Ques. What is vaporization?
Ans. The formation or making of steam.

Ques. Describe the formation of steam.
Ans. A particle of water in contact with the metal is heated until it is changed into steam, first appearing as a small bubble which for a time clings to the metal as in fig. 6.

Its size gradually increases by the addition of more steam, formed from the surrounding water until it finally disengages itself from the metal as in fig. 8.

After disengagement, since the bubble is much lighter than the water, it quickly rises and bursts on reaching the surface, allowing the steam to escape into the atmosphere, as in figs. 8 to 10. Note expansion of the bubble during its ascent due to decreasing head.

Ques. Name two kinds of circulation.
Ans. Undirected, as in fig. 11, and directed, as in fig. 12.

NOTE.—In steam making, a considerable amount of the heat generated by the fuel goes up the chimney instead of heating the water—especially in sectional cast iron alleged house heating boilers.

Ques. What can be said, if anything, in favor of early cast iron sectional house heating boilers?
Ans. Nothing.

Fig. 11—Familiar coffee pot “boil over” due to undirected flow with accompanying reaction by the cook.

Fig. 12—Directed flow with cylindrical baffle or inner vessel—no boil over with this arrangement.

Figs. 1 to 4—Effect of inadequate heating surface with reference to house heating boilers. Assume equal flames and that the area (heating surface) of the several kettles is 8, 15, 20 and 25 square inches. Put the same quantity of water in each. The result is No. 4 will begin to boil first, No. 3 next, then No. 2 and last No. 1. Evidently it takes less fuel to heat No. 4 than any of the others. The same thing happens in a heating boiler—don’t blame the manufacturer, but yourself. Take your choice—buy a cheap boiler with characteristics like kettle No. 1 with big coal bills or an expensive boiler like kettle No. 4 with minimum coal bills. However, what is the use of preaching this to greenhorns, thermal idiots and miscellaneous non-descripts residing in districts remote from centers of learning and culture?
Ques. Why?
Ans. Where is the heating surface—in the stack?

Ques. What has been done to make these boilers less wasteful of fuel?
Ans. Various attempts have been made to decrease short circuiting and increase the heating surface by increasing the number of passes and by providing fins, pins, ribs and what not cast integral, etc., also baffling is resorted to.

Ques. What item should every manufacturer of cast iron boilers state in his catalogue?
Ans. The amount of heating surface.

Ques. What is the usual construction of a vertical cast iron sectional boiler?
Ans. It comprises a base section (in the case of coal, containing the grate), a fire pot with space all around for the water, and piled up on top of this are one or more intermediate “pancake” sections and a top or dome.
Ques. How can the efficiency of this type of boiler be increased?

Ans. By piling on more intermediate sections increasing the heating surface in amount, depending upon the number of sections piled on.

Ques. Why didn't they pile on intermediate sections to begin with?

Ans. Usually due to ignorance of the house owner and architect and desire of the contractor to get the job by putting in a low bid—everything too small—this goes for the whole heating system in some cases.
Results obtained with coal burning boilers are given in the following tables, according to Kent—they speak eloquently for themselves.

**Proportions and Performance of Heating Boilers**

<table>
<thead>
<tr>
<th></th>
<th>Low boiler</th>
<th>Medium boiler</th>
<th>High boiler</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 square foot of grate should burn....</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>&quot; &quot; &quot; &quot; &quot; &quot; &quot; develop...</td>
<td>30,000</td>
<td>40,000</td>
<td>50,000</td>
</tr>
<tr>
<td>&quot; &quot; &quot; &quot; &quot; &quot; will require...</td>
<td>15</td>
<td>20</td>
<td>25</td>
</tr>
<tr>
<td>&quot; &quot; &quot; &quot; &quot; &quot; supply...</td>
<td>120</td>
<td>160</td>
<td>200</td>
</tr>
</tbody>
</table>

Note also the following table from Kent:

**Steam Heating Boiler Tests**

<table>
<thead>
<tr>
<th>Number of boiler</th>
<th>Fuel anthracite pounds per square foot of grate</th>
<th>Area of grate square feet</th>
<th>Number of sections including dome</th>
<th>Steam produced per pound of coal</th>
<th>8 hour rating square feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>4.39</td>
<td>1.23</td>
<td>1</td>
<td>7.5</td>
<td>200</td>
</tr>
<tr>
<td>1</td>
<td>5.12</td>
<td>1.23</td>
<td>2</td>
<td>8.5</td>
<td>250</td>
</tr>
<tr>
<td>1 1/2</td>
<td>5.28</td>
<td>1.23</td>
<td>3</td>
<td>8.5</td>
<td>275</td>
</tr>
<tr>
<td>2</td>
<td>5.44</td>
<td>1.23</td>
<td>4</td>
<td>9.5</td>
<td>300</td>
</tr>
</tbody>
</table>

To put the finishing touches on this matter the author quotes the following from the Division of Agricultural Engineering of the U. S. Dept. of Agriculture:

"Tests conducted by the Engineering Dept. on 25 inch round hot water boilers showed some interesting results as to saving realized by the addition of numbers of sections.

The smallest was a four section boiler consisting of base, fire pot, one intermediate section and dome. The next boiler had two inter-

These results should be sufficient to convince even a **thermal idiot** that boilers should be provided with **plenty** of heating surface.

**Ques.** What names are given to vertical cast iron boilers with respect to the number of intermediate sections provided?
Ans. Low, medium and high.

Ques. What is the best form of heating surface and why?
Ans. Tubular, because it is the most efficient.

Ques. Why?
Ans. It provides a multiplicity of paths of small cross sectional area for the escaping hot gases of combustion.

Ques. In considering the lack of heating surface in some house heating boilers, why do the tenants get no hot water?
Ans. See fig. 12.

Ques. What may be said with respect to calling cored cast passages in some sectional cast iron heating boilers, tubes?
Ans. Ridiculous, they are far from being tubes—simply hot air agents talk.

Conversion: Coal to Oil

Some types of cast iron boilers designed to burn coal are not suited to burn oil. Aside from adapting the furnace for oil burning, changes must be made in the passages formed by the heating surface.

Extra large flue passages are not suited to the high temperature flue gases encountered with oil.

In these boilers having the large flue passages, baffling must be resorted to in order to slow down the high velocities of the extra hot gases, otherwise unburned particles of oil may lodge on the heating surface, resulting in carbon. Since carbon is an excellent insulator, the efficiency of the heating surface is lowered whenever it collects.

Preliminary to Conversion.—Before constructing a combustion chamber and installing a burner, the heating system should be carefully checked for defects and cleanliness. A boiler which is inadequate for the job (most of them are inadequate) or is in need of repairs will not give satisfactory results after the burner is installed.

All flue passages should be cleaned so that the maximum amount of heat generated is absorbed by the boiler.

Soot or ash are good insulators and both are always undesirable.