Ans. The forked insulation is carried with it and likewise the small metal contact arm which breaks the contacts of the starting circuit.

In this way the burner motor can never start until the ignition circuit is completed and due to the unique construction of the combination switch, the ignition circuit always "makes" before the starting circuit contacts touch each other (unless some reason the stationary starting contact bracket has become bent out of position).

Ques. What are the conditions when the burner shuts off (either by normal action of the thermostat or due to power failure)?

Ans. It cannot re-start until the heating coil, fig. 11, has cooled sufficiently to bring the ignition arm back to the contact making position, at which time the starting circuit contacts also close — the burner circuit is then ready to operate.

Ques. What preliminary precaution should be taken?

Ans. Do not recommend the installation of an oil burner (conversion) in a heating plant unless you have reasonable assurance that the plant is suitable for oil burning.

If by questioning the owner, it is apparent that the heating system has been and is satisfactory, it can be taken for granted that a calculation of the connected load is not necessary.

*NOTE.—Some language butcher started it with the usual result. When a Civil engineer with aid of surveying instruments and a rod man locates boundary lines, their lengths and directions on a piece of property, that is surveying. When an oil burner man goes into a basement to see what kind of junk it contains and what he is up against in installing a burner, that is inspection. However, language butchers are always on the job — mark ye, always.
Ques. What is the first thing to inspect?
Ans. Inspect the boiler or furnace and determine its suitability for oil burning.

Ques. What should be noted about round cast iron boilers?
Ans. They show very poor efficiency, especially when operated with oil burners, unless there be four or five pancake sections.
A boiler of this type (according to Branford) provided with but two pancake sections, will probably not allow of more than 40% efficiency with oil, because the boiler offers then so little heating surface and flue travel; what little there is, is inefficient due to short circuiting in the large and short passages. Moreover the gas velocities will be so high that the gases of combustion will not be able to transfer their heat thoroughly before passing into the stack — often on a heavy load resulting in a red hot stack which not only is very wasteful of fuel, but constitutes a distinct fire hazard.

Ques. What fault is usually found with the boiler regardless of type?
Ans. Too small to heat the building without carrying a radiation load greater than its rated capacity.

Ques. What inspection should be given to the chimney?
Ans. It should be examined to make sure that it has no obstructions; that is, of sufficient size for the boiler and that the outlet is not located where it will be subjected to down draughts.

Ques. How are chimney down draughts formed?
Ans. Various causes are shown in figs. 1 to 4.

Ques. How about proper flue sizes?
Ans. The table on page 193, by Branford may be used as an approximate guide in the absence of boiler manufacturers' recommendations.

The sizes of chimneys in the table by Williams, page 62, are based on the following assumptions: 1. That the height of chimney is measured from the top of chimney to the level of the ash pit door of the furnace or boiler; 2. Not more than 50% excess air for combustion (10% or more CO₂); 3. Flue gas temperature 425° Fahr. or more at inlet of chimney; 4. Length of breeching not over 10 chimney diameters; 5. No turns in breeching, etc. Chimney to extend at least 3 ft. above a flat roof and 2 feet above roof ridge.

Ques. In converting from coal to oil, what should be noted about a boiler which is inadequate for the job or in need of repairs?
Ans. It will not give satisfactory results after the burner is installed.

Ques. If certain parts or rooms of the building were difficult to heat when using coal for fuel, what is the usual result in converting to oil?
Ans. The same difficulty will most likely be present, or conditions rendered worse on steam systems.

Ques. Why?
Ans. The trouble is due to inadequate venting.

On inspection it will be found that the cheapest air valves were installed, mains improperly vented with smallest size (½ connection) valves—in some cases no valve at all.

See pages 229-246, Chapter 25, on “How to Vent a Conversion Job.”

Ques. What should be considered with respect to the heating plant?
Ans. Check the amount of fuel used the previous year and determine if the heating plant be large enough and satisfactory.

Any defects should be called to the attention of the owner and proper repairs or alterations recommended. A furnace or boiler which is inadequate for the job or is in need of repairs will not give satisfactory results no matter what make burner is installed.

The oil burner only furnishes heat to the fire box. From there the heating system must absorb and distribute the heat.
How to Determine Size of Burner Required.—Oil burner men are not always expected to be expert on heating plant design, but there are a number of fundamental principles that are easily understood, and the more the oil burner man knows about heating plants, the more success he will have with his installations.

These instructions will point out the important points to look for in determining the load in a heating plant and its ability to do the work expected of it.

Ques. How do you determine the actual heating load on a boiler (steam, vapor, vacuum or hot water)?
Ans. Measure each radiator with a rule and add up the number of square feet of heating surface.

Ques. How is the number of square feet of heating surface (radiation) obtained?
Ans. The heating surface is listed according to height, number of columns and number of sections in the accompanying illustrations and tabulated in the tables.

Ques. How is the total obtained?
Ans. To total sq. ft. for radiators, add 25% if all piping is not covered with insulation. If covered add only 15%.

Ques. What additional allowance must be made?
Ans. Add also from 10% to 20% for “pickup”.

Ques. What is “pick up”?
Ans. The ability of a heating plant to warm up the building after it has been allowed to cool down, such as happens when a thermostat is set back at night.
The total thus far determined is the total heating load on the boiler, to which must be added the heat required for domestic hot water if furnished by the boiler.

Ques. What allowance is made for hot water supply?
Ans. Figure 1 to $1\frac{1}{2}$ sq. ft. of steam radiation for each gallon of tank capacity.

**RADIIATION TABLE**

For Column Cast Iron Radiators

<table>
<thead>
<tr>
<th>HEIGHT OF RADIATOR</th>
<th>45</th>
<th>38&quot;</th>
<th>32&quot;</th>
<th>29&quot;</th>
<th>26&quot;</th>
<th>23&quot;</th>
<th>20&quot;</th>
<th>18&quot;</th>
<th>16&quot;</th>
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<td>2$\frac{1}{2}$</td>
<td>2</td>
<td>1$\frac{1}{2}$</td>
<td>1$\frac{1}{2}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 COLUMN</td>
<td>4</td>
<td>3$\frac{1}{2}$</td>
<td>2$\frac{2}{3}$</td>
<td>2$\frac{1}{3}$</td>
<td>2$\frac{1}{4}$</td>
<td>2</td>
<td>$1\frac{3}{4}$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 COLUMN</td>
<td>5</td>
<td>4$\frac{1}{2}$</td>
<td>3$\frac{1}{3}$</td>
<td>3$\frac{1}{4}$</td>
<td>3</td>
<td>$1\frac{1}{2}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 COLUMN</td>
<td>6</td>
<td>5$\frac{1}{2}$</td>
<td>4$\frac{1}{3}$</td>
<td>4$\frac{1}{4}$</td>
<td>4</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 COLUMN</td>
<td>7</td>
<td>6</td>
<td>5$\frac{1}{2}$</td>
<td>5$\frac{1}{4}$</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 COLUMN</td>
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<td>7</td>
<td>7$\frac{1}{2}$</td>
<td>7$\frac{1}{4}$</td>
<td>7</td>
<td>6</td>
<td>5</td>
<td>$1\frac{1}{2}$</td>
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<td></td>
</tr>
<tr>
<td>WINDOW RADIATOR</td>
<td>9</td>
<td>8</td>
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<td>8$\frac{1}{3}$</td>
<td>8</td>
<td>7</td>
<td>6$\frac{1}{4}$</td>
<td>6$\frac{1}{2}$</td>
<td>5$\frac{1}{4}$</td>
<td></td>
</tr>
<tr>
<td>2 COLUMN HOSP RAD</td>
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<td>9</td>
<td>9$\frac{1}{2}$</td>
<td>9$\frac{1}{3}$</td>
<td>9</td>
<td>8</td>
<td>7$\frac{1}{4}$</td>
<td>7$\frac{1}{2}$</td>
<td>6$\frac{1}{4}$</td>
<td></td>
</tr>
<tr>
<td>WALL RADIATOR</td>
<td>11</td>
<td>10</td>
<td>10$\frac{1}{2}$</td>
<td>10$\frac{1}{3}$</td>
<td>10</td>
<td>9</td>
<td>8$\frac{1}{4}$</td>
<td>8$\frac{1}{2}$</td>
<td>7$\frac{1}{4}$</td>
<td></td>
</tr>
</tbody>
</table>

Ques. How is the burner size determined from the load?
Ans. Under average conditions, one gallon of No. 3 oil per hour will heat about 300 sq. ft. of steam radiation for each gallon of tank capacity.
Refer to table of capacities given by manufacturer of the burner to be used and pick out the size corresponding.

Useful Data.—According to “Nu-way”: To find equivalent steam radiation when the hot water radiation is known, divide the hot water radiation by 1.6.

RADIATION TABLE
For Tubular Cast Iron Radiation

<table>
<thead>
<tr>
<th>SQUARE FEET PER SECTION</th>
<th>HEIGHT OF RADIATOR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>45-</td>
</tr>
<tr>
<td>3 TUBE</td>
<td>2 1/2</td>
</tr>
<tr>
<td>4 TUBE</td>
<td>3 1/2</td>
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<tr>
<td>5 TUBE</td>
<td>4 1/2</td>
</tr>
<tr>
<td>6 TUBE</td>
<td>5 1/2</td>
</tr>
<tr>
<td>7 TUBE</td>
<td>6 1/2</td>
</tr>
<tr>
<td>SECTIONS 3 LONG</td>
<td>3 1/4</td>
</tr>
<tr>
<td>HOSPITAL 3 LONG</td>
<td>3 1/2</td>
</tr>
</tbody>
</table>

Example.—If a building have a total of 600 sq. ft. hot water radiation, this is equivalent to

\[ \frac{600}{1.6} = 375 \text{ sq. ft. steam radiation.} \]

**NOTE.**—Repeated tests have shown that the amount of heat given off by ordinary cast-iron radiators per degree difference in temperature between the steam (or water) in the radiator and the air surrounding same, to be about 1.6 B.t.u. per sq. ft. of heating surface per hour.
To find the equivalent steam radiation when the area of warm air pipes is known, divide the number of sq. ins. of warm air pipe area by 1.4.

Example.—If a building have a warm air furnace whose total area of warm air pipes is 800 sq. ins., this is equivalent to:

\[
800 \div 1.4 = 571 \text{ sq. ft. steam radiation.}
\]

Figures to remember.—

1 sq. ft. steam radiation = 1.6 sq. ft. not water radiation.
1 sq. ft. steam radiation = 1.4 sq. in. of hot air pipe area.

I gallon hot water storage = about 1\(\frac{1}{4}\) to 1\(\frac{1}{2}\) sq. ft. steam radiation.

240 B.t.u. = amount of heat given off by ordinary cast iron radiators per sq. ft. of heating surface per hour average.*

*NOTE.—This is true for steam at 21\(\frac{1}{4}\) lbs. pressure (220°) surrounding air 70° Fahr. (220°—70°) 1.6 = 240 B.t.u.

2. Preparation

Before installing an oil burner, the heating system should be carefully inspected for defects and cleanliness.

Ques. What attention should be given to the boiler?
Ans. All flue passages and heating surfaces should be thoroughly cleaned so that the maximum amount of heat generated may be absorbed.

Soot or ash is a good insulator, and accordingly should be removed.

On a conversion job the damper should be removed. The boiler or furnace should be examined for air leaks and in the stack connection to chimney. If leaks be found, they should be sealed with suitable compound. Remove ash pit door, door frame and grate. Do not throw away unless by directions of the owner.

Ques. What attention should be given to the stack?

In making the original installation, certain regulations of the Underwriter's Laboratories and the various local authorities must be considered. Heaters using pot burners require more draught and no manual damper should be installed. The draught regulator supplied with these heaters is adjustable with marking High-Med.-Low on dial. By setting the pointer to High, the draught will be increased (provided the chimney will give more draught as indicated by the gate still swinging inwardly at least one quarter way) and the capacity without smoking can be increased up to the limit of the valve capacity which has been set at a safe amount for the particular heater. In general, however, it is recommended, that the regulator be set at Medium which will give the most efficient operation. Oil feed system:

The tank is fixed in place and fills at the top. It is not air tight. To control the oil level,
Ans. Remove and clean; if in poor condition replace with new stack.

If a thimble type draught regulator is to be installed, cut the hole for it.

Ques. How do you inspect inside of a chimney for obstructions?
Ans. Hold a mirror at an angle of 45 degrees and any obstruction may be seen through the mirror.

CHAPTER 24

Installing and Adjusting

1. Installing

Before installing a burner, it is assumed that inspection and preparation have been made as instructed in Chapter 23. The inspection includes the calculations for radiation and checked against the house loss and the size of nozzle and burner determined.

In addition to this, the size and location of the tank and thermostat should be discussed with the owner and adjusted to his satisfaction.

In the opinion of the author, the location of the thermostat is very important as the whole operation of the system depends upon the "orders" given by the thermostat. That is to say, the thermostat is the pulse which gives life to the system.

Of course, the size and location of the tank should also be discussed with the owner and adjusted to his satisfaction—informing him that the standard size of tank is 275 gallons.

Tools.—The following is a complete list of tools required for the proper installation and service of a conversion burner.

Laborer's Tools.—2 long handled shovels, round nose; 1 pick axe; 2 bull points; 2—12 quart pails; 1 sledge; 1 mash hammer; 1—\(\frac{1}{2}\) in. star drill; 1 large star drill; 1\(\frac{1}{2}\) in. star drill; 1 fire shovel; 1 crow bar; 1 pinch bar; 1 wire brush; 1 large square canvas.

Pipe Fitter's Tools.—1 pipe vise—up to 2\(\frac{1}{2}\) ins. capacity; 1 pipe vise stand; 1—24 in. pipe wrench; 1—18 in. pipe wrench; 1—10 in.