usually of the underfeed type with multiple retorts and either side cleaning or rear cleaning. In the side cleaning type there may be as many as three retorts in the furnace and the stoker functions in the same manner as has been described for the single retort. This stoker is usually limited in length to approximately 8½ ft while the width may be as great as 10½ ft. In the rear cleaning stokers the number of retorts and the dimensions of the furnace are practically unlimited.

FURNACE DESIGN

The complete combustion of coal involves the combination of the various elements of the coal with the oxygen of the air into such compounds as are no longer effected by oxygen even at the furnace temperature. The chemical reactions which take place during this process are very rapid and take place principally within the fuel bed. However, a considerable volume of gas escapes from the surface of the fire in an active state and must be mixed with air in the furnace chamber before coming in contact with the comparatively cool surfaces of the boiler and being sufficiently reduced in temperature to become inert. It is obvious, therefore, that the design of the furnace is equally as important as the selection of the proper stoker. A certain amount of carbon monoxide formed by the breaking down of the solid fuel may escape from the surface of the fire but this is readily reduced to carbon dioxide within a short distance above the fire. This accounts for the fact that anthracite coal, with its low volatile content, can be completely burned with a small combustion chamber. The difficult portion of the fuel is the volatile constituent. To properly care for this, the following three factors must be given careful consideration in the furnace design:

1. The distance from the fuel bed to the boiler must be such that sufficient time shall be allowed for the combustion of this gas before it comes in contact with the boiler, as otherwise it will pass off as unburned gas and as smoke. This distance will vary with different types of stokers, as for instance, in an overfeed stoker all of the volatile must be burned in the combustion chamber, and, therefore, a greater distance must be allowed than for an underfeed stoker where a considerable portion of gas is burned while passing through the fire. Also the greater the percentage of gas in the coal the greater must be the travel. And finally the design of the boiler will affect this distance, since in certain types the gas travels directly upward to the boiler while in others it travels toward the rear and thus has a longer travel before cooling.

2. The volume of the combustion chamber must be sufficient to permit room for the mixing of gas and air. This condition is more or less interlocked with the first condition and is usually satisfied if the first condition is met.

3. The area of boiler heating surface exposed to the fire must not be so great that the radiant heat of the fire absorbed by the boiler will be such that the furnace temperature will be reduced sufficiently to slow up the combustion process. From the standpoint of the fire, the boiler surface exposed to the fire constitutes a cooling surface and it is quite possible to have enough surface exposed to cause a comparatively low temperature furnace, and, therefore, an inefficient one. A customary rule-of-thumb method of figuring furnace volume is to allow one cubic foot of space per boiler horsepower developed which means a heat release in the furnace of approximately 50,000 Btu per cubic foot of furnace. This, obviously, is not an entirely satisfactory method because of the wide difference in the percentage of volatile contained in different coals. It is recommended, therefore, that the furnace volume shall be based on the volatile constituent and shall be sufficient to give a heat release of approximately 15,000 to 18,000 Btu per cubic foot of furnace volume based on volatile only.

Chapter 18

OIL BURNERS

Domestic Burners; Atomization; Air for Combustion; Ignition; Temperature Control; Protective Devices; Intermittent and High-Low Operation; Boilers for Domestic Oil Burners; Installation; Adjustment of Burner; Service: Commercial Oil Burners; Oil Pumps; Boiler Settings.

AN *oil burner* is primarily a device for preparing oil fuel for combustion. While this is true with most industrial and commercial types of burners it is only partially true with the domestic oil burner. The function of some domestic oil burners is merely to prepare the fuel and air for combustion in combination with automatic operation. There are, however, many types of domestic oil burners in which a considerable portion of the combustion takes place in an integral part of the burner. There is also the type in which the combustion is started and controlled within the burner, the major part of the combustion taking place in the combustion chamber.

There is no line of demarcation between burners used for domestic and commercial or industrial purposes; in some cases homes are heated with units that are miniatures of burners used to fire large heating or power boilers or even marine boilers; in other instances distinctive burner types have been developed to meet requirements in one particular field.

Various classifications can be made to group burners according to different bases, such as:

1*A*. *Atmospheric.*	Utilizes natural chimney draft to provide combustion air
1*B*. *Mechanical Draft*	Electric-motor-driven fan or blower provides air supply, or
2*A*. *Vaporizing.*	Oil distilled on hot surface or in hot *cracking chamber*
2*B*. *Atomizing.*	Oil is thrown from rotating cup or disc, or is blown or forced through orifice, or otherwise broken up into minute globules as an aid to vaporization, or
3*A*. *Luminous.*	Referring to the property of the flame by which it emits proportionately a large amount of radiant energy.
3*B*. *Non-luminous.*	Producing a Bunsen-type flame with little radiant power, or

4*A*. *Mechanical atomizing.* Oil is broken up by mechanical means.