

CHAPTER I.

FURNACES.

A furnace consists essentially of a stove within a casing. Air is admitted to the space between the two, where it becomes heated, rises, and flows through the pipes to the various rooms.

The earlier forms of furnaces were practically ordinary heating stoves incased in brick work. Such furnaces were very deficient in heating surface, and consequently were wasteful in the consumption of fuel. Various methods were adopted to increase their heating surface and efficiency. Radiators were added through which the gases would pass and lose a considerable portion of their heat before reaching the smoke pipe. Projections or extended surface in the form of pins or ribs were cast on the fire pot, or the pot, in some cases, was made corrugated. In other furnaces flues were added, through which the fresh air supply would pass, surrounded by hot gases.

Small air flues, pins and ribs retard the flow of air over the heating surface, hence are not so effective as, at first thought, they appear.

AREA OF AIR PASSAGES.

Furnaces with sufficient heating surface properly arranged and having the area of the air passages not greatly in excess of the combined area of the warm air pipes will deliver air at a nearly uniform temperature, even during strong winds.

When the passages are too large the wind will force an excessive amount of air through the furnace, much of which will fail to come in contact with the heating surface, with the result that the air issuing from the registers will vary greatly in velocity and temperature.

The examination of a number of well proportioned furnaces showed the average area for the passage of air to be about 180 square inches per square foot of grate surface, equal to about $1\frac{1}{4}$ square inches of free air-way to each square inch of grate surface.

JOINTS.

A furnace should have as few joints as possible, consistent with proper provision for expansion and contraction. These forces are practically irresistible, and if proper allowance for their action is not made, something must give way, causing, as a rule, the leakage of gas. Where the sections join, a deep cup joint packed with kaolin, asbestos cement or other suitable material should be used, permitting a reasonable amount of "play" without the escape of gas.

MATERIALS EMPLOYED.

The materials chiefly used in the construction of furnaces are cast iron and wrought iron or steel plate. Much has been stated (especially by the makers of steel plate furnaces) as to the ease with which gases pass through cast iron at high temperatures. The experiments most quoted, however, were made on thin plates and under conditions dissimilar to those existing in a furnace. The best authorities on heating and ventilation agree that the danger of contamination from this source is very slight, and is not to be compared with that from ill fitting joints and other leaks due to bad workmanship, or to causes having nothing whatever to do with the kind of materials used.

CAST IRON VS. STEEL PLATE.

Cast iron furnaces may be built in almost any desired form and arranged to present large radiating surfaces with few joints.

The variety of design with wrought iron or steel plate is much more limited. The superior weight of cast iron furnaces over those of other materials renders them less susceptible to sudden variations in temperature, with changes in the condition of the fire. When once heated, the castings take longer to cool than thin steel plate; consequently the temperature of the air passing through the furnace is maintained more nearly constant. In point of durability cast iron is thicker and less subject to corrosion than wrought iron or steel plate. It is, therefore, more suitable for use in damp places.

Steel plate furnaces transmit heat readily, and with thoroughly riveted seams and well packed joints afford little opportunity for gas leakage.

The domes of such furnaces are generally built in one piece. They are so bulky in the larger sizes that it is often impossible to get them through narrow doorways.

DIRECT AND INDIRECT DRAFT.

Furnaces may be divided into two general types, known as direct draft and indirect draft (see Figs. 1, 2 and 3). The better class of direct draft furnaces have a radiator, generally placed

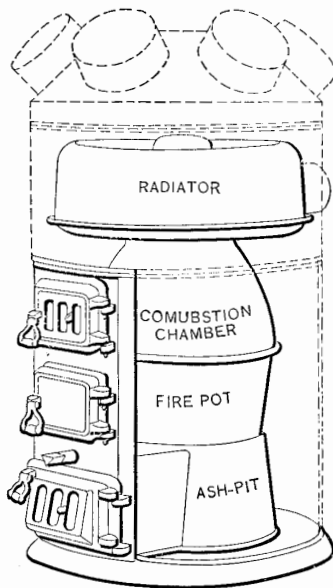


Fig. 1.—Cast Iron Direct Draft Furnace.

at the top, through which the gases pass before reaching the smoke pipe. They have but one damper, generally combined with a cold air check. Many of the cheaper direct draft furnaces have no radiator whatever, in the true sense of the term; the gases passing directly to the smoke pipe, carrying with them much heat that should be utilized. Such furnaces are very wasteful, but find a market among certain builders, whose chief requirement is that a furnace shall have a large casing to deceive prospective purchasers as to its actual capacity.

In the ordinary indirect draft type of furnaces (see Fig. 3), the gases pass downward through flues to a radiator located near the base, thence upward through another flue to the smoke pipe. In addition to the damper in the smoke pipe, a direct draft damper is required, to give a direct connection with the funnel when coal is put on, to prevent the escape of gas. When the chimney draft is weak, trouble from gas is more likely to be experienced with furnaces of this type than with those having direct draft.

GRATES.

No part of a furnace is more important to the user than the grate. That much study has been put into their design is shown by the many styles that have been put on the market.

The plain grate, oscillating about a center pin was for a long time the one most commonly used. Such grates were usually provided with a clinker door through which a poker could be introduced to remove any refuse too large to pass between the grate bars.

Grates of the draw center and dump center type followed. In all these the removal of ashes takes place principally around the circumference, decreasing toward the center, where the motion ceases. The action of such grates tends to leave a cone of ashes in the center of the fire, causing it to burn more freely around the edges. Vigorous shaking often results in depositing a considerable quantity of unconsumed coal in the ash pit before the ashes near the center of the grate can be dislodged. Different forms of rocking grates have been used, which, though easy to shake, have not proved effective in breaking up clinkers, and have been liable to clog and restrict the passage of air through the fire. A radical departure from all forms of oscillating grates is the revolving triangular pattern now used in many of the leading furnaces. It consists of a series of triangular bars, having teeth. The bars are connected by gears and are turned by means of a detachable lever. If properly used this grate will cut a slice of ashes and clinkers from under the entire fire, with little, if any, loss of unconsumed coal. Its action tends to break up the mass of fuel, permitting the air to pass freely through the fire and causing it to respond quickly. An oscillating grate tends to pack the fuel more closely.

THE FIRE POT.

Fire pots are generally made of cast iron or of steel plate lined with fire brick. The depth varies considerably, ranging from about 12 to 18 inches. In cast iron furnaces of the better class the fire pot is made very heavy to insure durability and to render it less likely to become red hot. Many furnaces have the fire pot made in two sections, the makers claiming less liability of crack-

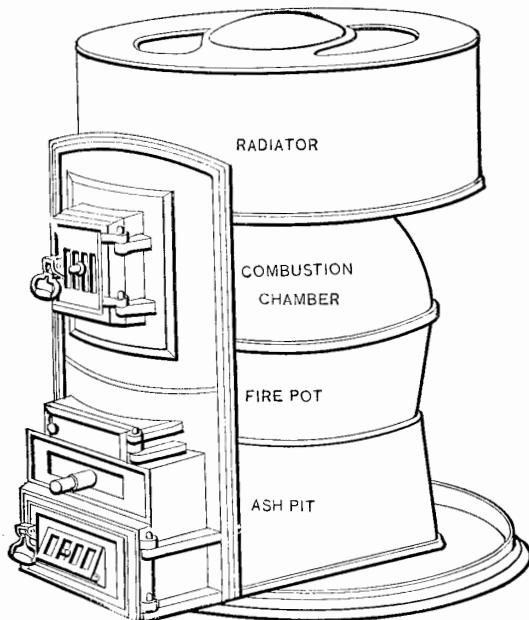


Fig. 2.—Direct Draft Furnace (Less Casing) with Steel Radiator.

ing, and in case of repairs less expense, than with a pot made in one piece. On the other hand, the latter presents fewer joints, and in point of durability often lasts, with good management, more than 20 years.

The heating surface of cast iron fire pots is often increased, as previously stated, by corrugations, pins or ribs. Clinkers never adhere to cast iron. To facilitate molding, a slight taper is necessary in all cast iron fire pots. An excessive taper is unnecessary and misleading. In comparing the size of furnaces the aver-

age diameter of the fire pot should be used as a basis, in order to allow for the difference in taper that may exist.

A fire brick lining is essential in a wrought iron or steel plate furnace to protect the thin shell from the intense heat of the fire. It is claimed for such fire pots that more perfect combustion is obtained than in a cast iron pot, that the fire requires less attention and that the air passing through the furnace is not likely to become overheated. Brick lined pots are generally of the same diameter throughout, no taper being necessary.

BRICK LINED VS. CAST IRON FIRE POTS.

Since brick lined fire pots are much less effective than cast iron in heat transmitting power, such furnaces depend to a great extent for their efficiency on the heating surface in the dome and the radiator. This is much greater as a rule than in cast iron furnaces.

When coal is put on, the direct draft damper is opened, which cuts out all the heating surface in the drop flues and radiator; the radiant heat from the top of the fire is checked by the layer of fresh coal, and as the heat from the fire pot must pass through about 2 inches of fire brick, it is obvious that until the gas has burned off and the direct draft damper can be closed, comparatively little heat is given off by the furnace, with the result that the temperature at the registers will fall. Under similar conditions, with a direct draft furnace having a cast iron fire pot, the heat of the fire will be readily transmitted through the sides of the pot while the fresh coal is becoming ignited. No part of the heating surface being cut off during this period, a more even temperature at the registers will be maintained.

The overheating of the air may be avoided in any furnace by selecting one so large that it will never be necessary to force it to the extent that the surfaces become red hot. A fire hot enough to heat a heavy cast iron fire pot to redness would be likely to have the same effect on the thin dome of a wrought iron furnace.

COMBUSTION CHAMBER.

The body of the furnace above the fire pot, commonly called the dome or feed section, provides a combustion chamber, which should be of sufficient capacity to permit the gases to become thoroughly mixed with the air passing up through the fire or

entering through openings provided for the purpose in or around the feed door. In most furnaces this space is somewhat larger than the capacity of the fire pot. In many of the cheaper ones,

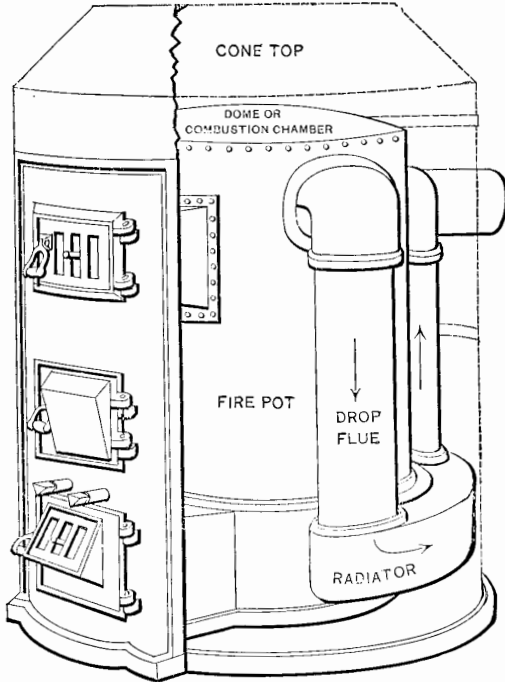


Fig. 3.--Steel Plate, Brick Lined, Indirect Draft Furnace.

however, it is very much restricted, resulting in incomplete combustion of the gases and waste of heat.

RADIATOR.

The radiator, so-called, with which all furnaces of the better class are provided, affords a sort of reservoir in which the gases are retained in contact with the air passing through the furnace until they have parted with a considerable portion of their heat.

Radiators are built of cast iron, of steel plate or of a combination of the two. The former is more durable, and can be made with fewer joints, but owing to difficulties in casting radiators of considerable height, steel plate is commonly used for the sides,

which may be made any desired height, and cast iron for the top and bottom. The effectiveness of a radiator depends on its form, its heating surface and the difference between the temperature of the gases and the surrounding air. Its form should be such that a thorough contact with the air passing through the furnace will be secured. Owing to the accumulation of soot, the bottom surface becomes practically worthless for heating after the furnace has been in use a short time, hence surfaces to be continuously effective must be self cleaning.

As to the location of the radiator, if placed near the bottom of the furnace the gases are surrounded by air at the lowest temperature, which renders the radiator, foot for foot, more effective than if placed near the top and surrounded by warmer air. The cold air surrounding a radiator near the base of a furnace is likely to cause condensation of the gases, the acids resulting therefrom eating into the iron.

EVAPORATING PAN.

The evaporating pan, with which nearly all furnaces are provided, is often placed where it will be of little service, so low down in some cases that the water actually freezes in cold weather. It is usually placed, however, above the level of the grate, where there is sufficient heat to cause a rapid evaporation. Care should be taken to keep the evaporating pan clean or the action of the heat on the sediment in the bottom, in case the pan becomes dry, is likely to cause a nauseating odor to pervade the house. To insure a supply of water in the pan at all times a plumber's tank and ball cock, properly connected, may be used with convenience.

DUST FLUE AND SIFTING GRATE.

The dust flue connected with the ash pit of many furnaces is often so small as to be practically useless. It is often neglected, and if carelessly left open acts as a check draft. In furnaces having a grate which thoroughly breaks up the fire, affording a passage for the dust to reach the chimney, such a flue is of little use.

Ash sifting devices are contained in some furnaces, but with a suitable grate the amount of unconsumed coal passing to the ash pit is so small that it is hardly worth while to put the ashes through a sifter.

FURNACES FOR OTHER FUELS.

Thus far we have discussed only furnaces for burning hard coal. In certain districts, however, this fuel is so expensive, as compared with soft coal, natural gas or wood, that furnaces de-

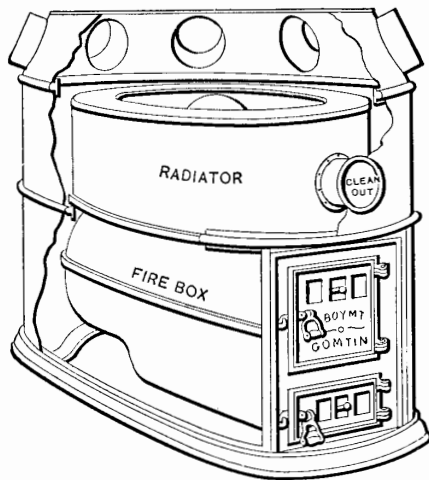


Fig. 4.—Portable Wood Furnace with Steel Radiator.

signed to burn such fuels are in demand. Furnaces for burning soft coal are designed to admit a quantity of heated air above the fire to combine with the gases, to diminish the waste of heat and the escape of free carbon, as soot, in the smoke. With all the precautions that may be taken the deposit of soot is much greater than with hard coal, necessitating more frequent cleaning of the furnace and smoke pipe. On account of the large volume of smoke the pipe is made 1 or 2 inches greater in diameter than for hard coal furnaces of the same size. A cold air check should not be used, as it increases the deposit of soot by cooling the smoke.

In the natural gas districts furnaces are commonly arranged to burn this most convenient of fuels. Such furnaces should have a grate for burning coal, in case the supply of gas should, from any cause, be cut off.

Wood furnaces, Fig. 4, are generally very simple in construction, little attention being paid, as a rule, to their efficiency, since

the cost of fuel where they are used is generally very low. The smoke should be made to pass through a radiator as in ordinary hard coal furnaces. The larger sizes are built to take ordinary cord wood sticks 4 feet long. Smaller furnaces may be had for burning sticks 2 to 3 feet in length. The smoke pipe must be made larger than for hard coal furnaces of the same heating capacity.

Coke may be burned in ordinary hard coal furnaces, but this fuel is very bulky for a given weight as compared with coal, and must be fed more frequently to keep the fire in good condition.

HEATING SURFACE.

Taking up again the discussion of hard coal furnaces we come to the question of heating surface. Many furnaces having ample grate area for the work intended, fall short from lack of heating surface. In cold weather such furnaces have to be forced, causing red hot surfaces, intensely heated air and lessened efficiency. Surfaces unlike in character and location vary greatly in heating power, therefore the kind, form and location of the heating surface, as well as its area, must be considered in comparing furnaces. It is by no means certain that of several furnaces having the same grate area the one having the greatest heating surface will be the most economical heater. In some furnaces having an unusually large amount of surface it will be found on inspection that a considerable portion would soon become almost useless from the accumulation of soot. In others a large portion of the surface is lined with fire brick, or is so situated that the air currents are not likely to strike it.

Heating surfaces may be classified as follows:

1. Fire pot surface, lined or unlined.
2. Surfaces acted upon by the direct rays of heat from the fire, such as the dome or combustion chamber.
3. Gas or smoke heated surfaces, such as flues or radiators.
4. Extended surfaces, such as pins or ribs.

Their relative value is an interesting question, on which available data are lacking.

The total heating surface, as compared with that of the grate, based on actual measurements of a number of furnaces of different makes sold in New England, is shown in Table I.

Table 1—The Area of Heating Surface and the Ratio of Heating to Grate Surface in Furnaces of Common Types.

	CAST IRON FURNACES.												WROUGHT IRON FURNACES.					
	No radiator.												Drop flues and radiator at the bottom.					
	Dome top.												Cast					
	Radiator at top.												Iron					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	
Average diameter of fire pot.....	15¾	18	16½	17	19	20¼	20¾	23	26¾	30	30	30	20	22	22	24	27	
Average area of fire pot = sq. ft. grate surface..	1.25	1.76	1.48	1.58	1.96	2.29	2.29	3.4	3.82	4.9	4.9	5.5	2.18	2.64	2.64	3.13	4	
Total heating surface in square feet.....	23	14	6	21.5	32.6	35.1	30.2	44.4	53.2	46.3	51.2	68.5	71.5	54	57	52.4	61	
Heating surface per square foot grate surface..	17	8.3	14.5	20.6	18	13.2	19.4	15.7	12.1	10.4	14	13	24.8	21.6	19.9	19.5	17.4	
Heating surface in radiator, square feet.....	None	None	None	12	18.3	19.5	17.2	24.6	28.8	29.6	30.8	37.5	53.5	33.8	34.8	36.6	36.7	
Brick lined heating surface, square feet.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	11.2	11.8	11.8	12.5

A furnace of peculiar construction of the vertical flue type that cannot be classified under any of the headings in the above table measured as follows: Fire pot 21 inches, total heating surface 111 square feet, heating surface per square foot grate surface 46.2. It will be noticed that these surfaces are much greater than any given in the table, due principally to the large amount of extended surface included. Much of the latter is of doubtful efficiency.

Various writers on heating recommend furnace proportions ranging from about 50 to 70 square feet of heating surface per square foot of grate. These proportions are much in excess of those found in ordinary house heating furnaces, as shown in Table I. Assuming a maximum rate of combustion of 5 pounds of coal per square foot of grate surface per hour the above proportions give 10 to 14 square feet of heating surface per pound of coal burned per hour.

Common furnace proportions would give about 10 square feet of heating surface per pound of coal burned per hour at the average rate throughout the heating season. By using larger furnaces than customary to heat a given space the same ratio may be obtained during cold winter weather, since by increasing the size of the furnace the rate of combustion is diminished and the heating surface per pound of coal burned increased.

In any line of furnaces of the same make and style it will be found that the heating surface per square foot of grate is less in the large sizes than in the smaller ones. For example, take two furnaces, one with a 20-inch fire pot and the other with a 30-inch pot, both 1 foot deep.

The 20-inch pot contains 2.4 square feet of heating surface per square foot of grate surface.

The 30-inch pot contains 1.6 square feet of heating surface per square foot of grate surface.

An advantage in the ratio of 3 to 2 in favor of the smaller fire pot. About the same ratio will hold for the total heating surface in the furnaces.

The great advantage in point of heating surface in small furnaces, as compared with larger ones, explains their greater proportional heating capacity.

SECONDARY HEATING SURFACE.

In addition to the heating surface stated in Table I, the inner casing of black iron forms a valuable secondary heating surface, absorbing the heat radiated from the body of the furnace and imparting it again by convection to the air passing over it. This secondary heating surface is very important, since air is heated only by convection—*i. e.*, by bringing it in contact with a heated

surface. Unless the radiant heat is absorbed by some surface, which in turn imparts it to the air, much of the heat radiated from the body of the furnace will be wasted in overheating the cellar.

RADIATION AND CONVECTION.

With highly heated surfaces the loss of heat by radiation is greatly in excess of that by convection.

Sir Wm. Thomson is credited with the statement that a stove heated to 1200 odd degrees gives off 92 per cent. of its heat by radiation and 8 per cent. by convection.

The formulas of Dulong show that with heated body at temperature of 780 degrees and surrounding air and objects 60 degrees, loss of heat by radiation, as compared with that by convection, will be as 7.17 is to 2.23, and with temperature of 960 degrees and surrounding air and objects 60 degrees, loss of heat by radiation, as compared with that by convection, will be as 12.68 is to 2.348. The higher the temperature of the heated surface the greater will be the loss of heat by radiation over that by convection.

HEATING SURFACES OF FURNACES AND BOILERS.

It may be of interest to compare the proportions given in Table I with those in hot water heaters and steam boilers. In such apparatus designed for house heating the amount of heating surface per square foot of grate generally ranges from about 15 to 1 in the smaller sizes to 25 to 1 in the larger ones.

In horizontal tubular boilers of approved design the ratio of heating surface to grate surface varies from about 33 to 1 to 40 to 1. It should be remembered that the rate of combustion in the latter is generally two to three times as rapid as in heaters used for warming dwellings.

EFFICIENCY.

One of the first items to be determined in estimating the heating capacity of a furnace is its efficiency, or the percentage of the heat in the coal that may be utilized. The efficiency depends chiefly on the area of the heating surface as compared with the grate, on its character and arrangement and on the rate of combustion. The proportions commonly found in furnaces of differ-

ent types are shown in Table I. The rate of combustion required to maintain a temperature of 70 degrees in the house varies, of course, with the outside temperature. Taken for the entire season the rate is generally less than 2 pounds of coal per square foot of grate per hour. In severe weather, however, a rate of 4 to 5 pounds per hour must be maintained. In tapered fire pots the grate surface should be considered equivalent to the average area of the pot.

It is apparent that the efficiency of a furnace decreases with an increase in the rate of combustion to the point of forcing since the more rapid the rate the less will be the amount of heating surface per pound of coal burned, and the hotter will be the gases passing to the chimney. On the other hand, a very slow fire is wasteful, due to incomplete combustion resulting from insufficient air supply. In the absence of definite available data based on tests, it is necessary in making calculations of the heating capacity to assume an efficiency that may reasonably be expected in practice. Carpenter says: "One pound of good anthracite coal will give off about 13,000 heat units*. Of this amount a good furnace should utilize 70 per cent. It is quite probable that the efficiency of combustion in an ordinary furnace is much less, often as low as 50 per cent."

The writer has assumed in the following calculations that 8000 heat units may be utilized per pound of coal burned at a maximum rate of 5 pounds per square foot of grate per hour. This allowance corresponds to an efficiency of about 60 per cent. In steam boiler practice an allowance of 9000 heat units per pound of coal is not uncommon.

HEATING CAPACITY.

The heating capacity of a furnace is generally stated in terms of the cubic space it is capable of warming. This measure is used from custom, but since its relation to the exposure varies with the size and shape of the building, it is more accurate to base the capacity directly on the exposed wall surface.

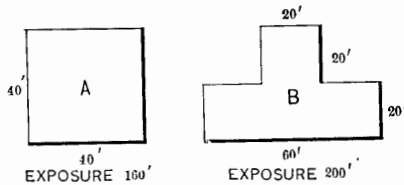
The variation in the relation between the exposure and the cubic space may be readily shown. For example, suppose we

* A heat unit may be defined with sufficient accuracy for the purposes of this work as the amount of heat required to raise the temperature of 1 pound of water 1 degree F.

have a house of plan shown in diagram A and another of the same cubic contents shown in B:

The relative exposure of A to B is as 160 to 200 = 4:5. That is, while the cubic contents is the same in each the exposure of B is 25 per cent. greater than that of A. The fact that the exposure is used by many of the best engineers in calculating the proportions of steam and hot water heating apparatus should be a sufficient guarantee of its fitness. To determine the size of the furnace required for a given exposure the latter should first be reduced to equivalent glass surface (E. G. S.). To do this we must know the heat transmitting power of walls of different kinds and thickness, as compared with that of glass.

It is convenient and sufficiently accurate for ordinary calculations to consider 1 square foot of glass equivalent to 4 square feet of wood and plaster, or brick walls. Hence to reduce the area of the solid walls to E. G. S. divide by 4. Add to this the glass sur-



face in windows and one-half the area of outside doors. The sum is the total E. G. S. of the outside exposure. Since 1 square foot of glass will transmit about 85 heat units per hour when the difference between the inside and outside temperature is 70 degrees (A. R. Wolff), to ascertain the total loss of heat by transmission multiply the E. G. S. by 85. To this must be added the loss of heat by leakage or ventilation.

If the air enters through the register at 140 degrees, which may be considered a good temperature under zero conditions, it is plain that one-half the heat supplied is carried away by the air escaping at 70 degrees, the other half (neglecting floors and ceilings) being lost through walls and windows. Therefore, twice the amount of heat lost by transmission must be supplied by the furnace.

Assuming that 8000 heat units are utilized per pound of coal burned in a well proportioned house heating furnace, with a

maximum coal consumption of 5 pounds per square foot of grate surface per hour (grate surface being considered equivalent to average fire pot area in case of tapering pots), we have $8000 \times 5 = 40,000$ heat units per hour per square foot of grate surface transmitted to the air passing through the furnace. Dividing the total loss of heat per hour (E. G. S. $\times 85 \times 2$) by 40,000 gives the required grate surface in square feet, from which the diameter of the fire pot in inches may be readily determined. Expressed as an equation this becomes

$$\frac{\text{E. G. S.} \times 85 \times 2}{40,000} = \text{grate surface in square feet } (a).$$

Now, reversing this process and assuming different grate areas, we may compute a table showing the heating capacity of furnaces expressed in the area of exposed wall to which they are adapted. The glass surface, as compared with the total exposure, may vary considerably in different houses, but from the inspection of a number of plans the writer has adopted, as a fair average for those with windows of generous size, a glass surface equivalent to one-sixth the total exposure of glass and walls combined. Outside doors are reckoned as equivalent to one-half their area in glass.

With a glass surface equal to one-sixth the total exposure, and with solid walls equal to one-fourth their area in glass in their power for transmitting heat, we have

$$\text{E. G. S. of house} = \left\{ \frac{1}{6} + \left(\frac{1}{4} \times \frac{5}{6} \right) \right\} \text{ exposure.}$$

$$= 0.375 \text{ exposure of glass and wall combined.}$$

Substituting in equation (a) this value of E. G. S. we have $\frac{0.375 \text{ exposure} \times 85 \times 2}{40,000} = \text{grate surface in square feet.}$ Or

transposing: Total exposure = grate surface in square feet $\times \frac{40,000}{0.375 \times 85 \times 2} = \text{G. S.} \times 627.4$, from which equation

Table II is derived.

Table II.*—The Capacity of Furnaces Expressed in Terms of the Exposed Wall Surface to Which They Are Adapted, to Maintain an Inside Temperature of 70 Degrees with an Outside Temperature of 0 Degrees. Temperature of Entering Air, 140 Degrees Rate of Combustion, 5 Pounds Coal per Square Foot of Grate Surface per Hour.

Average diameter of fire pot in inches.	Corresponding area in square feet.	Total exposure in square feet to which furnace is adapted.
18	1.77	1,110
20	2.18	1,370
22	2.64	1,655
24	3.14	1,970
26	3.69	2,310
28	4.27	2,680
30	4.91	3,080
32	5.58	3,500

In unusually exposed locations add from 5 to 10 per cent., according to the conditions, to the actual exposure of the house and select a furnace with a rating corresponding most nearly to the corrected exposure.

*In this table no allowance has been made for the higher efficiency of the smaller sizes, due to their greater ratio of heating surface to grate surface. It has been assumed that this advantage is to a great extent offset by the more rapid combustion common in large furnaces and by the better care they generally receive.

Note in connection with Table II, in calculating the gross exposure, to measure the entire distance around the house; multiply this by the combined clear heights of the several floors to be heated. The product will be the total exposure in square feet. The kitchen walls are included, simply to serve as a rough allowance for the loss of heat through floors and ceilings, which if estimated separately would make the calculation less simple. Where but a single room on a floor is to be heated, as for example an attic chamber, add its exposed wall surface. In estimating the size of furnaces for double houses, flats, or houses in blocks; it should be borne in mind that in case an adjoining house is unoccupied the loss of heat will be considerably increased. It is well, therefore, to provide for such a contingency by adding to the actual exposure of the house one-third the area of the party wall or one-third of the floor area, as the case may be. In city houses, which may stand apart from others for some time before the adjoining lots are built upon, the loss of heat through the party walls must be taken into consideration in estimating the size of the furnace. A solid brick wall of this nature will transmit about two-thirds as much heat as an ordinary wall having an average amount of glass. Hence add to the area of front and rear walls two-thirds the area of the party walls. Select a furnace having a rating in Table II most nearly corresponding to the total exposure thus obtained.

MANUFACTURERS' RATINGS.

It may be of interest to note the rated capacity of furnaces as stated in manufacturers' catalogues, the capacity being expressed in terms of the cubic space in frame dwellings the furnaces are rated to heat. Table III gives a fair average of the minimum ratings of furnaces of the better class. Column *d* shows the exposure corresponding to a given cubic space, assuming the house to be square and the clear heights of the first and second floors to be 9 feet and 8 feet 6 inches respectively. These exposures are considerably in excess of those in Table II, indicating a tendency on the part of manufacturers to overrate their furnaces:

Table III.

Diameter of fire pot in inches. (a.)	Area of fire pot in square feet (b.)	Rated capacity in cubic feet for frame dwelling. (c.)	Exposed wall surface corresponding. (d.)
18	1.8	8,000	1,500
20	2.2	10,000	1,670
22	2.6	14,000	1,980
24	3.1	19,000	2,300
26	3.7	26,000	2,700
28	4.3	33,000	3,040
30	4.9	40,000	3,340
32	5.6	50,000	3,740