

### 13.1. Introduction

A steam generator or boiler is, usually, a closed vessel made of steel. Its function is to transfer the heat produced by the combustion of fuel (solid, liquid or gaseous) to water, and ultimately to generate steam. The steam produced may be supplied :

1. to an external combustion engine, *i.e.* steam engines and turbines,
2. at low pressures for industrial process work in cotton mills, sugar factories, breweries, etc., and
3. for producing hot water, which can be used for heating installations at much lower pressures.

### 13.2. Important Terms for Steam Boilers

Though there are many terms used in steam boilers, yet the following are important from the subject point of view :

**1. Boiler shell.** It is made up of steel plates bent into cylindrical form and riveted or welded together. The ends of the shell are closed by means of end plates. A boiler shell should have sufficient capacity to contain water and steam.

**2. Combustion chamber.** It is the space, generally below the boiler shell, meant for burning fuel in order to produce steam from the water contained in the shell.

**3. Grate.** It is a platform, in the combustion chamber, upon which fuel (coal or wood) is burnt. The grate, generally, consists of cast iron bars which are spaced apart so that air (required for combustion) can pass through them. The surface area of the grate, over which the fire takes place, is called *grate surface*.

**4. Furnace.** It is the space, above the grate and below the boiler shell, in which the fuel is actually burnt. The furnace is also called *fire box*.

**5. Heating surface.** It is that part of boiler surface, which is exposed to the fire (or hot gases from the fire).

**6. Mountings.** These are the fittings which are mounted on the boiler for its proper functioning. They include water level indicator, pressure gauge, safety valve etc. It may be noted that a boiler cannot function safely without the mountings.

**7. Accessories.** These are the devices, which form an integral part of a boiler, but are not mounted on it. They include superheater, economiser, feed pump etc. It may be noted that the accessories help in controlling and running the boiler efficiently.

### 13.5. Classifications of Steam Boilers

Though there are many classifications of steam boilers, yet the following are important from the subject point of view :

1. **According to the contents in the tube.** The steam boilers, according to the contents in the tube may be classified as :

(a) Fire tube or smoke tube boiler, and (b) Water tube boiler.

In *fire tube steam boilers*, the flames and hot gases, produced by the combustion of fuel, pass through the tubes (called multi-tubes) which are surrounded by water. The heat is conducted through the walls of the tubes from the hot gases to the surrounding water. Examples of fire tube boilers are Simple vertical boiler, Cochran boiler, Lancashire boiler, Cornish boiler, Scotch marine boiler, Locomotive boiler, and Velcon boiler.

In *water tube steam boilers*, the water is contained inside the tubes (called water tubes) which are surrounded by flames and hot gases from outside. Examples of water tube boilers are : Babcock and Wilcox boiler, Stirling boiler, La-Mont boiler, Benson boiler, Yarrow boiler and Loeffler boiler.

2. **According to the position of the furnace.** The steam boilers, according to the position of the furnace are classified as :

(a) Internally fired boilers, and (b) Externally fired boilers.

In *internally fired steam boilers*, the furnace is located inside the boiler shell. Most of the fire tube steam boilers are internally fired.

### Steam Boilers

In *externally fired steam boilers*, the furnace is arranged underneath in a brick-work setting. Water tube steam boilers are always externally fired.

**3. According to the axis of the shell.** The steam boilers, according to the axis of the shell, may be classified as :

(a) Vertical boilers, and (b) Horizontal boilers.

In *vertical steam boilers*, the axis of the shell is vertical. Simple vertical boiler and Cochran boiler are vertical boilers.

In *horizontal steam boilers*, the axis of the shell is horizontal. Lancashire boiler, Locomotive boiler and Babcock and Wilcox boiler are horizontal boilers.

**4. According to the number of tubes.** The steam boilers, according to the number of tubes, may be classified as :

(a) Single tube boilers, and (b) Multitubular boilers.

In *single tube steam boilers*, there is only one fire tube or water tube. Simple vertical boiler and Cornish boiler are single tube boilers.

In *multitubular steam boilers*, there are two or more fire tubes or water tubes. Lancashire boiler, Locomotive boiler, Cochran boiler, Babcock and Wilcox boiler are multitubular boilers.

**5. According to the method of circulation of water and steam.** The steam boilers, according to the method of circulation of water and steam, may be classified as :

(a) Natural circulation boilers, and (b) Forced circulation boilers.

In *natural circulation steam boilers*, the circulation of water is by natural convection currents, which are set up during the heating of water. In most of the steam boilers, there is a natural circulation of water.

In *forced circulation steam boilers*, there is a forced circulation of water by a centrifugal pump driven by some external power. Use of forced circulation is made in high pressure boilers such as La-Mont boiler, Benson boiler, Loeffler boiler and Velcon boiler.

may be classified as

remove the... The space... to be heated.

### 13.7. Cochran Boiler or Vertical Multitubular Boiler

There are various designs of vertical multitubular boilers. A Cochran boiler is considered to be one of the most efficient type of such boilers. It is an improved type of simple vertical boiler.

This boiler consists of an external cylindrical shell and a fire box as shown in Fig. 13.2. The shell and fire box are both hemispherical, The hemispherical crown of the boiler shell gives maximum space and strength to withstand the pressure of steam inside the boiler. The hemispherical crown of the fire box is also advantageous for resisting intense heat. The fire box and the combustion chamber is connected through a short pipe. The flue gases from the combustion chamber flow to the smoke box through a number of smoke tubes. These tubes generally have 62.5 mm external diameter and are 165 in number. The gases from the smoke-box pass to the atmosphere through a chimney. The combustion chamber is lined with fire bricks on the shell side. A manhole near the top of the crown on the shell is provided for cleaning.

At the bottom of the fire box, there is a grate (in case of coal firing) and the coal is fed through the fire hole. If the boiler is used for oil firing, no grate is provided, but the bottom of the fire box is lined with firebricks. The oil burner

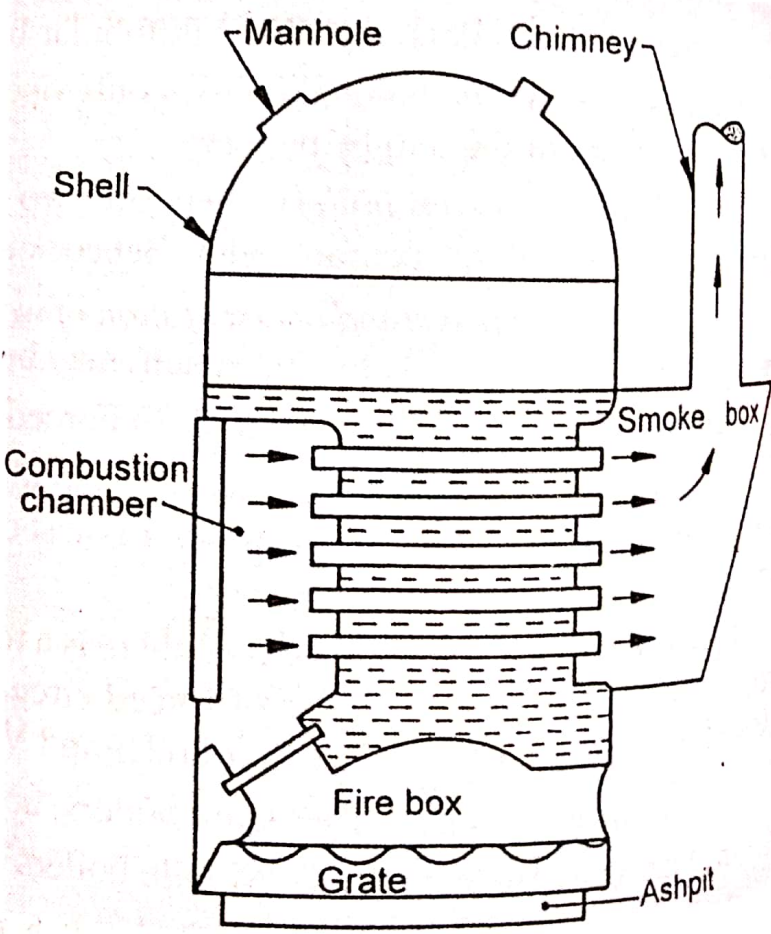
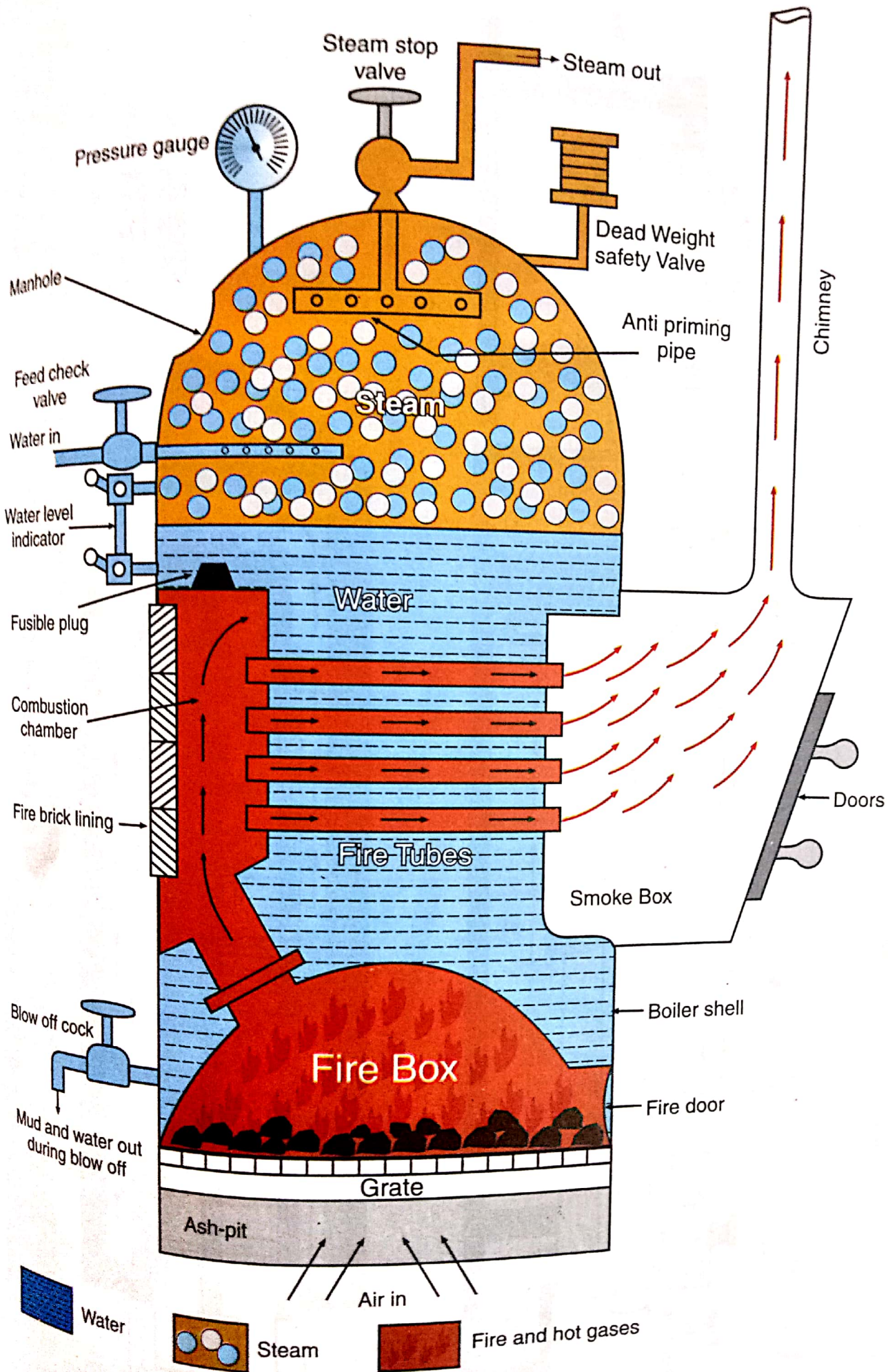


Fig. 13.2. Cochran boiler.

### 13.8. Scotch Marine Boiler



**COCHRAN BOILER**

dampers operated by rods and levers.

### 13.12. Babcock and Wilcox Boiler

It is a straight tube, stationary type water tube boiler, as shown in Fig. 13.7. It consists of a steam and water drum (1). It is connected by a short tube with uptake header or riser (2) at the back end.

The water tubes (5) (100 mm diameter) are inclined to the horizontal and connects the uptake header to the downtake header. Each row of the tubes is connected with two headers, and there are plenty of such rows. The headers are curved when viewed in the direction of tubes so that one tube is not in the space of other, and hot gases can pass properly after heating all the tubes. The headers are provided with hand holes in the front of the tubes and are covered with caps (18).

A mud box (6) is provided with each downtake header and the mud, that settles down is removed. There is a slow moving automatic chain grate on which the coal is fed from the hopper (21). A fire bricks baffle causes hot gases to move upwards and downwards and again upwards before leaving the chimney. The dampers (17) are operated by a chain (22) which passes over a pulley to the front of a boiler to regulate the draught.

The boiler is suspended on steel girders, and surrounded on all the four sides by fire brick walls. The doors (4) are provided for a man to enter the boiler for repairing and cleaning. Water circulates from the drum (1) into the header (2) and through the tubes (5) to header (3) and again to the drum. Water continues to circulate like this till it is evaporated. A steam superheater consists of a large number of steel tubes (10) and contains two boxes ; one is superheated steam box (11) and other is saturated steam box (12).

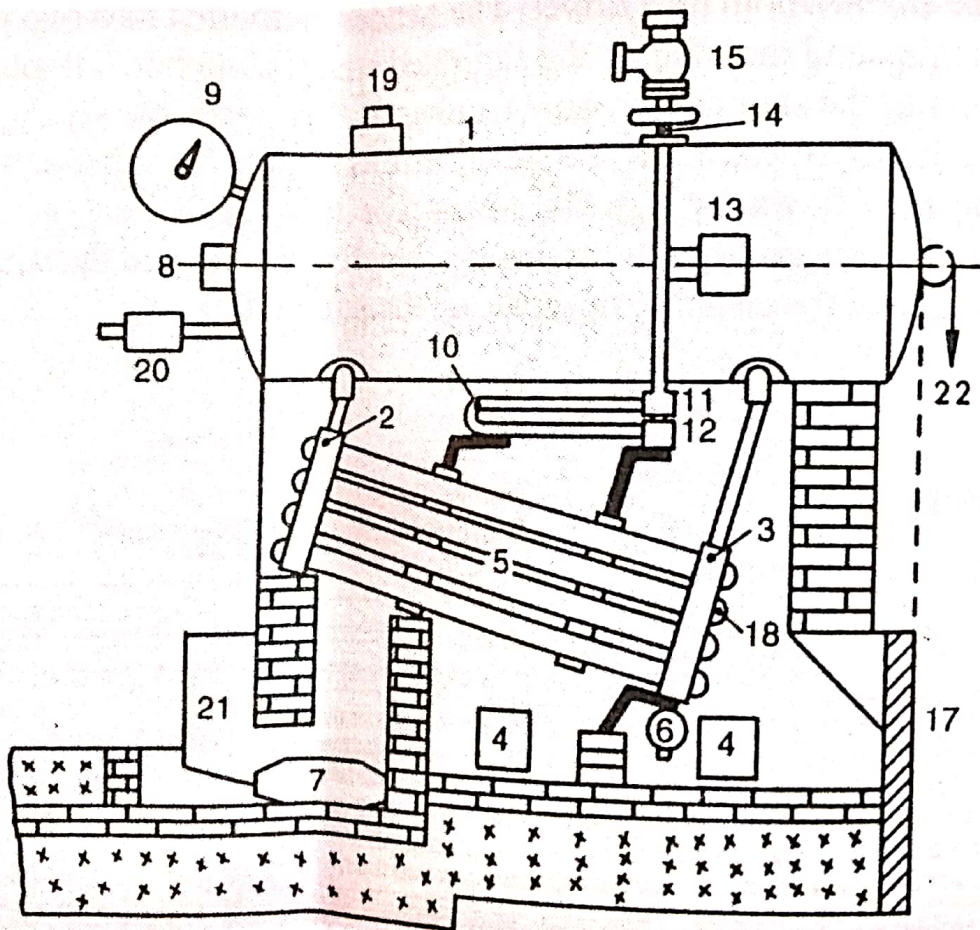
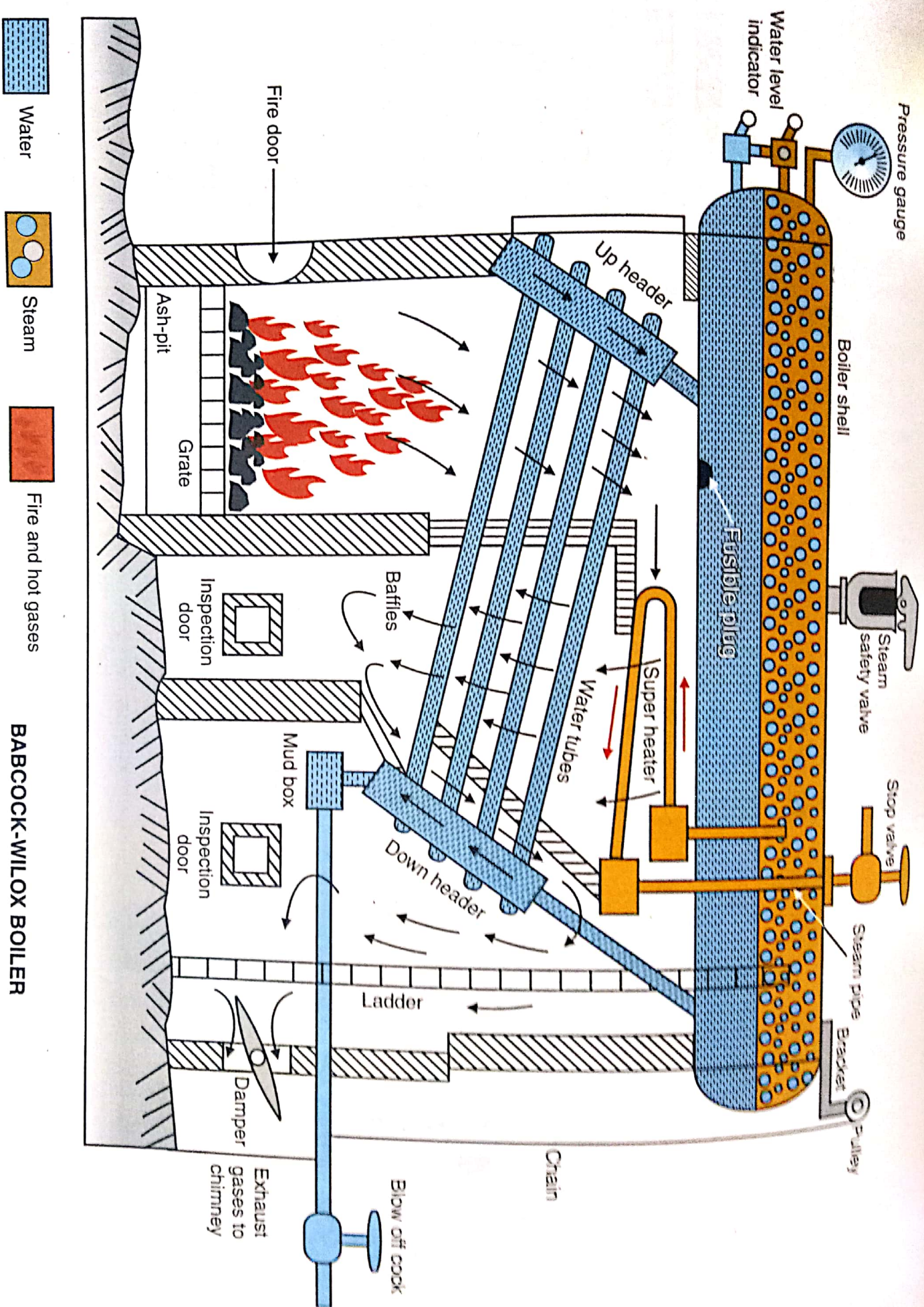


Fig. 13.7. Babcock and Wilcox boiler.



**BABCOCK-WILOX BOILER**