STEAM BOILERS

Course : B.Tech Mechanical
Subject : Elements of Mechanical Engineering
Unit-2

INTRODUCTION

STEAM GENERATOR OR BOILER

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 to water and ultimately to generate steam.

BOILER PROPERTIES:

- (i) Safety. The boiler should be safe under operating conditions.
- (ii) Accessibility. The various parts of the boiler should be accessible for repair and maintenance.
- (iii) Capacity. Should be capable of supplying steam according to the requirements.

- (iv) Efficiency. Should be able to absorb a maximum amount of heat produced due to burning of fuel in the furnace.
- (v) It should be simple in construction .
- (vi) Its initial cost and maintenance cost should be low.
- (vii) The boiler should have no joints exposed to flames.
- (viii) Should be capable of quick starting and loading.

Requirements of a boiler

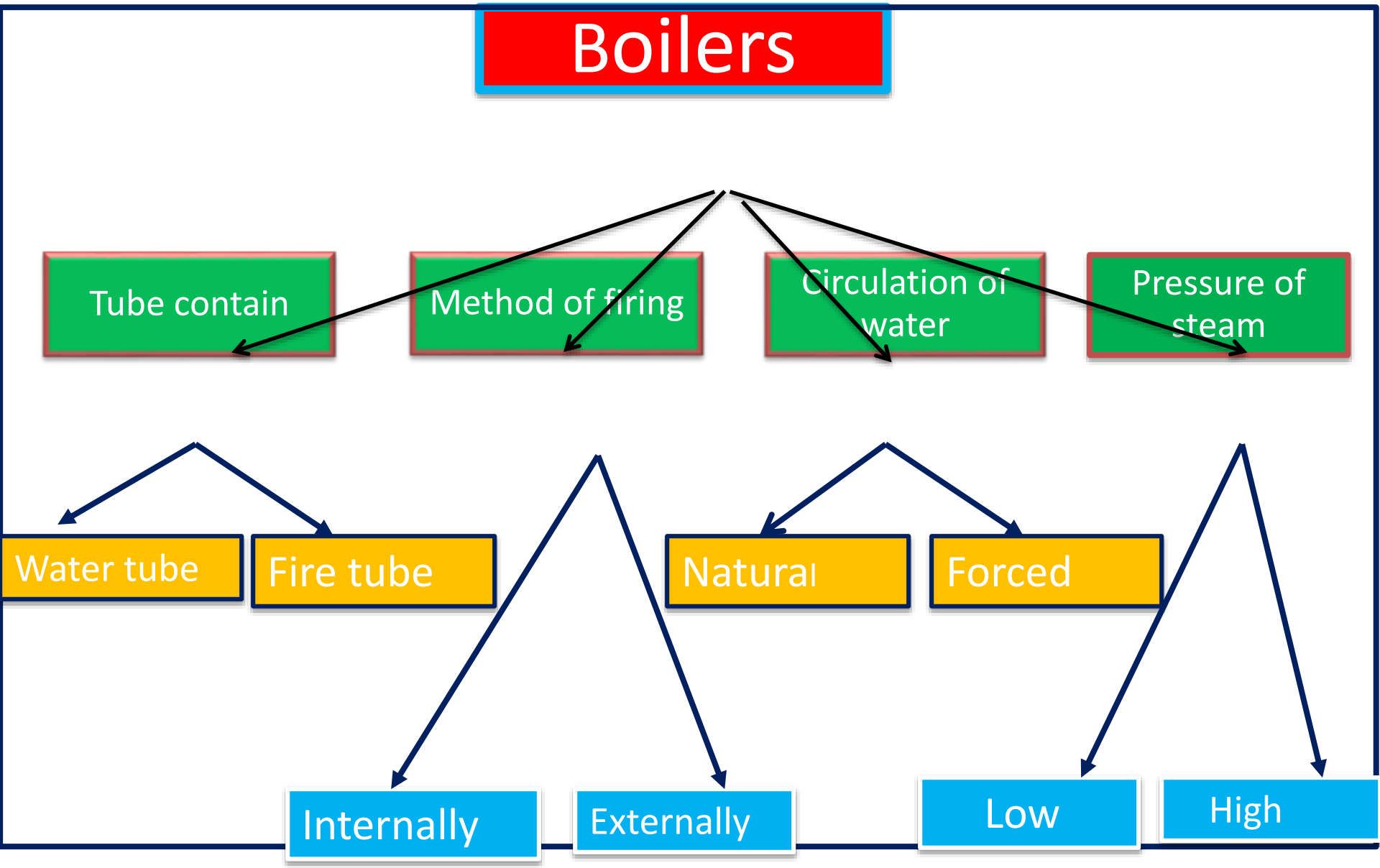
- Generate maximum steam.
- Light in weight and not occupy large space.
- Proper safety regulations.
- Cheaper in cost.
- Easy cope up with fluctuating demands of requirements.
- Easily accessible for inspection and repair.

FUEL

The source of heat for a boiler are :

- WOOD
- COAL
- DIESEL
- NATURAL GAS
- NUCLEAR ENERGY

CLASSIFICATION OF STEAM BOILERS


Boilers
Tube contain
Method of firing
Circulation of water
Pressure of steam
Water tube
Fire tube
Natural
Forced
Internally
Externally
Low
High

CLASSIFICATION OF STEAM BOILERS

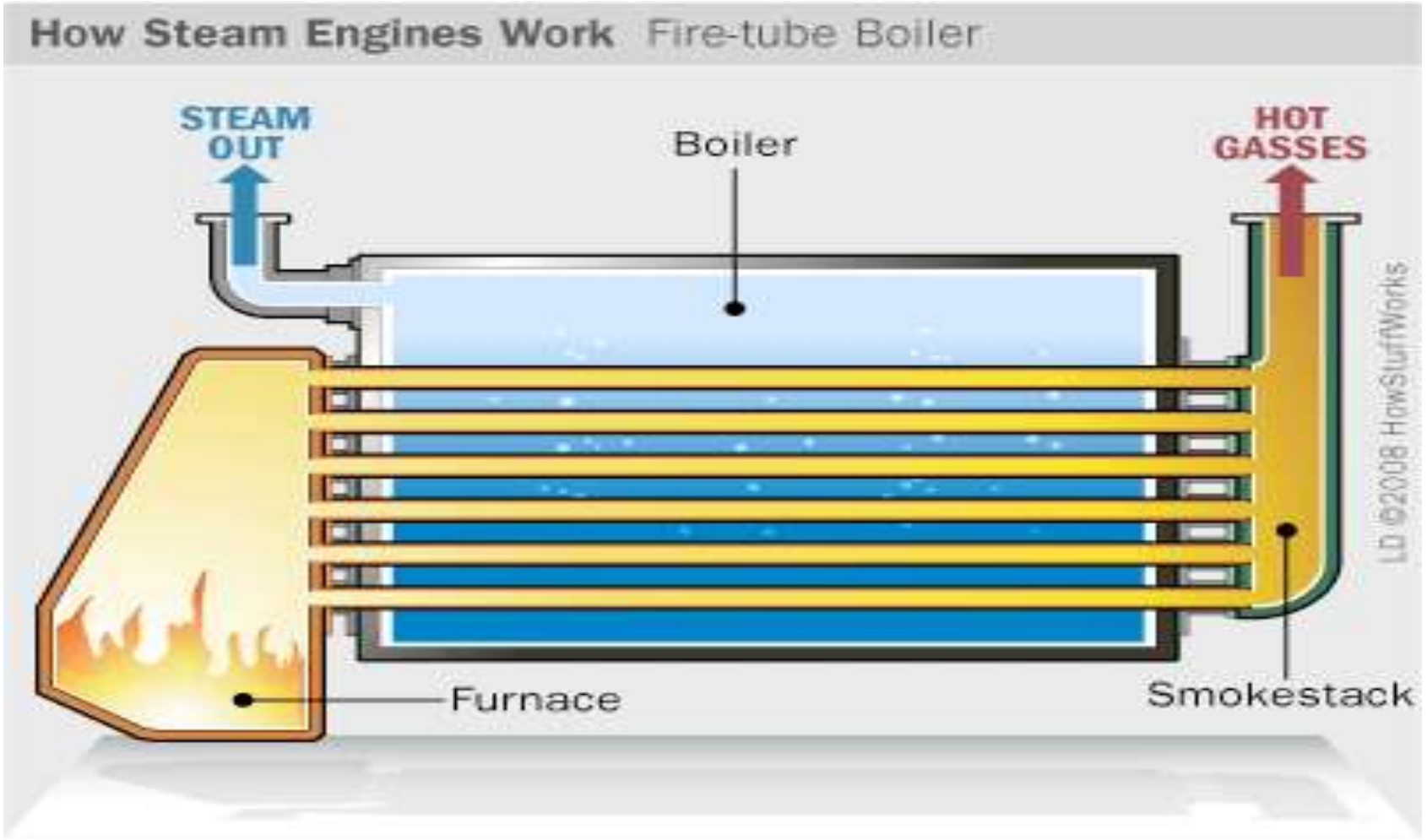
- **Though there are many classifications of steam boilers, yet the following are important.**

➢ ACCORDING TO THE CONTENTS IN THE TUBE:

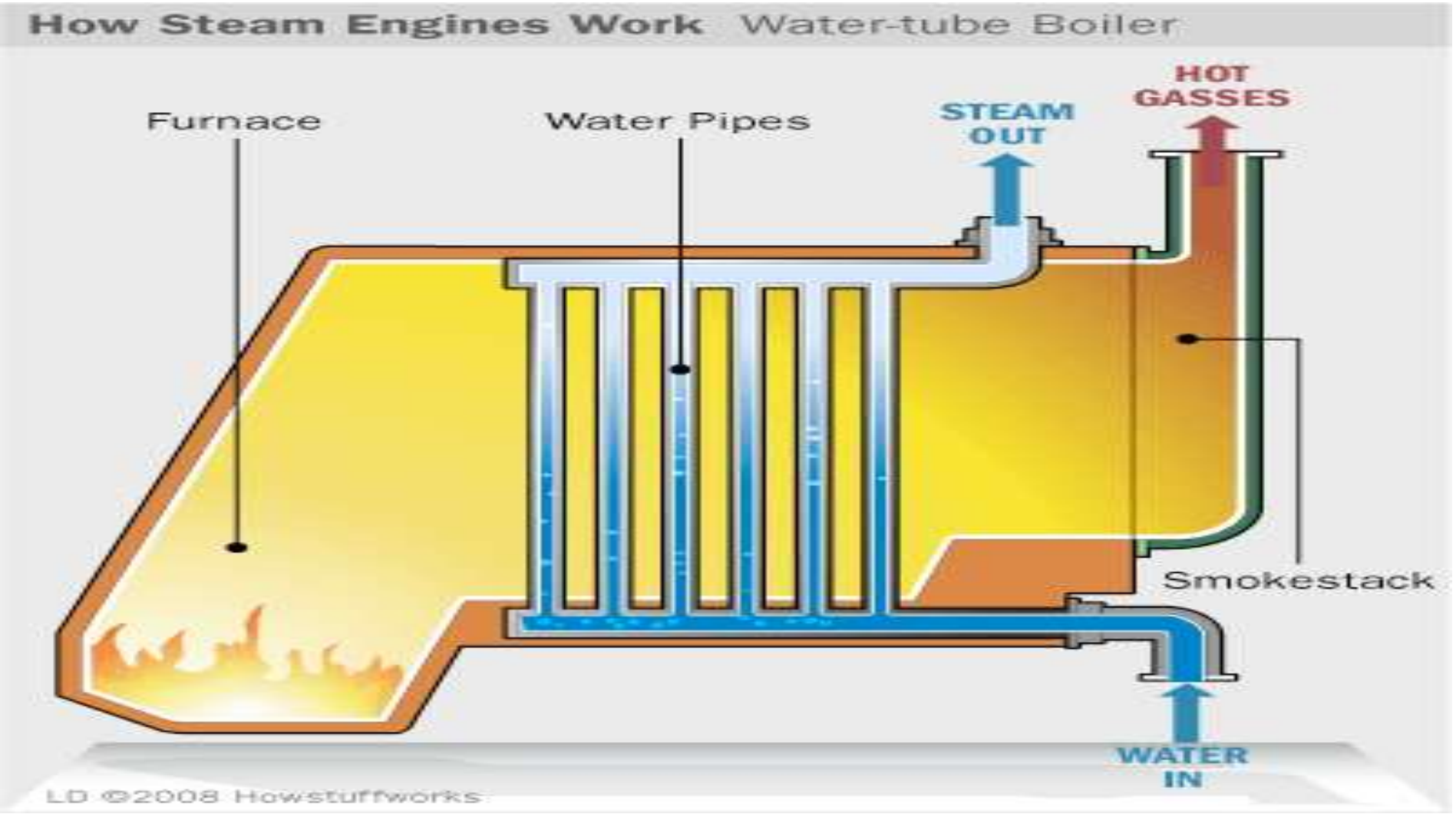
a) fire tube or smoke tube boiler

b) water tube boiler.

FIRE – TUBE BOILERS



WATER TUBE BOILERS



- **ACCORGING TO POSITION OF FURNACE:**

a) Internally fired boilers
b) Externally fired boilers

- **ACCORDING TO AXIS OF FURNACE:**

a) Vertical boilers
b) Horizontal boilers

- **ACCORDING TO NUMBER OF TUBES:**

a) Single tube boilers
b) Multi tube boilers

- **ACCORDING TO METHOD OF CIRCULATION OF WATER:**

a) Natural circulation boilers
b) Forced circulation boilers

- **ACCORDING TO THE USE**

a) Stationary boilers
b) Mobile boilers

FACTORS AFFACTING TO SELECTION OF BOILER

❖Following factors should be considered

- Quality of steam required
- Steam Generation rate
- Accessibility of repair and inspection
- Area
- Cost
- Erection facility
- Fuel and Water available

COMPONENTS OF A BOILER

- Boiler shell
- Combustion chamber
- Furnace
- Grate
- Heating surface
- Mounting
- Accessories

BOILER MOUNTINGS

- Pressure Gauge
- Water level indicator
- Safety valve
- Fusible plug
- Blow of cock
- Steam stop valve
- Feed check valve

BOILER ACCESSORIES

Air preheater : It utilize the heat of exhaust gases.

Economizer: Heat is used to raise the temperature of feed water supplied to the boiler.

Steam super heater: Used to super heat the steam.

Feed pump: Raise the pressure of water and force it into the boiler.

Injector: Used to feed water in boilers.

Types of Boiler

FIRE TUBE BOILERS

- Simple vertical boiler
- Cochran boiler
- Locomotive boiler
- Lancashire boiler

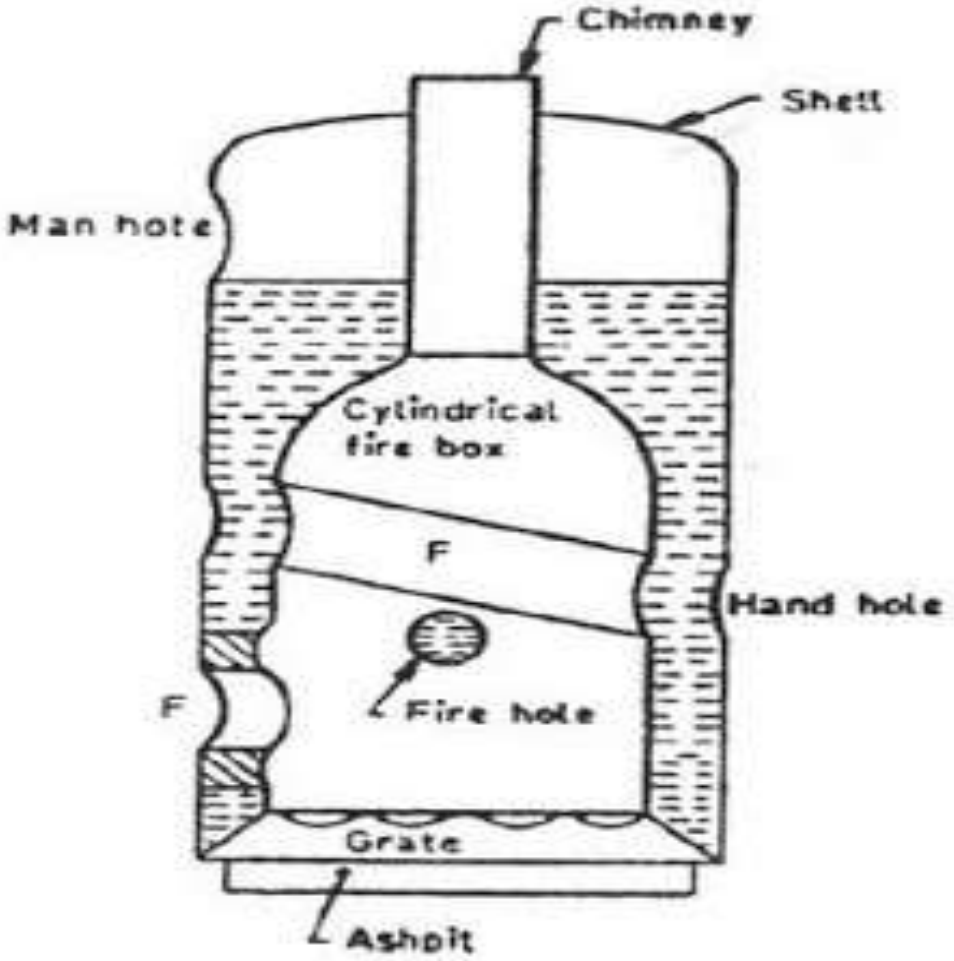
Water tube boiler

* La-Mont boiler
* Babcock and Wilcox boiler.

3-High pressure boiler

- La-Mont boiler
- Loeffler boiler
- Benson boiler

SIMPLE VERTICLE BOILER



COCHRAN BOILER

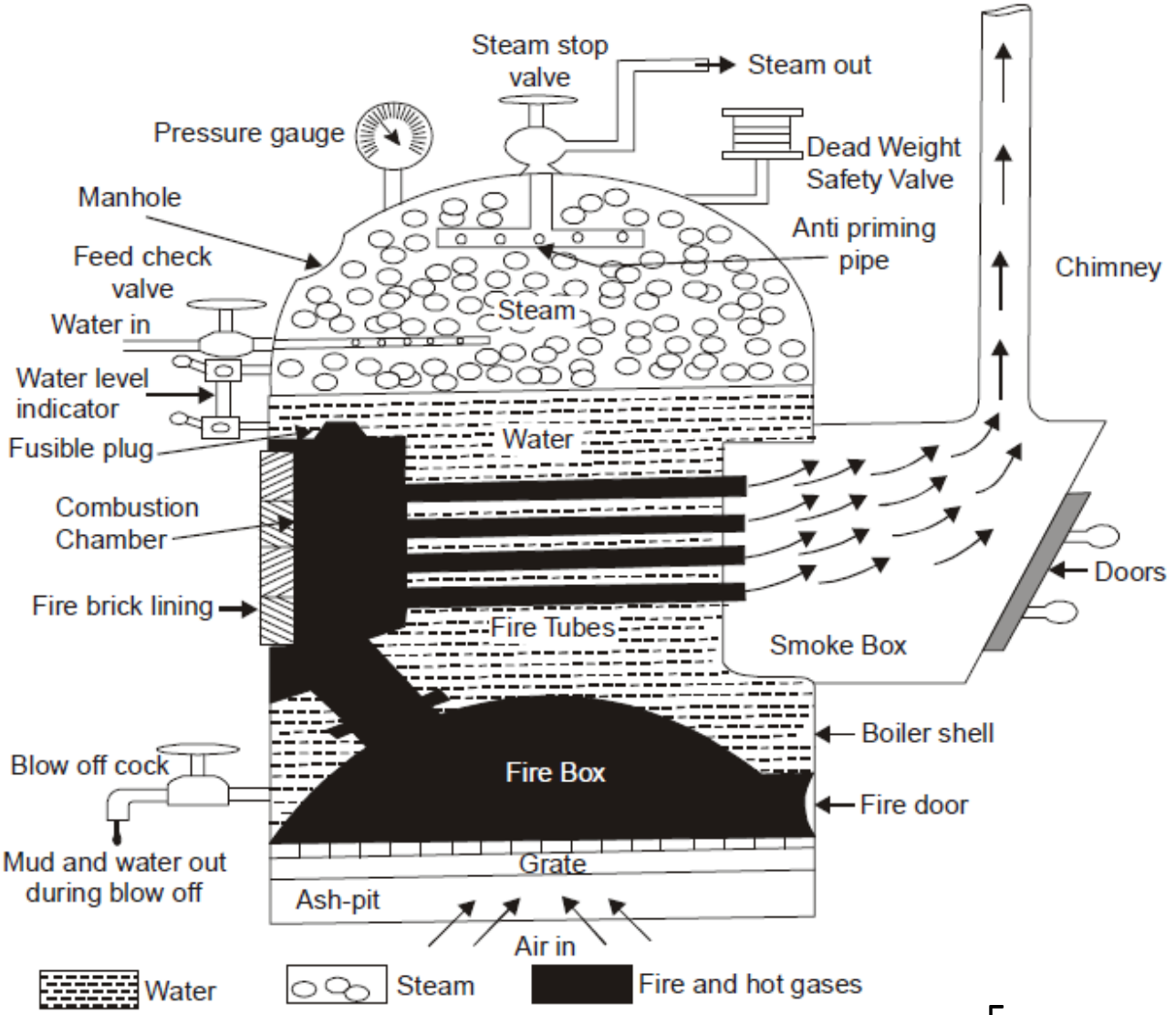


Fig. 5.1. Cochran Boiler.

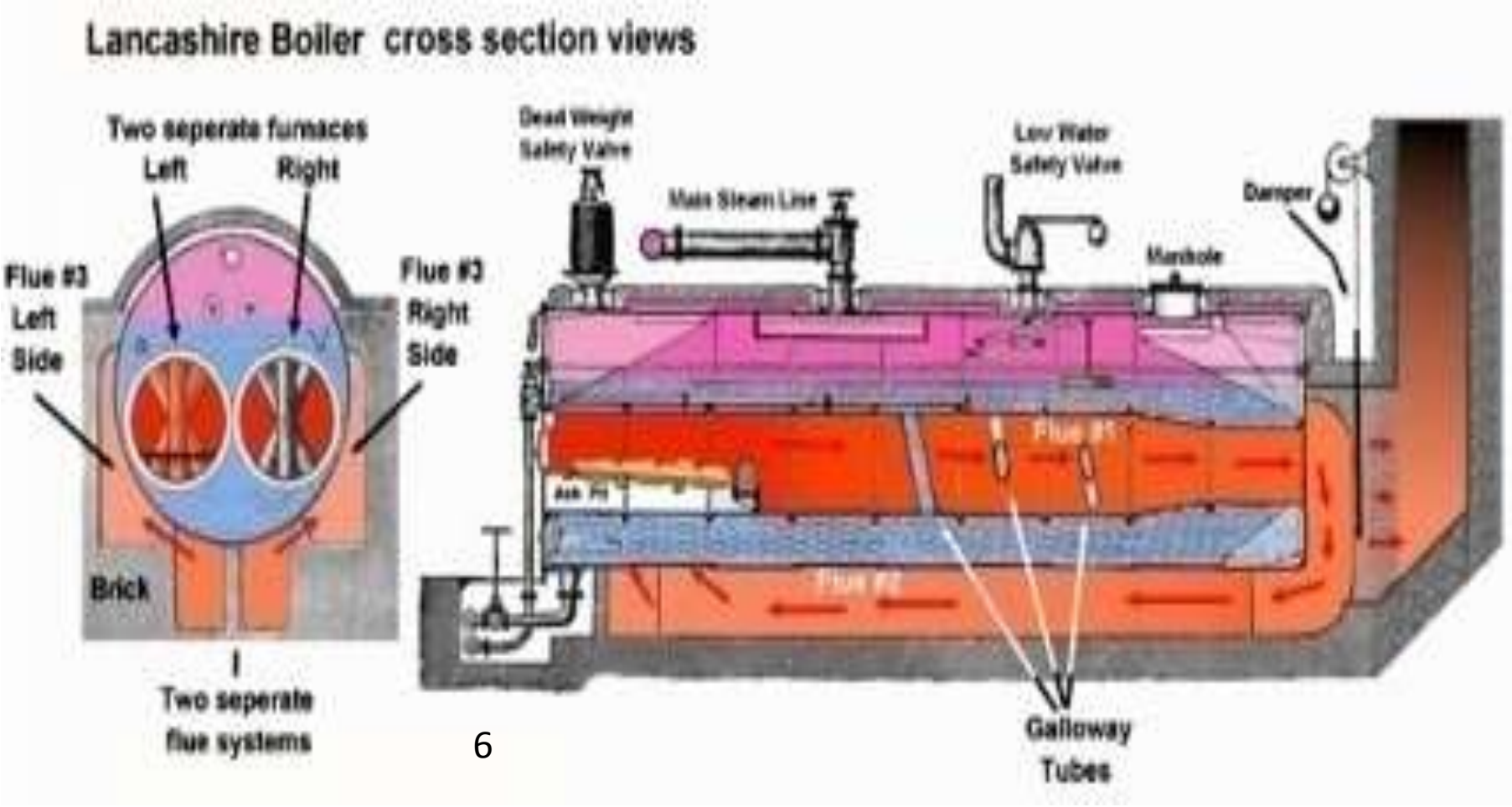
WORKING OF COCHRAN BOILER

- Considered to be one of the most efficient type multi tubular boilers.
- Consists of external cylindrical shell and fire box. The shell and fire box both are hemispherical.
- The fire box and 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.

WORKING OF COCHRAN BOILER

- The gases from the smoke box pass to the atmosphere through a chimney
- The external diameter of pipe is 62.5mm and are 165in number.
- Manhole is provided for cleaning.

LANCASHIRE BOILER



LANCASHIRE BOILER

- The boiler consists of a long cylindrical external shell (1) built of steel plates in sections riveted together.
- It has two large internal flue tubes (2).
- A fire grate (3) is also called furnace is provided at one end of the flue tubes on which solid fuel is burnt.
- At the end of the fire grate there is a brick arch (5) to deflect the flue gases upwards.
- The hot flue gases leaving internal flue tubes passes through the bottom tube(6).

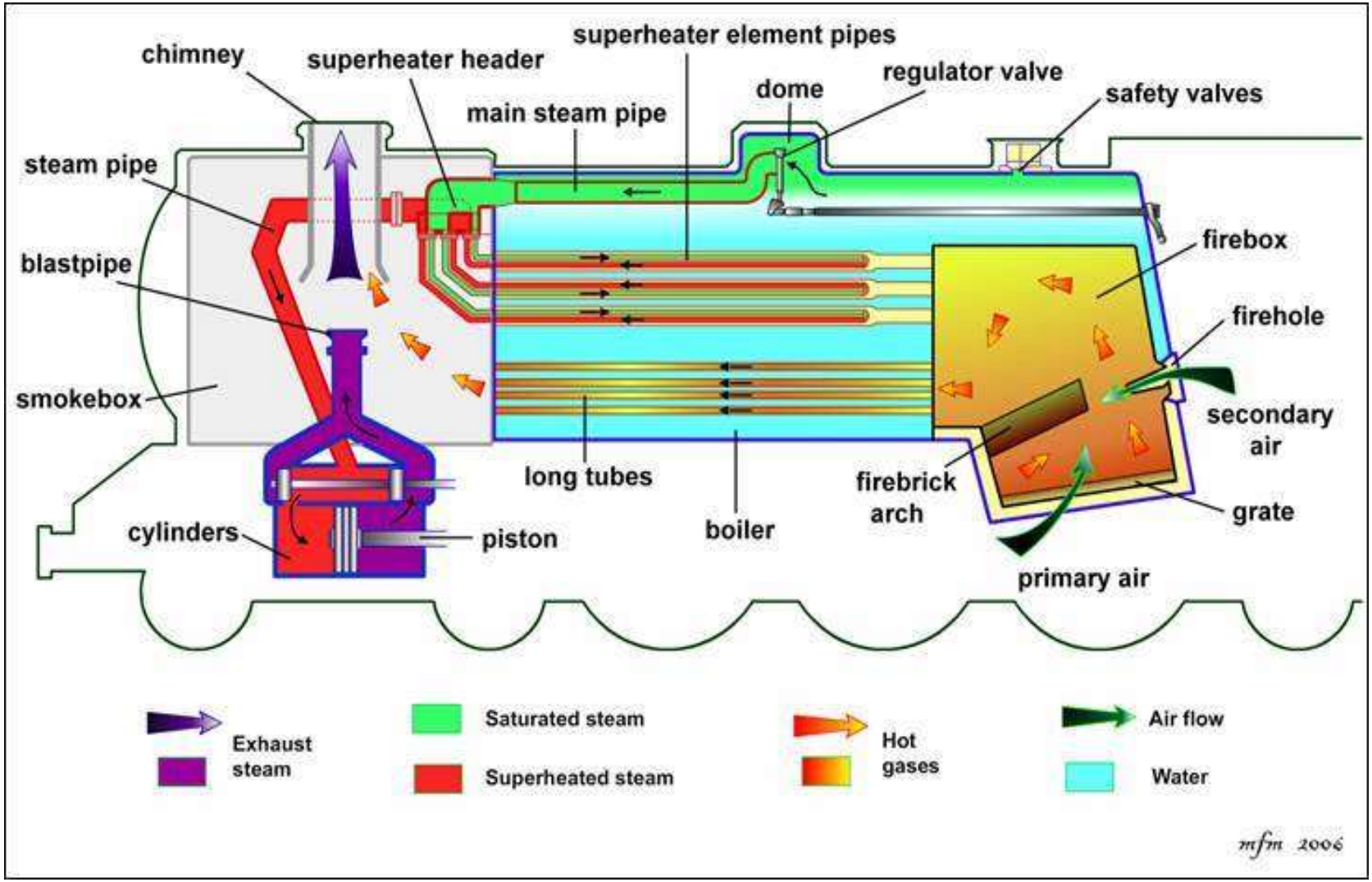
LANCASHIRE BOILER

- These flue gases move to the front of the boiler where they divide and flow into side tube (7).
- The flue gases then enter the main flue (9) which leads them to chimney.
- The damper (8) is fitted at one side flues to control the draught and thus regulate the rate of generation of steam.
- A spring loaded safety valve (10) and stop valve (11) are mounted.

LOCOMOTIVE BOILER

- Locomotive boiler is a horizontal fire tube type mobile boiler. The main requirement of this boiler is that it should produce steam at a very high rate. Therefore, this boiler requires a large amount of heating surface and large grate area to burn coal at a rapid rate. In order to provide the large heating surface area, a large number of fire tubes are setup and heat transfer rate is increased by creating strong draught by means of steam jet

LOCOMOTIVE BOILER

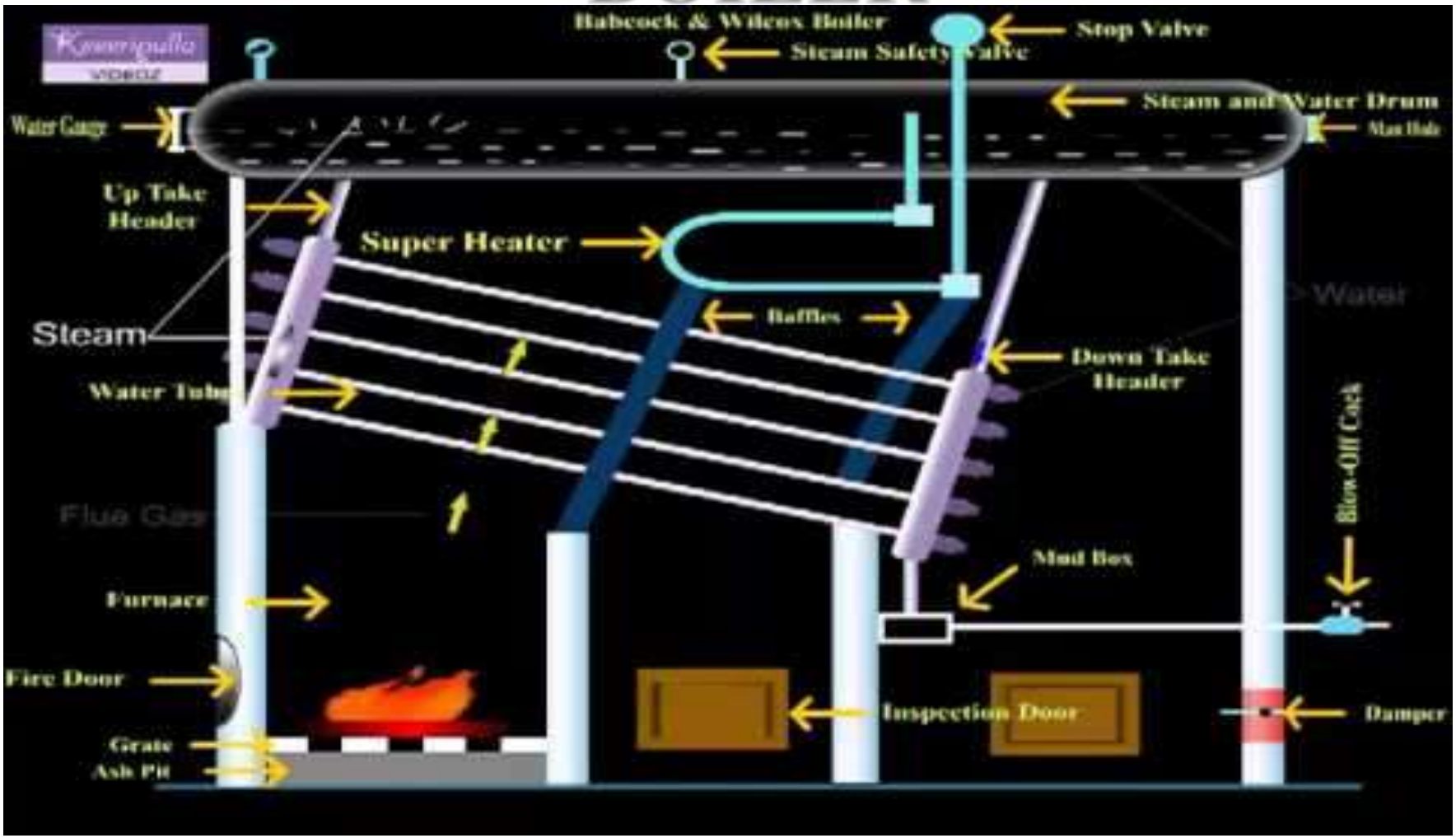


ADVANTAGES

- Large rate of steam generation per square metre of heating surface. To some extent this is due to the vibration caused by the motion.
- It is free from brickwork, special foundation and chimney. This reduces the cost of installation.
- It is very compact.

The pressure of the steam is limited to about 20 bar.

BABCOCK AND WILCOX BOILER



1. This is an example of water tube boiler and is used in stationary and marine engine.
2. The efficiency of this boiler is much greater than that of the fire tube boiler.
3. This boiler is used when pressure is above 10bar and steam generating capacity is required higher then 7000kg/hr.

BOILER MOUNTINGS

- ❖ SAFETY MOUTINGS
  - ➢ Safety valves (2 Nos)
  - ➢ Fusible plug
- ❖ Control mountings
  - ➢ Water level indicator
  - ➢ Pressure Gauge
  - ➢ Blow of cock
  - ➢ Steam stop valve
  - ➢ Feed check valve
- ❖ Inspection Mountings
  - ➢ Man hole
  - ➢ Mud hole

BOILER ACCESORIES

- ***Air preheater :*** It utilize the heat of exhaust gases.
- ***Economizer:*** Heat is used to raise the temperature of feed water supplied to the boiler.
- ***Steam super heater:*** Used to super heat the steam.
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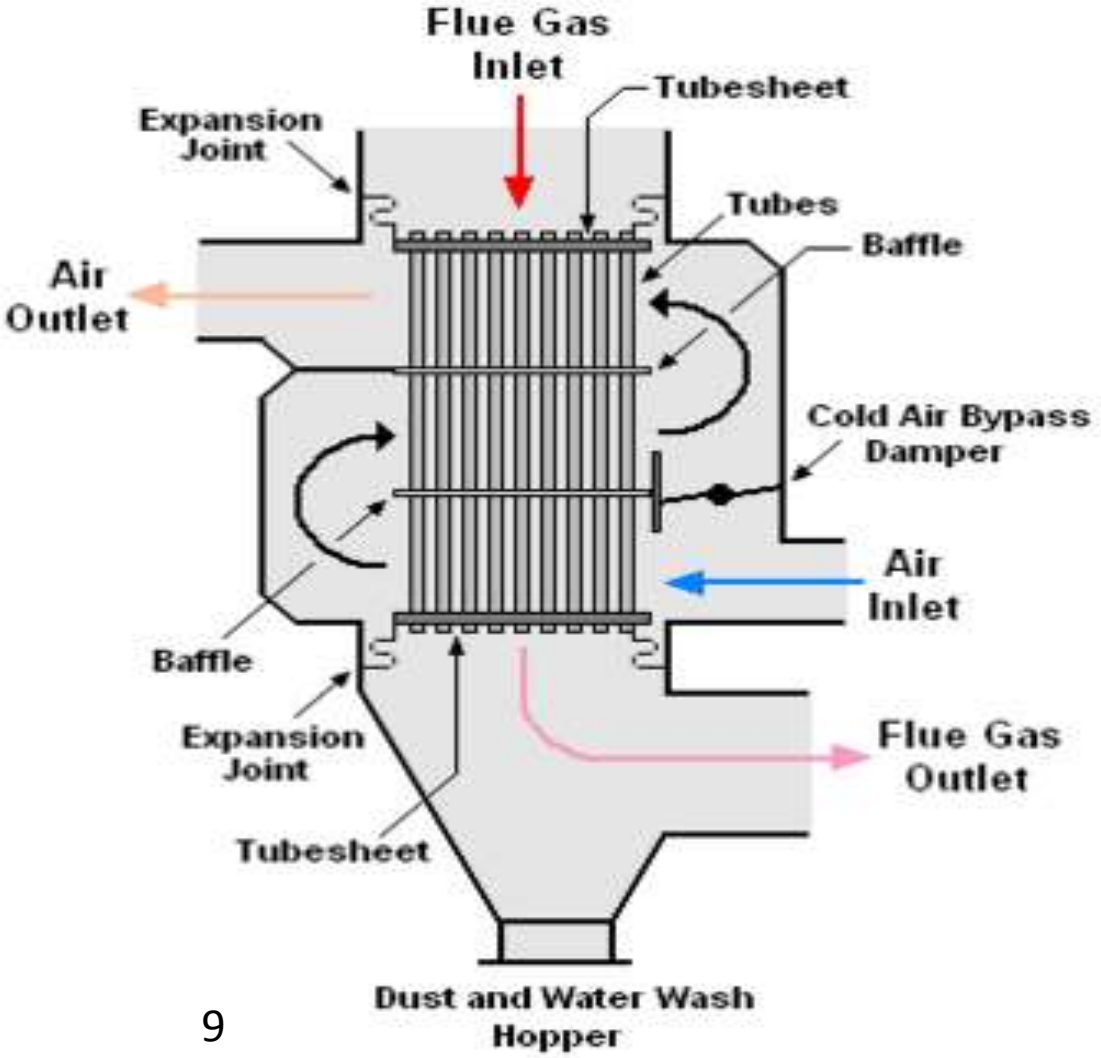
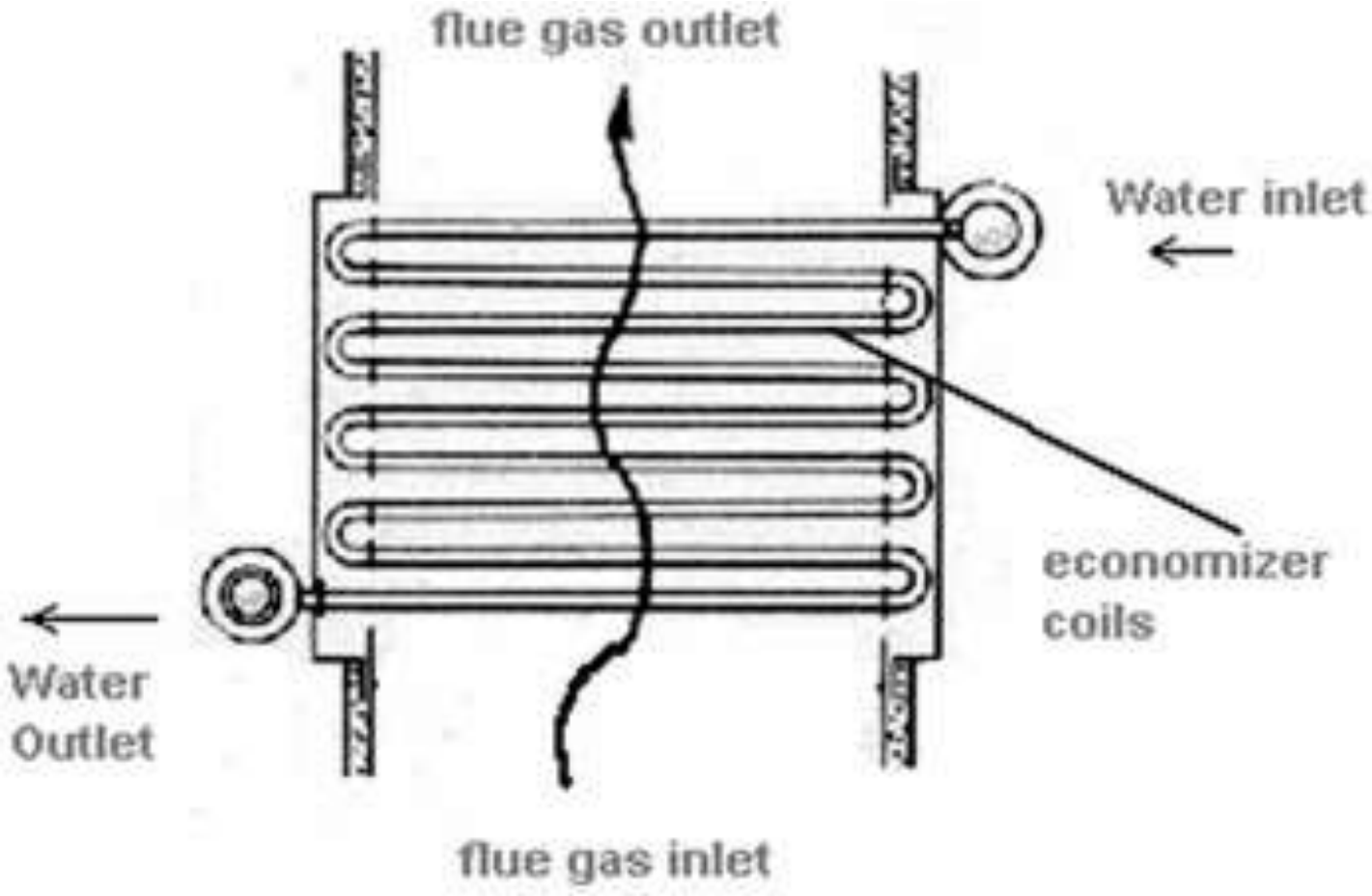
BOILER ACCESORIES

- ***Air preheater***



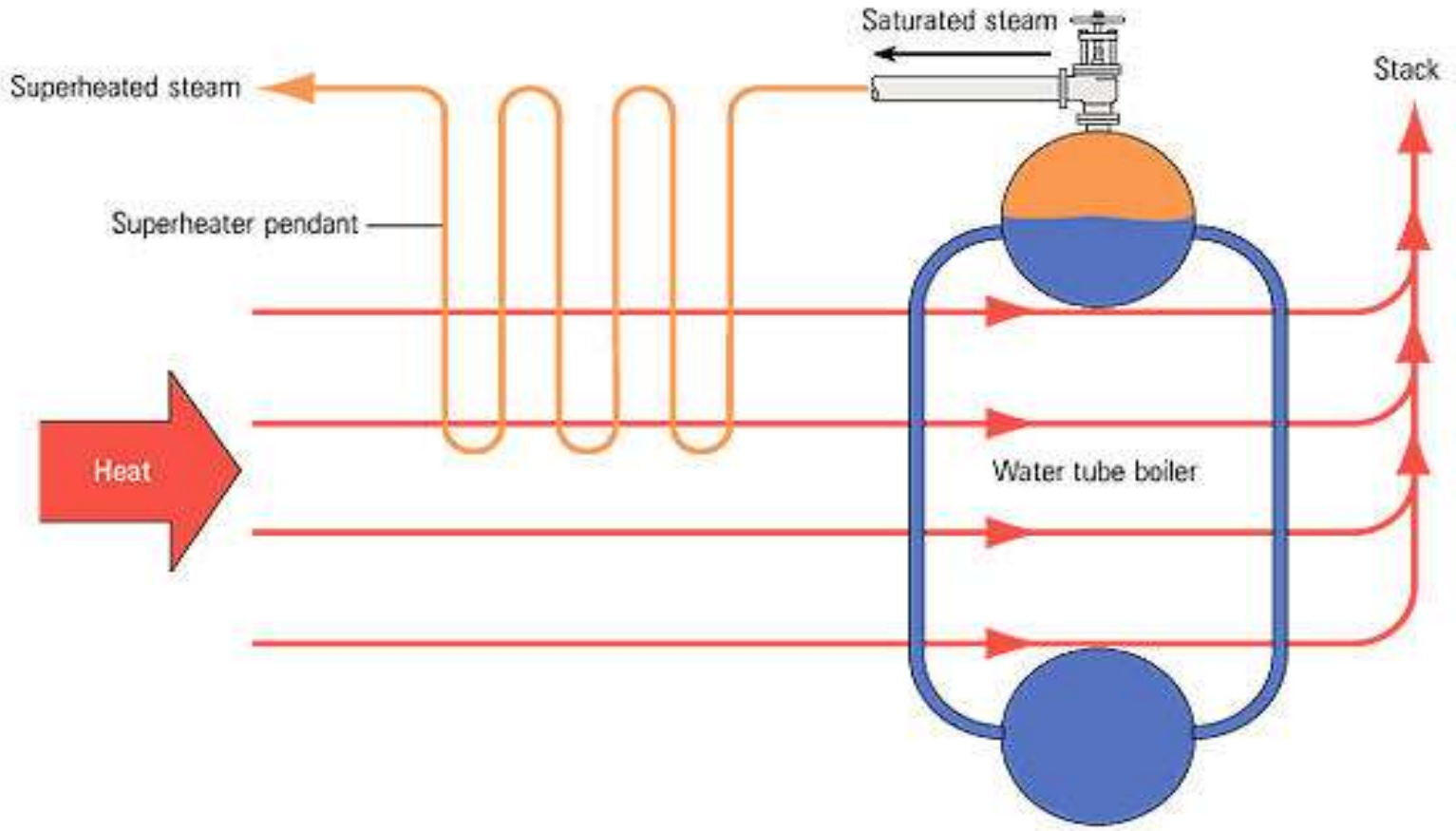
BOILER ACCESORIES

- ***Economizer***



BOILER ACCESORIES

- ***Steam super heater***



BOILER PERFORMENCE

1. Evaporative capacity
2. Equivalent evaporation
3. Factor of evaporation
4. Boiler efficiency

1. Evaporate capacity

- Ability to evaporate water.
- Generally it is expressed in terms of

A. Kg of steam/hour

B. Kg of steam /hour/area of heating surface

C. Kg of steam/kg of fuel is fired

2. Equivalent evaporation

- It can be defined as the amount of water evaporated from water at 100 deg C to dry and saturated steam at 100 deg C.
- Simply it means that the capacity of boiler to generate same evaporation.

3. Factor of evaporation

- Ratio of heat received by 1kg water under working condition to that received by 1kg of water evaporated from and at 100deg C.
- $Fc=h-h_f/2257$

4. Boiler efficiency

- Ratio of heat utilized to the heat supplied.
- Efficiency= ma (h – hf)/c
- Where ma=mass of water actual evaporated to the system
- C= calorific value to the fuel
- hf=enthalpy of water at given feed temp.
- h=enthalpy of fuel.

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