, J. T.
Rowley, F. B.
Ruff, D. C., 2nd
Sanford, A. L.
Sperzel, H. J.
Tangeman, B. W.
Tweed, C. F.
Uhl, W. F.
Wilbur, E. R.
Womrath, G. F.

Owatonna—
Clarkson, W. B.

St. Paul—
Adams, Neil D.
Bredeson, C. R.
Buecker, A. H.
Challman, S. A.
Cochran, M. M.
Davis, H.
Gordon, E. B., Jr.
Heagler, J. M.
Lockhart, G. L.
McQuillan, J. A.
O'Brien, V. R.
Spriggs, W. A.
Stewart, E. J.
Wagner, A. M.
Winterer, F. C.
Winterer, R. J.

St. Cloud—
Cummings, J. J.

MISSISSIPPI

Greenwood—
Mack, J. A.

Laurel—
Coffin, R. K.

MISSOURI

Kansas City—
Adams, C. W.
Arthur, J. M., Jr.
Burton, C. A.
Caleb, D.
Campbell, E. K.
Clegg, C.
Cline, E. A.
Cook, B. F.
Dickson, G. P.
Dodds, F. F.
Downes, N. W.
Dunlap, R. L.
Ellis, J. E.
Fehlig, J. B.
Fiske, T. D.
Foley, G. E.
Gilham, W. E.
Griffin, F. A., Jr.
Hale, F. M.
Hardy, A. R.
Hauser, M.
Hayes, P. M.
Hitchcock, F. P.
Howe, W. W.
Johnson, R. B.
Kitchen, F. A.
Kitchen, J. H.

Laurie, R. J.
McIntyre, W. N.
McKeighan, E. E.
Millis, L. W.
Natklin, B.
Nottberg, H. J.
Parks, V. H.
Pease, J. G.
Pines, S.
Reed, W. D.
Russell, W. A.
Sheppard, F. A.
Stackhouse, R. M.
Stephenson, L. A.
Waddington, E. C.
Walsh, J. G.
Wise, F. W.
Wright, H. H.

Liberty—
Dudfield, A.

Sedalia—
Sellers, R. F.
Suter, G.

St. Joseph—
Rock, A. C.

St. Louis—
Baetz, H.
Berg, A. H.
Bowers, J. S.
Bradley, E. P.
Bradley, J. T.
Breitenbach, W.
Buder, C. G.
Cook, C. D.
Cooper, J. W.
DeNeille, J. V.
Edwards, D. F.
Eichler, A.
Falvey, J. D.
Ferris, T. J.
Forgan, D. M.
Foster, J. M.
Gale, T. J.
Gallagher, J. E.
Griffin, J. J.
Hall, A. L.
Hallett, E. S.
Halley, W. H.
Hammer, H. M.
Haynes, W. J.
Heister, 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.
McMorran, F. J.
Meagher, J. F.
Milligan, R. M.
Milward, R. K.
Moon, L. W.
Moorman, T. A.
Moritz, C. J.
Mueller, B. H.
Nader, J. H.
Niestrath, W. H.
Quentin, E. H.
Riley, A. H.
Rosebrough, R. M.
Rossman, V. D.
Sachleben, E. H.
Schulze, B. H.
Sodemann, W. C.
Thomsen, W. T.
Vogel, A. H.
Walmsley, C.
White, E. A.
Winsborough, W. C.

ROLL OF MEMBERSHIP

MONTANA

Bozeman—
Powers, F. I.
Billings—
Cohagen, C. C.
Tooker, C. C.
Helena—
Bain, J. G.
Haire, C. S.

NEBRASKA

Lincoln—
Koenig, A. C.
Omaha—
Finan, J. J.
McCulley, D. E.
Shea, M. B.
Waddington, B. C.

NEW HAMPSHIRE

Nashua—
Wilson, F. A.

NEW JERSEY

Atlantic City—
Nesbitt, A. J.
Strouse, S. B.
Bridgeport—
Custer, A. E.
Camden—
Binder, C. G.
Deckman, E. M.
(Woodylyne)
Eveleth, C. F.
Kappel, G. W. A.
Lind, C. C.
Strandwitz, W. J.
Webster, E. K.
Webster, W.
East Orange—
Turno, W. G. W.
Elizabeth—
Cornwall, G. T.
Hoboken—
Strader, B. K.
Jersey City—
Calahan, J. J.
Gill, M. J.
Jones, H. L.
Tallman, D. S.
Jobstown—
Allinson, O. H.
Montclair—
Chapman, F. T.
Newark—
Beatty, D. J.
Bolling, J. E.
Carrier, W. H.
Crone, T. E.
Geiser, H.
Janet, H. L.
Jones, R. L.
Joyce, H. B.
Lewis, L. L.
Lyle, J. I.
Pearce, C. E.
Smith, M. S.
Soule, L. C.
Stacey, A. E., Jr.

North Bergen—
DeVore, M. J.
Passaic—
Morris, C. R.
Paterston—
Pryor, F. L.
Plainfield—
Tobin, G. J.
Trenton—
Black, J.
Black, J. A.
McDougall, B. W.
Piper, A.
Piper, E. R. W.
Russell, W. E.

NEW YORK

Albany—
Clifton, W. A.
Hynes, L. P.
Murray, T. E.
Ryan, H. J.
Taggart, R. C.
Amsterdam—
Dwyer, F. A.
Brooklyn—
Baldwin, W. J.
Bampton, C. M.
Crutchley, E., Jr.
Dwyer, T. F.
Ferris, D. M.
Kiewitz, C.
Gornton, M. H.
McCann, F. G.
Mandeville, E. W.
Moss, E.
Norton, T.
Phillips, F. W., Jr.
Richardson, F. J.
Robertson, G. A.
Scollay, U. G.
Snyder, C. B. J.
Thuen, A.
Tisnow, W.
Weibert, C. J.
Williamson, F. W.
Buffalo—
Ahlf, A. A.
Booth, C. A.
Bresnahan, J. J.
Carroll, J. N.
Case, E. W.
Cherry, L. A.
Crique, A. A.
Danforth, N. L.
Dempsey, H. P.
Dillman, E. J.
Dix, H. N., Jr.
Drake, G. H.
Dyer, O. K.
Eddy, E. J.
Eggleston, L. W.
Evans, C. A.
Farnham, R.
Farrar, C. W.
Frank, G. W.
Frank, O. E.
Fraser, W. G.
Gibbs, H. E.
Harding, L. A.
Howell, F. B.
Hutzel, H. F.
Jackson, M. S.
Johnson, J. A.
Kamman, A. R.
Landon, A. A.
Laperle, L. G.
Love, C. H.

Lynd, R. E.
Monin, E. H.
Moorman, W. G.
Moosher, 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.
Whittlesay, G.
Worsham, H.
Yager, J. J.

Dunkirk

Sawade, C. A.

Eastwood

Longwell, H. E.

Elmira

Davenport, E.
Davis, B. C.
Frutchey, A. E.
McGlenn, G. R.

Geneva

Herendeen, F. W.

Hempstead

Hinkle, E. C.

Herkimer

Ertman, B. R.

Irrington-on-Hudson

Angell, W. T.
Bastedo, A. E.

Ithaca

Sawdon, W. M.
Williams, J. W.

Morton

Stangland, B. F.

New York City

Adams, H.
Adler, A. A.
Alling, H. W.
Almirall, J. A.
Anderson, F. P., Jr.
Angus, R. A.
Armagnac, A. S.
Ashley, E. E., Jr.
Atkinson, H. G.
Bachler, L. J.
Bailman, E. J.
Barrett, L. L.
Barwick, T.
Baum, A. L.
Beebe, F. E. W.
Bennitt, G. E.
Bentz, H.
Berman, L. K.
Binder, H.
Birch, G. R.
Bishop, C. R.
Blackmore, J. J.
Bolton, R. P.
Booth, H. N.
Brassington, A. F.
Brennan, T. P.
Broderick, J. F.
Browne, J. A.
Buensod, A. C.
Butler, P. D.
Cadmus, R.
Callahan, M. J.

Carpenter, R. H.
Cary, A. A.
Chase, J. M.
Chew, F. K.
Child, E. T.
Clark, W. D.
Cosgrove, W. M.
Cullen, H. J.
Darts, J. A.
Meyer, H. C., Jr.
Miller, C. A.
Miller, R. B.
Molby, E. C.
Morton, J.
Munier, L. L.
Musselman, J. F.
Nichols, G. B.
Norton, F. W.
Oaks, O. O.
Obert, C. W.
O'Donnell, T. J.
Offner, A. J.
Ohmes, A. K.
Olvan, W. J.
Oswald, W. L.
Palmer, Dr. G. T.
Parkhill, D.
Parter, S. C.
Peabody, E. H.
Peacock, J. K.
Peterson, G.
Pieron, A.
Pinder, P. H.
Pratt, E. D.
Pryor, R. W., Jr.
Quirk, C. H.
Raisler, S.
Reeder, F. C.
Reynolds, T. W.
Riblet, W. H.
Richardson, D. R.
Riley, C. L.
Ritchie, E. J.
Ritchie, W.
Ritter, A.
Roodman, R. W.
Ross, J. O.
Rudio, H. M.
Ruppel, R. L.
Russell, W. A.
Schloss, N. L.
Schluter, H.
Schmidt, G. G.
Schroth, A. H.
Scott, C. E.
Scott, E. A.
Scott, G. M.
Sellman, N. T.
Seward, P. H.
Siegel, J. F.
Soling, W.
Spoonner, H. R.
Stern, H. R.
Still, F. R.
Sweeney, S. H.
Tazelaar, P.
Teran, C.
Timmis, P.
Timmis, W. S.
Titzell, J. E.
Treat, E. J.
Tree, R. T.
Tusch, W.
Upton, G. P.
Walterthum, J. J.
Watters, P. J.
(Staten Island)

Devereux, L. W.
Dill, H. O.
Donnelly, J. A.
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.
Ehrlich, M. W.
Ellison, J. H.
Emerson, R. R.
Engle, A. C.
Evans, W. A.
Feldman, A. M.
Fleisher, W. L.
Fletcher, S. W.
Fogg, O. H.
Fogge, F. A.
Friedman, A.
(Corona)

Foulhoux, J. A.
Fuller, C. A.
Gaylor, W. S.
Goldschmidt, O. E.
Gombers, H. B.
Goodnow, W. F.
Greason, S. L.
Grill, G. E.
Grotz, A. B.
Haight, T.
Hankin, R.
Hanson, H. A.
Harris, G. D.
Hartford, C.
Haynes, C. V.
Heatherton, J. M.
Heebner, W. M.
Heibel, W. E.
Hoffman, G. D.
Hook, M. G.
Hunt, R. B.
Hunter, C. C.
Hyman, W. M.
Innis, H. R.
Ireland, T. H.
Issertell, H. G.
Jacobus, Dr. D. S.
Jalieu, J. J.
Janas, A.
Johnson, E. B.
Kahn, H. P.
Keasbey, A. P.
Kahn, H. P.
Keenan, P. F.
Kelly, J. G.
Keyes, R. E.
Kiewitz, A. A.
Kimball, D. D.
Klaus, L. J.
(L. I. City)
Knowles, A. F.
Koehler, G. T.
Koithan, W. S.
Lawrence, C. E.
LeCompte, W. G.
Lipkeman, H.
Lissauer, A. F.
Loughlin, F. J.
McKiever, W. H.
McMillan, L. B.

ROLL OF MEMBERSHIP

Macon, W. W.
Maier, G. M.
Mallory, H. C.
Marshall, H. H.
Martin, G. W.
Martin, J. H.
Medway, F. J.
Merritt, J. H.
Meyer, H. C., Jr.
Miller, C. A.
Miller, R. B.
Molby, E. C.
Morton, J.
Munier, L. L.
Musselman, J. F.
Nichols, G. B.
Norton, F. W.
Oaks, O. O.
Obert, C. W.
O'Donnell, T. J.
Offner, A. J.
Ohmes, A. K.
Olvan, W. J.
Oswald, W. L.
Palmer, Dr. G. T.
Parkhill, D.
Parter, S. C.
Peabody, E. H.
Peacock, J. K.
Peterson, G.
Pieron, A.
Pinder, P. H.
Pratt, E. D.
Pryor, R. W., Jr.
Quirk, C. H.
Raisler, S.
Reeder, F. C.
Reynolds, T. W.
Riblet, W. H.
Richardson, D. R.
Riley, C. L.
Ritchie, E. J.
Ritchie, W.
Ritter, A.
Roodman, R. W.
Ross, J. O.
Rudio, H. M.
Ruppel, R. L.
Russell, W. A.
Schloss, N. L.
Schluter, H.
Schmidt, G. G.
Schroth, A. H.
Scott, C. E.
Scott, E. A.
Scott, G. M.
Sellman, N. T.
Seward, P. H.
Siegel, J. F.
Soling, W.
Spoonner, H. R.
Stern, H. R.
Still, F. R.
Sweeney, S. H.
Tazelaar, P.
Teran, C.
Timmis, P.
Timmis, W. S.
Titzell, J. E.
Treat, E. J.
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