BOILERS

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.

IMPORTANT TERMS OF BOILER:-

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 is burnt. It consists of cast Iron bars which are spaced apart so that air can pass through them. The surface area of the grate, over which the fire is laid, is called grate surface

It is the space, above the grate and below the boiler shell, in which the fuel is actually burnt. It is also called as firebox

5. Heating Surface:

It is the part of Boiler surface, which is exposed to the fire (or ht 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 safety without the mounting.

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. They help in controling and running the boiler efficiently.

SELECTION OF A STEAM BOILER:-

1) The power required and the working pressure.
2) The rate at which the steam is to be generated.
3) The geographical position of power house.
4) The fuel and water available.
5) The type of fuel to be used.
6) The probable permanency of the station.

CLASSIFICATION OF STEAM BOILERS:

(1) ACCORDING TO THE CONTENTS IN THE TUBE:

(a) Fire tube or smoke tube BOILER

(b) Water tube BOILER.

In fire tube steam Boilers, the flame and hot gases produced by the combustion of fuel, pass through the tubes which are surrounded by water. The heat is conducted through the walls of the tubes from the hot gases to the surrounding water.

Ex: Simple vertical Boiler, Cochran Boiler, Lancashire, Cornish, Scotch marine, Locomotive and Velcan Boiler.

In water tube steam boiler, the water is contained inside the tubes which are surrounded by flames, and hot gases from outside.

Ex: Babcock and Wilcox, Stirling, La-Mount, Benson, Yarrow, Loeffler Boilers.

ACCORDING TO POSITION OF FURNACE:-

(a) Internally fired (b) Externally fired.

In internally fired steam Boilers, the furnace is located inside the Boiler shell; Most of the fire tube steam Boilers are internally fired.

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

3) According TO AXIS OF THE SHELL:-

(a) VERTICAL (b) HORIZONTAL

In vertical Boilers, the axis of the shell is vertical.

Ex: Simple vertical Boiler, Cochran Boiler.

In horizontal Boiler, the axis of the shell is horizontal.

Ex: Lancashire, Locomotive, Babcock wilcox

4) ACCORDING TO NUMBER OF TUBES:-

(a) SINGLE TUBE

(b) MULTI TUBULAR BOILER.

In Single tube boilers, there is only one fire & water tube. Simple vertical and Cornish boiler are Single tube boilers.

In multitubular boiler, there are two & more fire & wat tubes.

Ex:- Lancashire, Locomotive, Cochran, Babcock-wilcox

ACCORDING TO METHOD CIRCULATION OF WATER & STEAM:-

(a) Natural Circulation (b) FORCED CIRCULATION

In natural Circulation Boilers, the circulation of water is by natural convection currents, which are setup during the heating of water. In most of Boilers, there is a natural circulation of water.

In forced circulation boiler, there is a forced circulation of water by a centrifugal pump driven by some external power. It is made in high pressure Boilers such as La-Mont, Benson, Loeffler, and Velox

6) ACCORDING TO USE:

(a) STATIONARY (b) MOBILE

The Stationary Boilers are used in power plants, and in industrial process work. These are called stationary because they do not move from one place to another.

The mobile steam Boilers are those which move from one place to another. These are locomotive and Marine Boilers.

7) ACCORDING TO SOURCE OF HEAT:

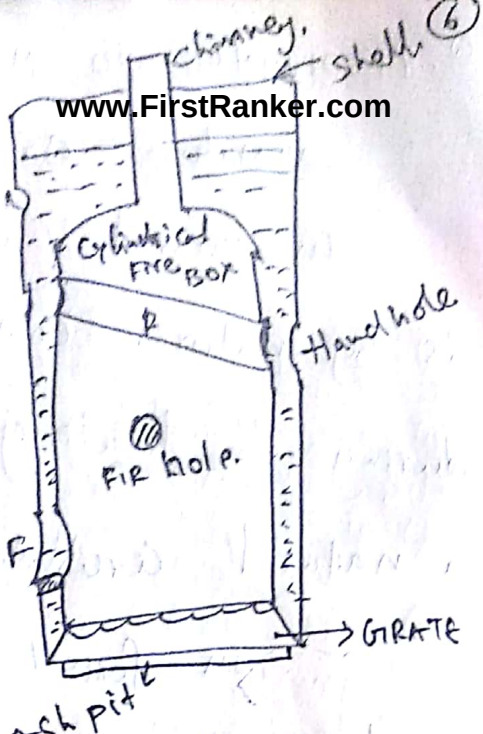
The sources may be the combustion of solid, liquid or gaseous fuel, hot waste gases as by products of other chemical process, electrical energy or nuclear energy.

(6)

LE VERTICAL BOILER:

A simple vertical Boiler produces steam at low pressure in small quantities.

It is, therefore, used for low power generation at places where the space is limited.



It consists of a cylindrical shell surrounding a nearly cylindrical fire box. The fire box is slightly taped towards the top to allow the ready ready passage of steam to the surface. At the bottom of the fire box, is a grate. The fire box is fitted with two or more inclined cross tubes F.F. The inclination is provided to increase the heating surface as well as to provided to increase the improve the circulation of water. The handholes are provided opposite to the end of each water tube for cleaning deposits. Manhole is for cleaning the Boiler. The space between Boiler shell and fire box is filled with the water. A mud hole is placed at the bottom of the shell to remove the mud, that settles down.

COCHRAN BOILER OR VERTICAL MULTITUBULAR BOILER:

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.

The Boiler consists of an cylindrical shell and a fire box of 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 fire box is also advantageous for resisting intense heat. The fire box and combustion chamber connected through a short pipe. The flue gases from the combustion chamber flow to the smoke Box through a number of smoke tubes which have 62.5mm external Dia and are in 165 in number. The gases from the smoke Box pass to the atmosphere through a chimney. The combustion chamber is line 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 and the coal is fed through the fire hole, which contains the oil Burner.

LANCASHIRE BOILER:-

→ It is a Stationary, fire tube, internally fired horizontal and natural Circulation Boiler. It is used where working pressure and power required are moderate. These Boilers have a cylindrical shell of 1.75m to 2.75m Dia.

→ Its length varies from 7.25m to 9m. It has two internal flue tubes having Diameter about 0.4 times that of shell. This type of Boiler is set in Brick wall forming external flue, so that part of heating surface is on the external shell.

→ This Boiler consists of a Long cylindrical external shell built of steel plates, in sections riveted together.

→ It has two long internal flue tubes, which are reduced in Diameter at the back end to provide access to the lower part of the Boiler.

→ A fire grate also called furnace, is provided at the one end of the flue tubes in which solid fuel is burnt.

→ At the end of the fire grate, there is Brickwork to deflect the flue gases upwards. The hot flue gases, after leaving the internal flue tubes pass downto

to the bottom tube and move to the front of the Boiler where they divide and flow into the side flue.

→ The flue gases then enter the main flue, which leads them to chimney.

→ The damper is fitted at the end of side flues to control the draught and thus regulate the rate of generation of steam. These dampers are operated by chain passing over a pulley at the front of the Boiler.

→ The stop valve supplies steam to the engine as required. A high steam and low water safety valve is also provided.

→ A perforated feed pipe controlled by a feed valve is used for feeding water uniformly. when the Boiler is strongly heated. The steam generated carries a large quantity of water in the steame space, known as priming. An antipriming pipe is provided to separate out water as far as possible.

CORNISH BOILER:-

→ It is similar to the Lancashire boiler in all respects, except there is only one fire tube in Cornish Boiler instead of two in Lancashire Boiler.

→ The Diameter of Cornish Boiler is generally 1m to 2m and its length varies from 5m to 7.5m.

→ The Diameter of flue tube may be about 0.6 times that of shell.

→ The capacity & working pressure is low.

LOCOMOTIVE BOILER:

→ It is a multi tubular, horizontal, internally fired and mobile Boiler. The principal feature of this Boiler is to produce steam at high rate.

→ It consists of a shell or barrel having 1.5m Diameter and 4m in length.

→ The coal is fed into the fire box through the fire door and burns on grate.

→ The flue gases from the grate are deflected by a Brick arch, and thus whole of the fire box is properly heated There are about 157 tubes or fire tubes (47.5mm Dia) and 2.4 thick

→ The flue gases after passing through the tubes enter a Smoke Box and are then lead to atmosphere through a Chimney.

→ The Boiler contains water around the tubes, which is heated up by the flue gases and gets converted into steam.

→ A stop valve as regulator is provided inside a cylindrical Steam Dome, which is operated by a regulator Shaft from the Engine room by a Driver.

→ The heater is divided into two portions. one is Superheated steam chamber and other is Saturated steam chamber.

→ The steam pipe leads to the steam from the regulator to the Saturated steam chamber.

→ It then leads the steam to the Superheated tubes, and after passing through these tubes, the steam returns back to the Superheated steam chamber

→ This steam now flows through the steam pipe to the cylinders one on each side.

Can be opened for cleaning

8) Repairing the Smoke Box

→ The ash from grate is collected in ash pan and is discharged out from time to time by opening it with the help of Dampers.

BABCOCK AND WILCOX BOILER:

→ It is a straight tube, stationary type water tube Boiler. It consists of a steam and water drum. It is connected by a short tube with uptake header & riser at the back end.

→ The water tubes (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 tube in that one tube is not in space of other. and hot gasses can pass properly after heating all tubes

→ The headers are provided with hand holes in the front of the tubes and are covered with caps.

→ There is a slow moving automatic chain grate on which the coal is fed from the hopper.

→ A fire bricks baffle causes hot gases to move upwards and downwards and again upwards before leaving the chimney.

→ The dampers are operated by a chain 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 are provided for a man to enter the Boiler for repairing and cleaning.

→ Water Circulates from the Drum into the header and through the tubes to header and again to the Drum. Water continues to Circulate like this till it is Evaporated.

→ A steam Superheater Consists of a large number of tubes and Contains two boxes; one is Superheated steam Box and other Saturated steam Box.

→ the steam generated above the water level in the Drum flows in the dry pipe and through the inlet tube into the Superheated Box.

→ The steam passes through the tube into the Superheated Steam Box.
→ The steam, During its passage through tubes, gets further heated and becomes Superheated
→ Now the steam is taken through the outlet pipe to the Stop Valve.

LAMONT BOILER:

→ This is a modern high pressure water tube steam Boiler working on a Forced Circulation.
→ The circulation is maintained by a Centrifugal pump, Driven by a steam turbine, using steam from the Boiler.
→ The forced circulation causes the feed water to circulate through the water walls and Drums Equal to ten times the mass of steam evaporated. This prevents the tube from being overheated.
→ The feed water passes through the economiser to an evaporating Drum. It is then drawn to the circulating pump through the tube.
→ The pump delivers the feed to the headers, at a pressure above the Drum pressure. The header distributes water through nozzles into the generating tubes acting in Parallel.

→ The steam and steam from these tubes passes into the Drum.

→ The steam in the drum is then Drawn through the Superheater.

LOEFFLER BOILER:-

→ This is the water tube Boiler using a forced circulation.

→ Its main principle of working is to evaporate the feed water by means of Superheated steam from the Superheater.

→ The hot gases from the furnace are used for superheating.

→ The feed water from the economiser tubes is forced to mix with Superheated steam in the evaporating Drum.

→ The Saturated steam, thus formed, is drawn from the evaporating drum by a steam circulating pump. This steam passes through the tubes of the Combustion Chamber walls and then enters the Superheater.

→ From the Superheater, about one third of the Superheated steam passes to the turbine and the remaining two third is used to evaporates the feed water in the evaporating Drum.

BENSON BOILER:

→ It is a high pressure, Drumless, water tube steam Boiler using forced circulation. In this Boiler the feed water enters at one end and discharges superheated steam at the other end.

→ The feed pump increases the pressure of water to supercritical pressure (i.e., above critical pressure of 225 bar) and thus the water directly transforms into steam without Boiling.

→ The feed water passes through the economiser to the water cooled walls of the furnace. The water receives heat by radiation and the temperature rises to almost critical temperature.

→ It then enters the evaporator and may of superheated.

→ Finally, it passed through superheater to obtain desired superheated steam.

→ The Benson Boiler is also known as light-weight Boiler as there is no large water and steam drum. The thermal efficiency upto 90% may be achieved. The average operating pressure and capacity of this Boiler is 250 bar and 135 tons/hr. It can be started with in 15 minutes.

1) The initial cost is Low Since there is no water drum (Steam Drum).

2) Since there is no pressure limit, so Supercritical pr. may be employ.

3) High pressure avoids the Bubble formation in the tubes which increase heat transforate.

4) It is a light-weight Boiler.

5) The Boiler Can be started with in 15 minutes.

SCOTCH MARINE BOILER:-

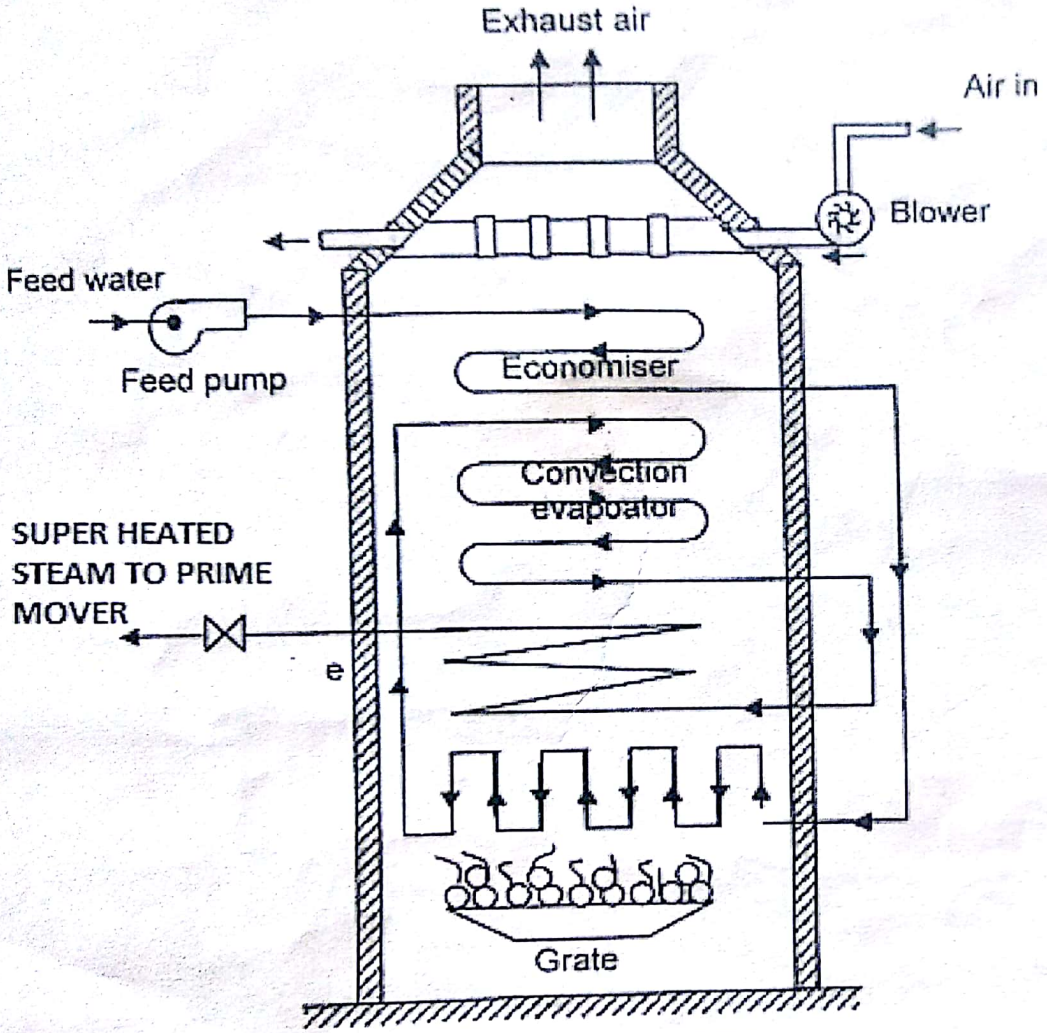
The marine steam Boiler of the Scotch Oil tank type are used for marine works, particularly, due to their compactness efficiency in operation and their ability to use any type of water. It does not require Brick work setting and external flues.

It has a Drum of Diameter from 2.5m to 3.5 meters placed horizontally. These steam boilers may be Single ended or double ended. The length of a Single ended steam Boiler may be upto 3.5 meters while for Double ended upto 6.5 meters

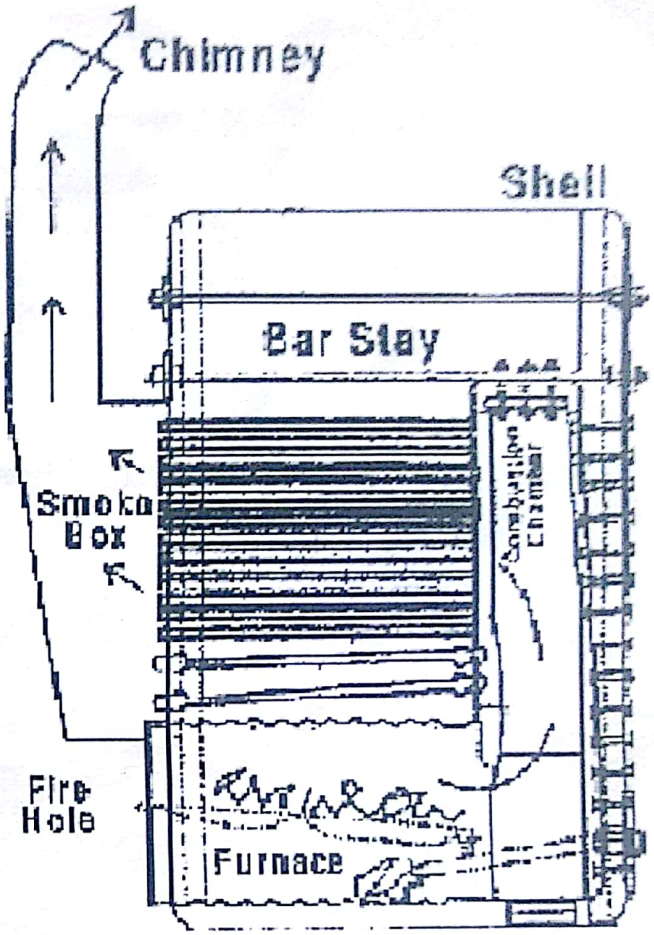
A Single ended Boiler has one to four furnaces which enter from front end of the Boiler. A double ended boiler has furnaces on both of its ends, and may have furnaces from three to four in each end.

furnaces are generally corrugated for strength Each furnace has its own combustion chamber. There are five flat plates in the combustion chamber, which require staying, i.e, the top plate, back plate, two side plates and the tube plates there are a no. of smoke tubes placed horizontally. The front and back plates of shell are strengthened by Longitudinally stays.

The combustion chamber walls form the best heating surface. The furnace tubes, smoke tubes and the combustion chamber, all being surrounded by water, give a very large heating surface area in portion to the cubical size of Boiler. The level of water is maintained a little above the combustion chamber. The flue gases, from the combustion chamber are forwarded by draught through the smoke tubes, and finally up the chimney.

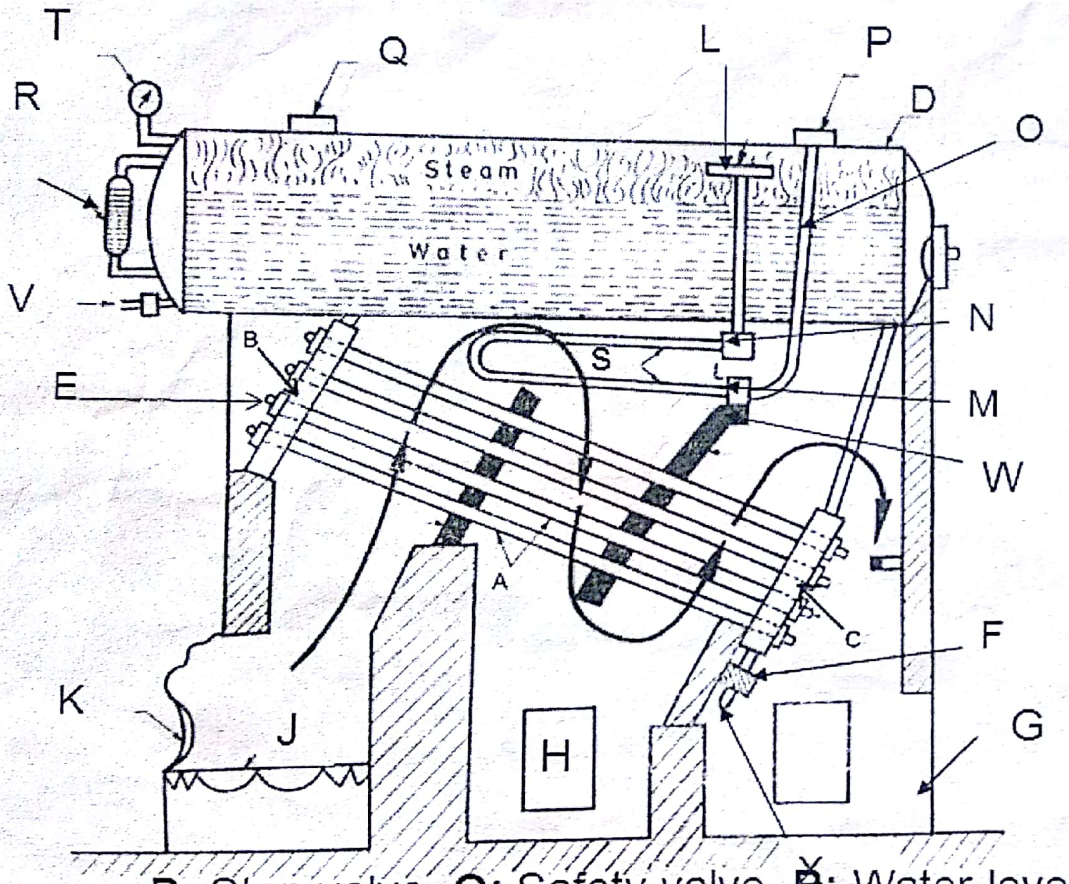


BENSON BOILER



SCOTCH MARINE BOILER

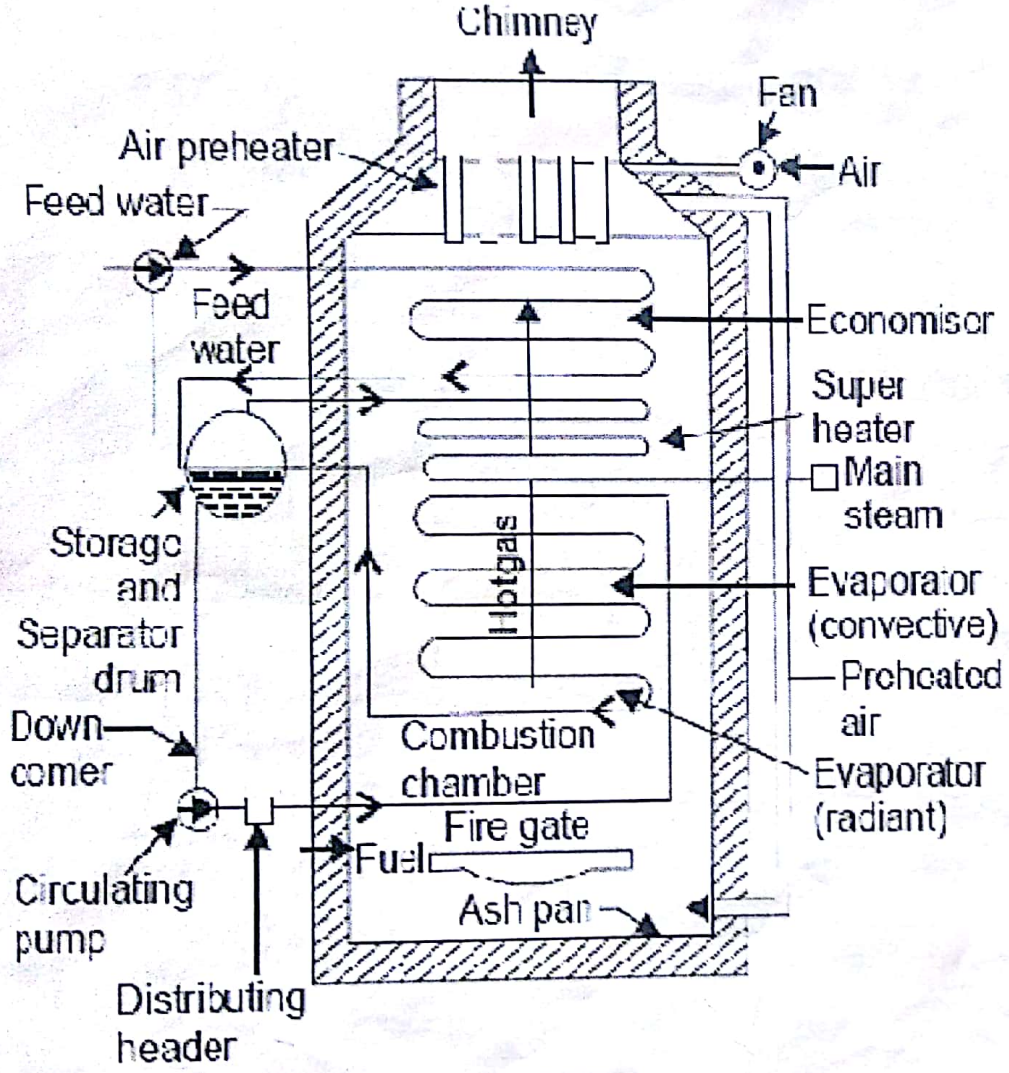
Babcock and Wilcox boiler



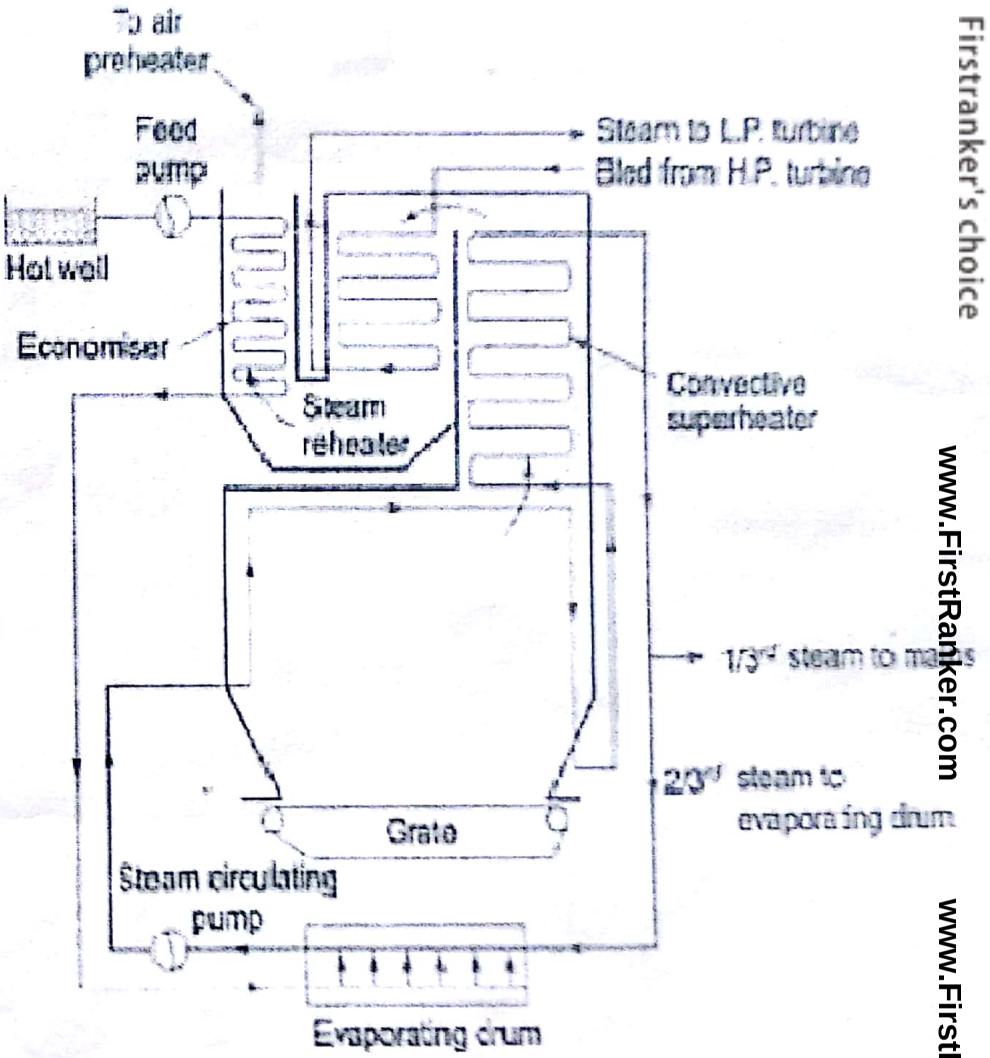
A: Water tubes
B: Uptake header
C: Downtake header
D: Water drum
E: Steel Caps
F: Mud Box
G: Dampers
H: Doors
J: Chain grate stoker
K: Furnace door
L: 'T' tube
M: Lower junction box
N: Upper junction box.
O: Stop valve connection

P: Stop valve, **Q:** Safety valve, **R:** Water-level indicator, **S:** Superheater,

T: Pressure gauge, **V:** Feed check valve, **W:** Baffles, **X:** Blowoff valve



LA-MONT BOILER



LOEFFLER BOILER

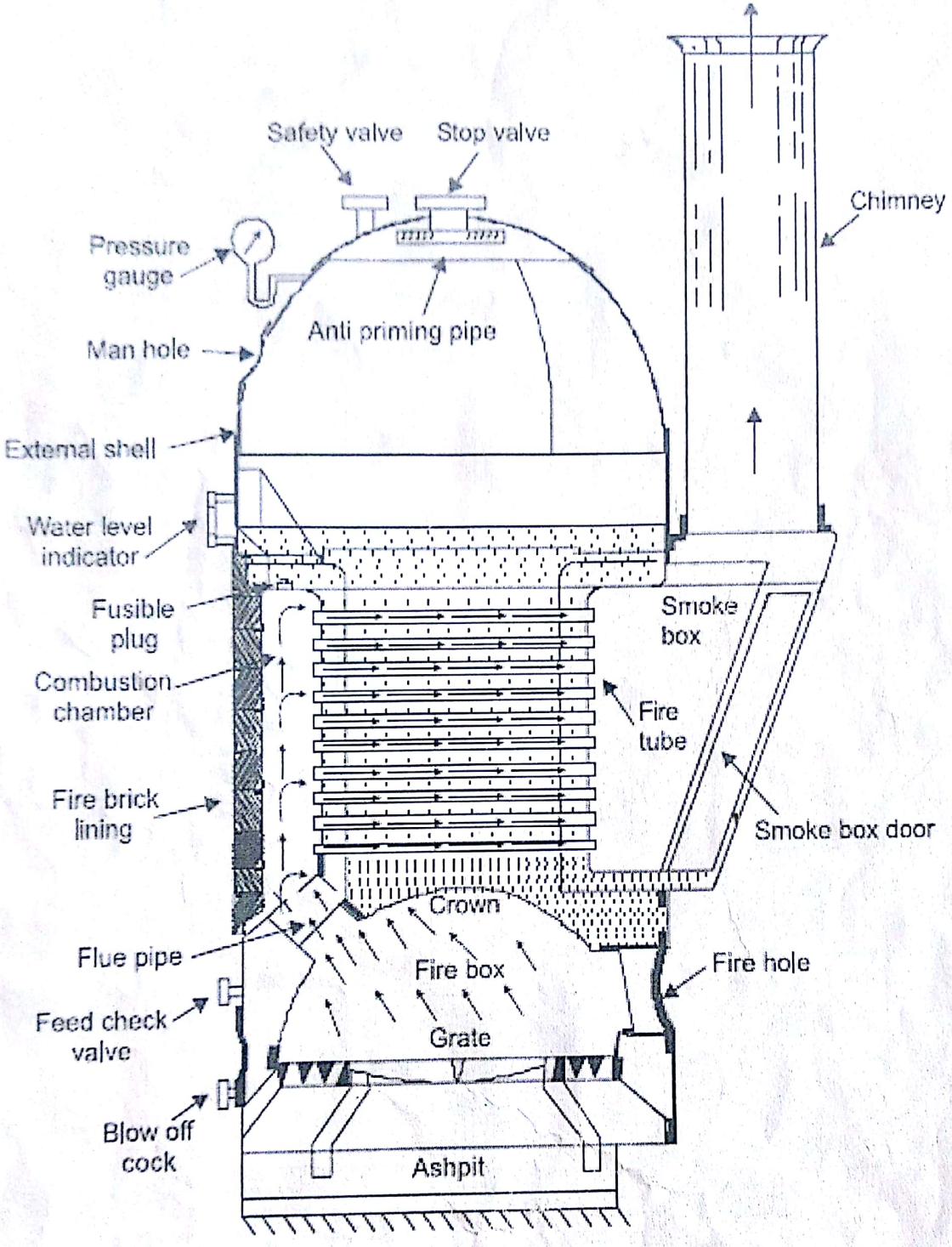
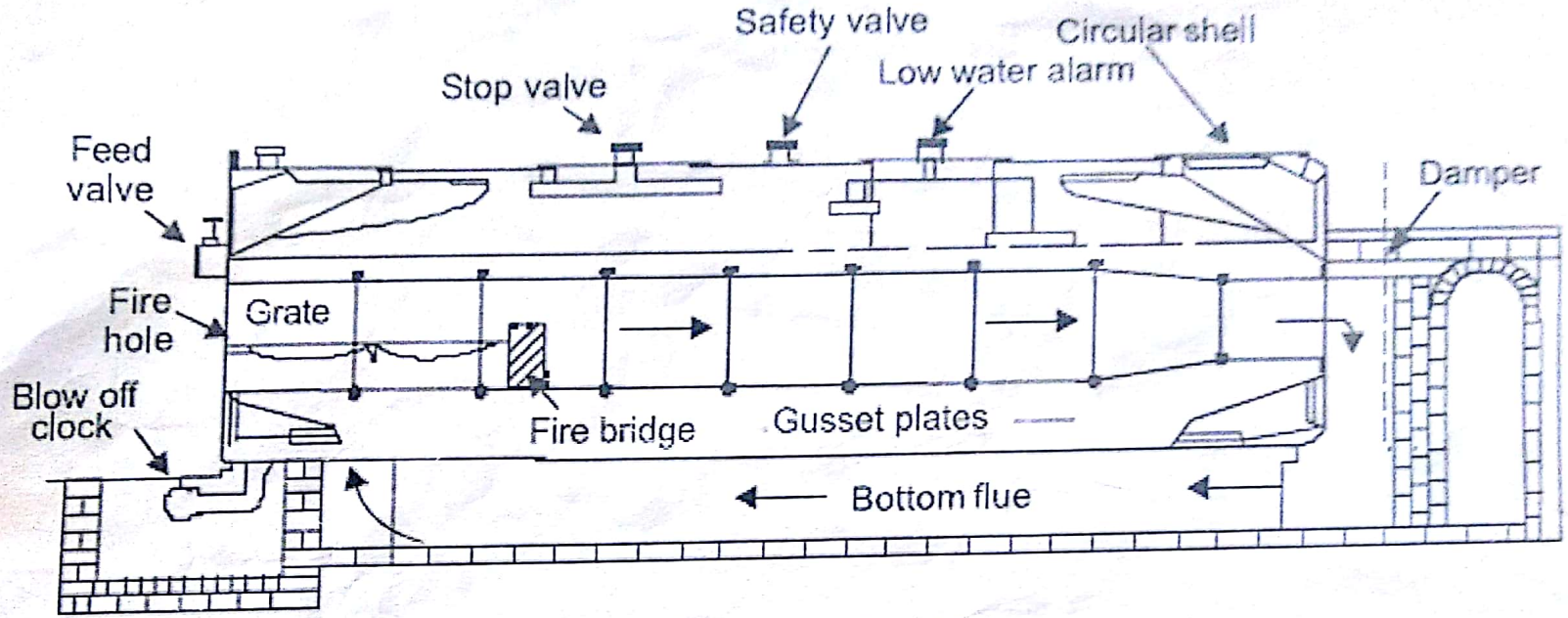
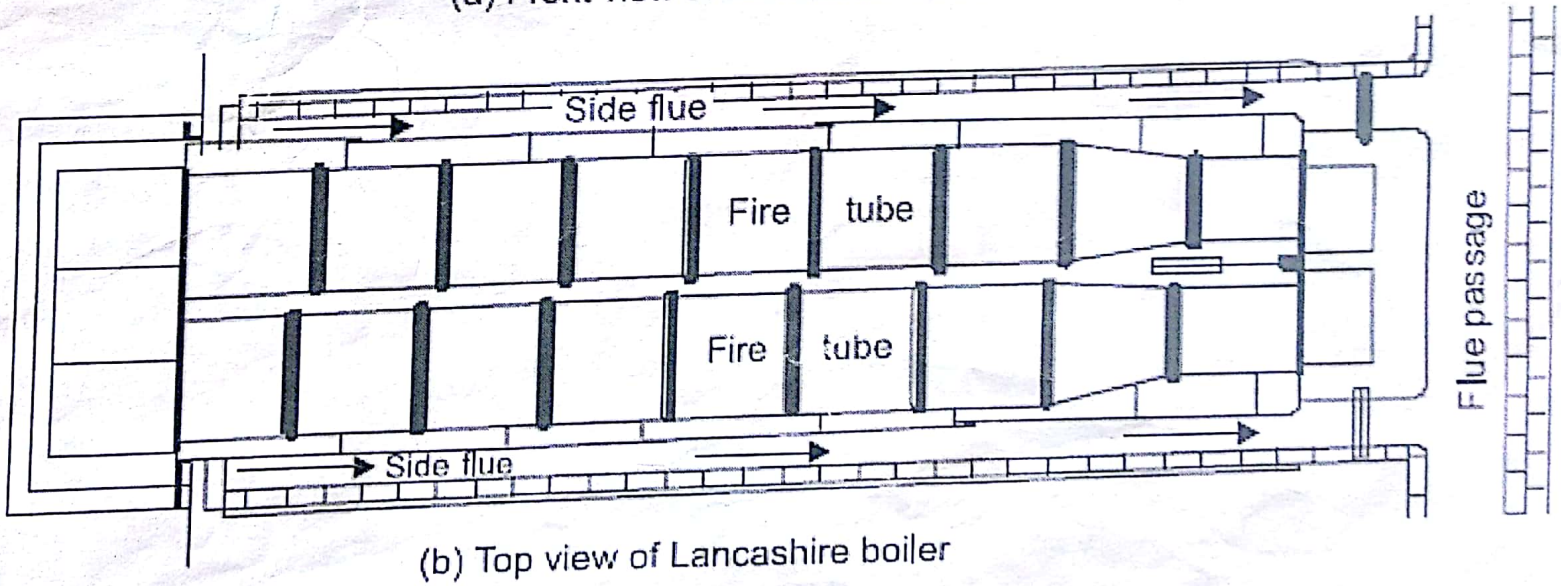


Fig. 11.7 *Cochran boiler*



(a) Front view of Lancashire boiler



(b) Top view of Lancashire boiler

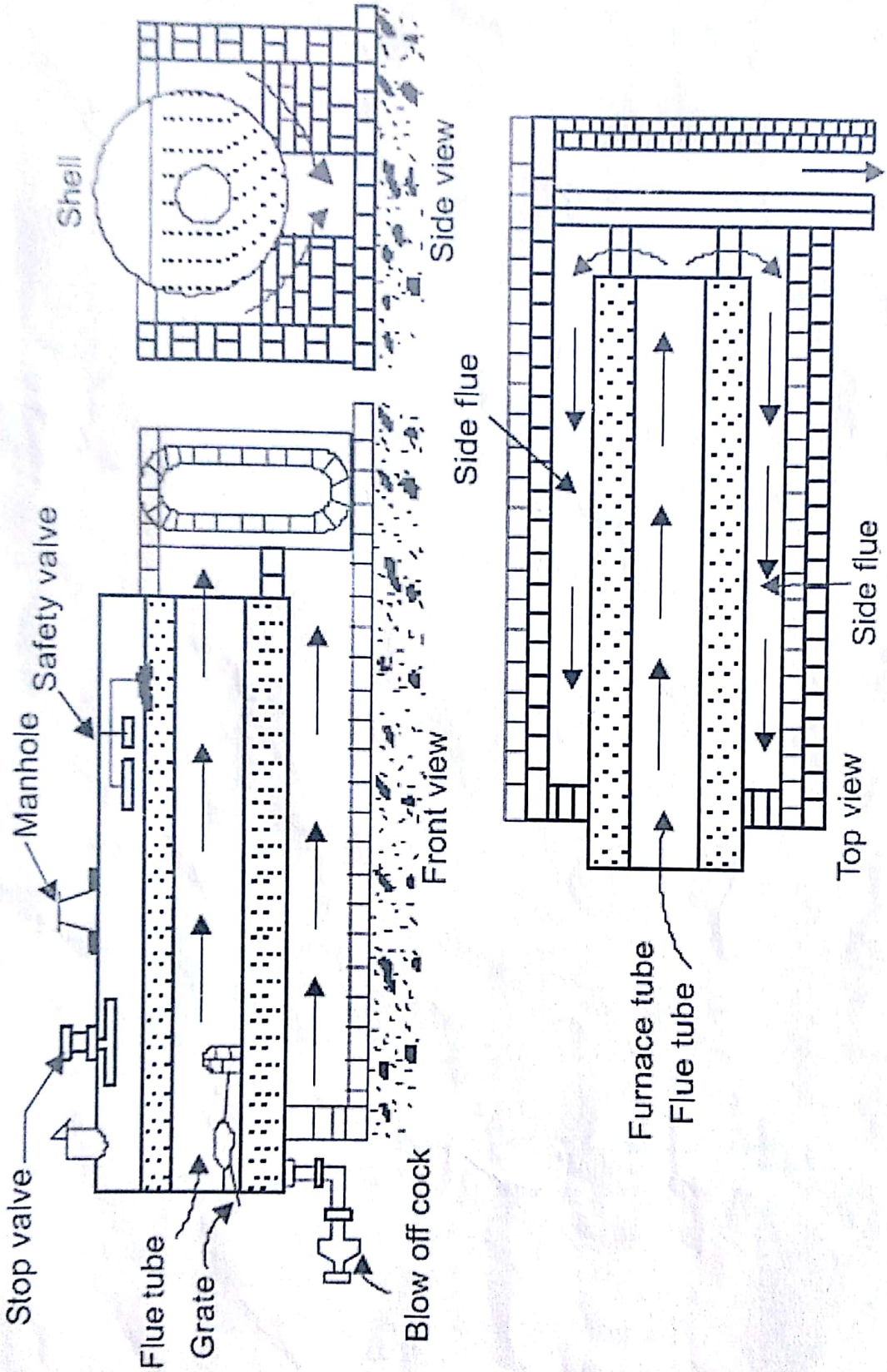
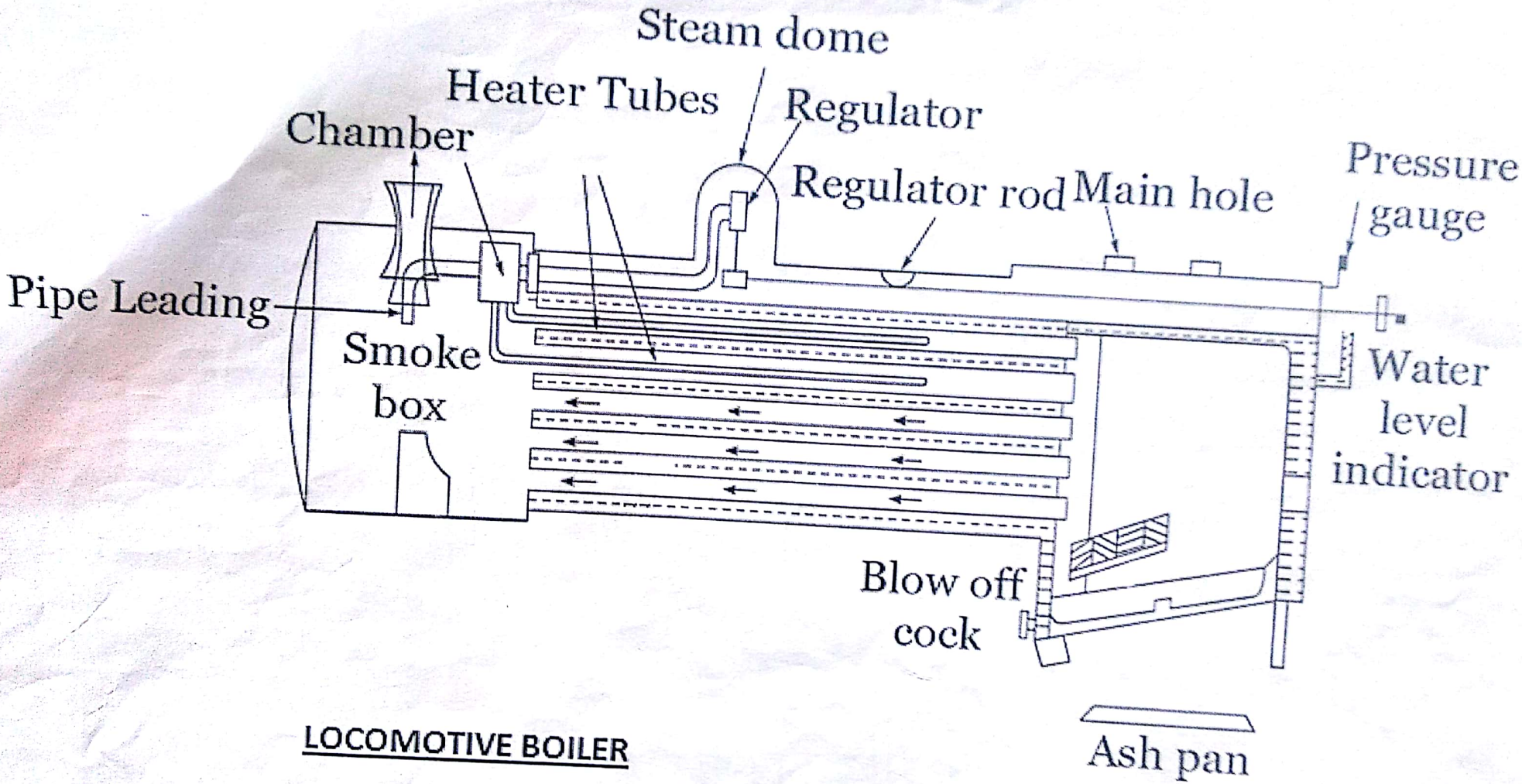


Fig. 11.9 *Cornish boiler*



LOCOMOTIVE BOILER

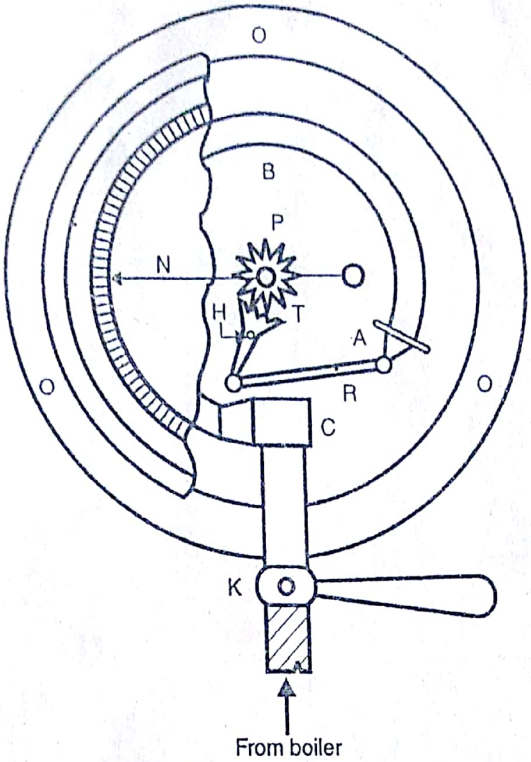


Fig. 2.2 Pressure Gauge

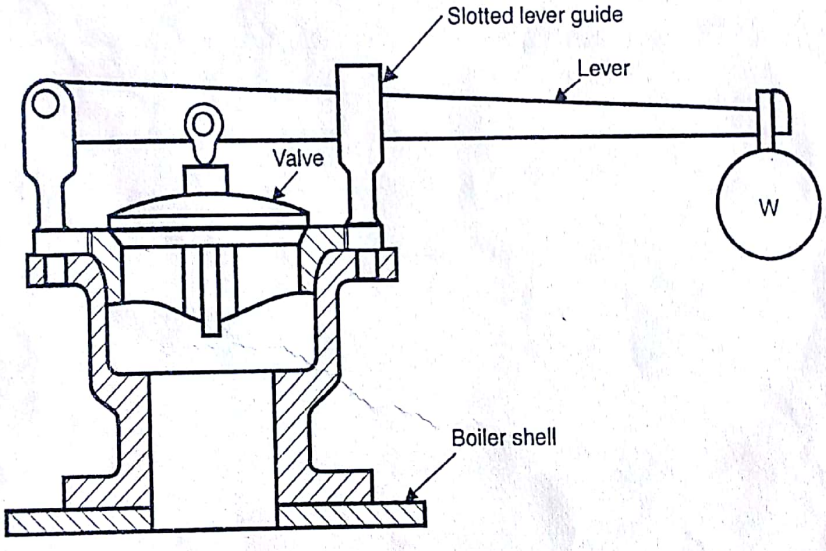
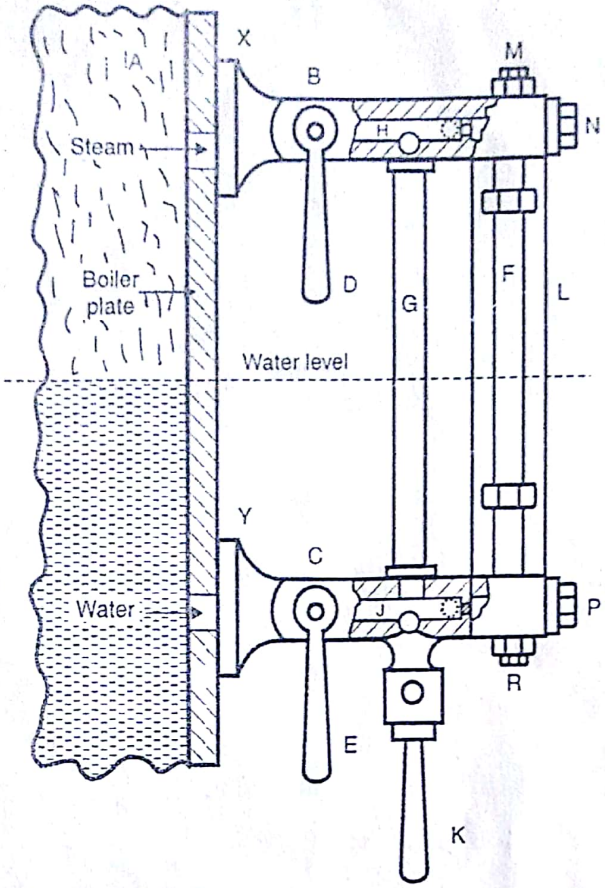


Fig. 2.3 Lever Safety Valve

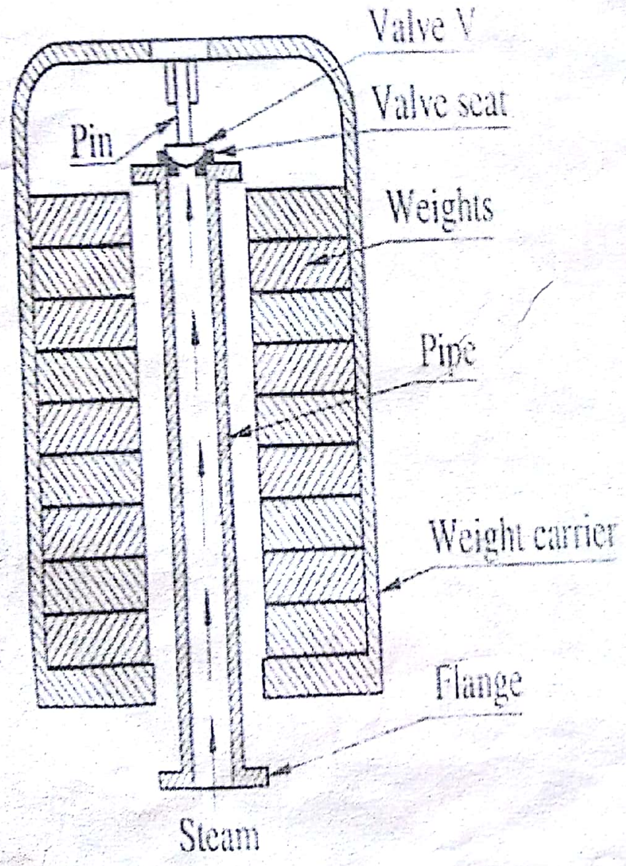


A = End plate of boiler
B and C = Hollow gun metal castings
D and E = Cocks
F = Gauge glass
G = Hollow metal column
H and J = Two balls
K = Drain cock
L = Guard glass
M, N, P, R = Screwed caps
X, Y = Flanges

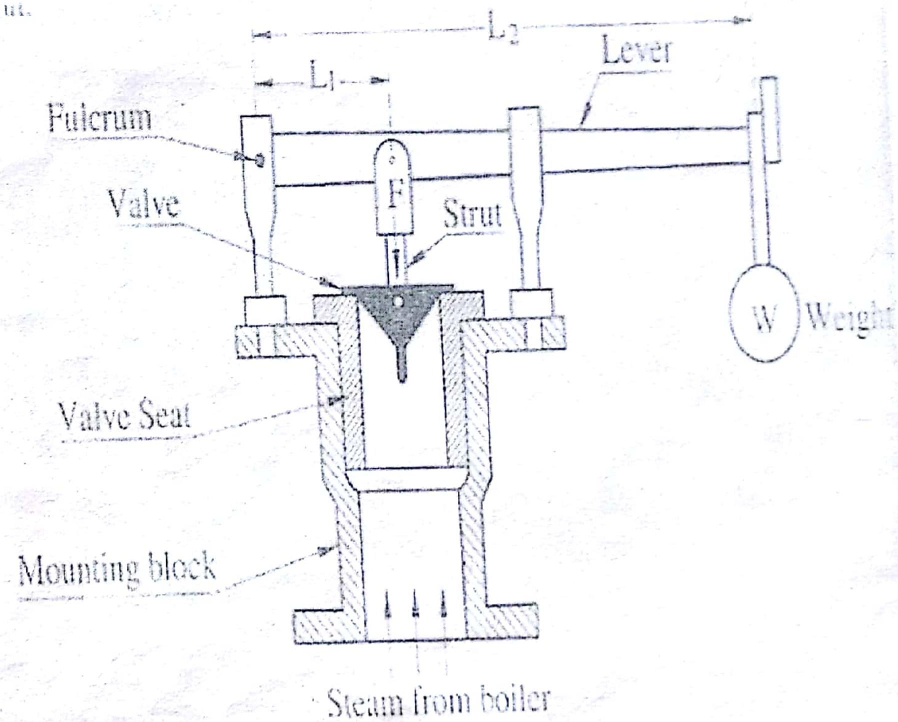
Fig. 2.1 Water Level Indicator

www.FirstRanker.com

Dead weight safety valve

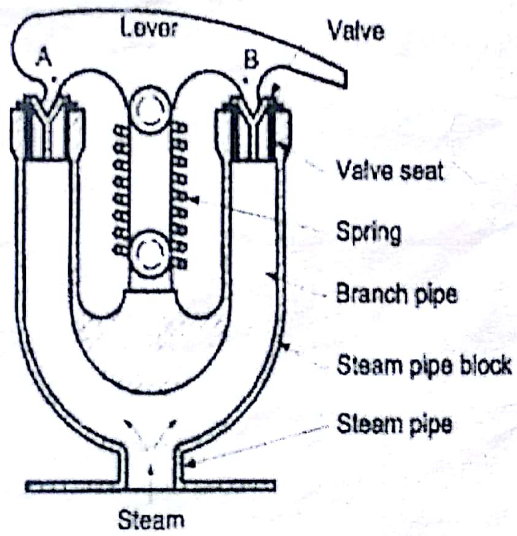


Lever safety valve

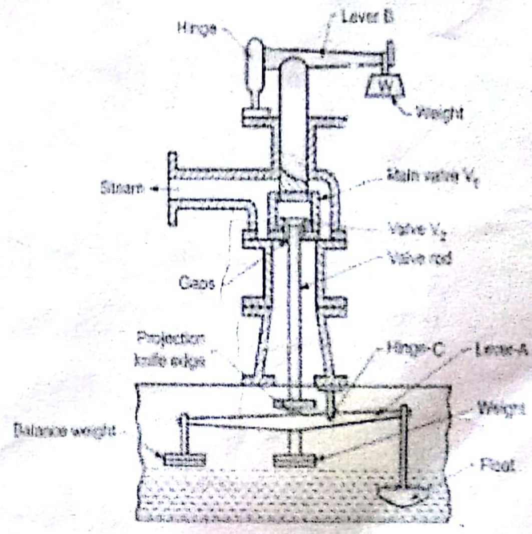


SAFETY VALVES

SPRING LOADED SAFETY VALVE



HIGH STEAM AND LOW WATER SAFETY VALVE



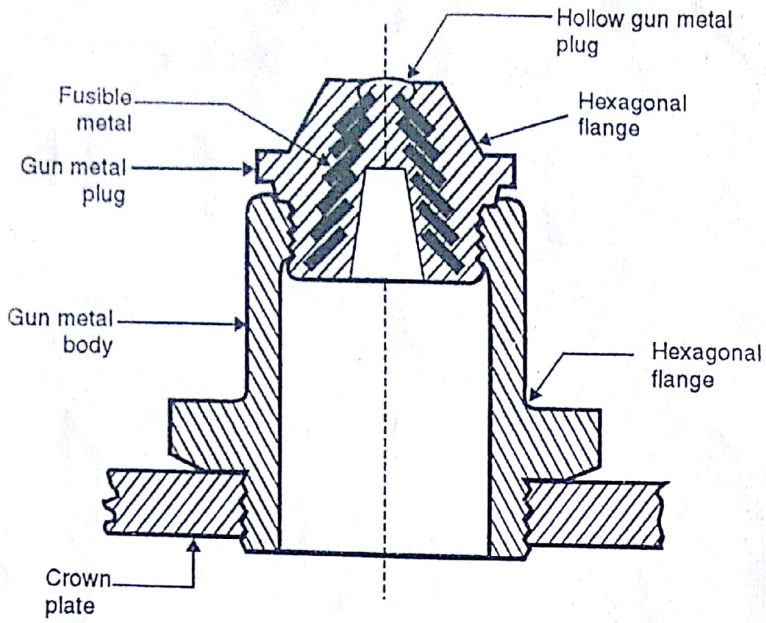
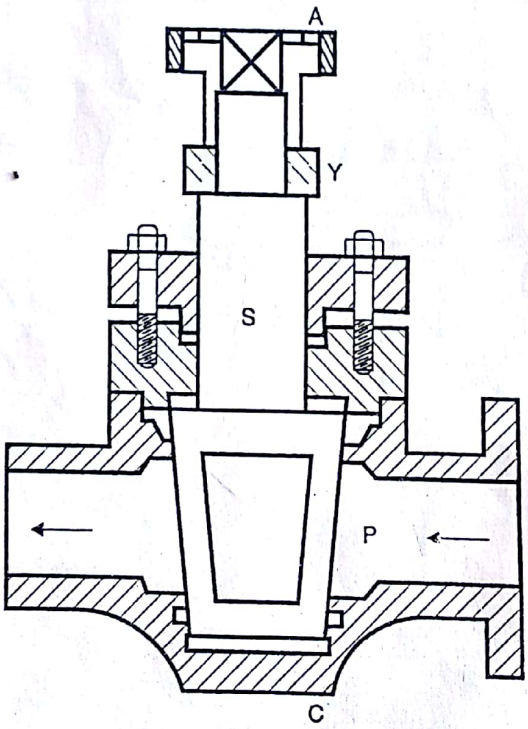


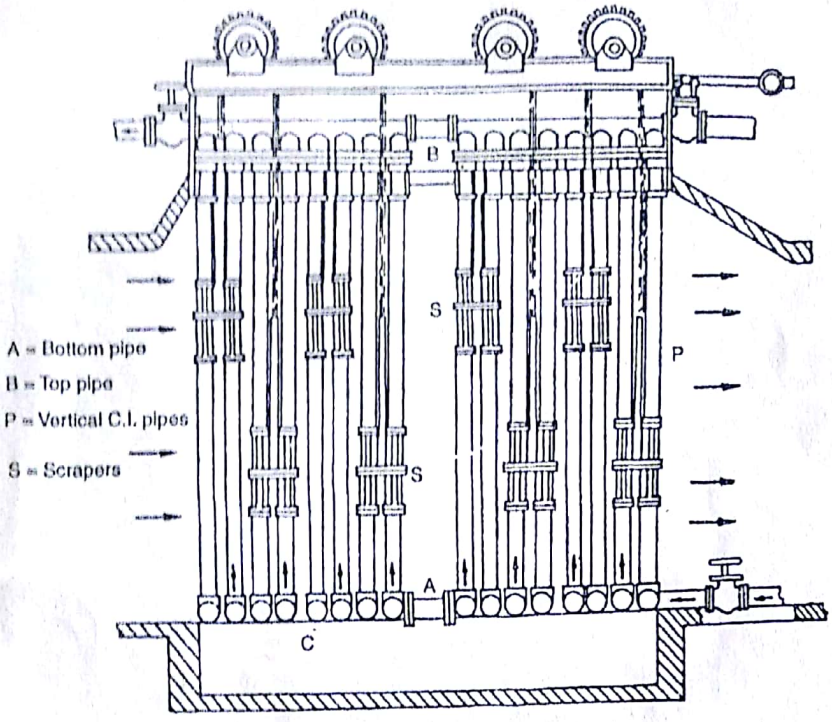
Fig. 2.4 Fusible Plug



C = Casing
S = Shank
P = Plug

A = Vertical slots
Y = Yoke

Fig. 2.5 Blow off Cock



A = Bottom pipe
B = Top pipe
P = Vertical C. I. pipes
S = Scrapers

Fig. 2.8 Economizer

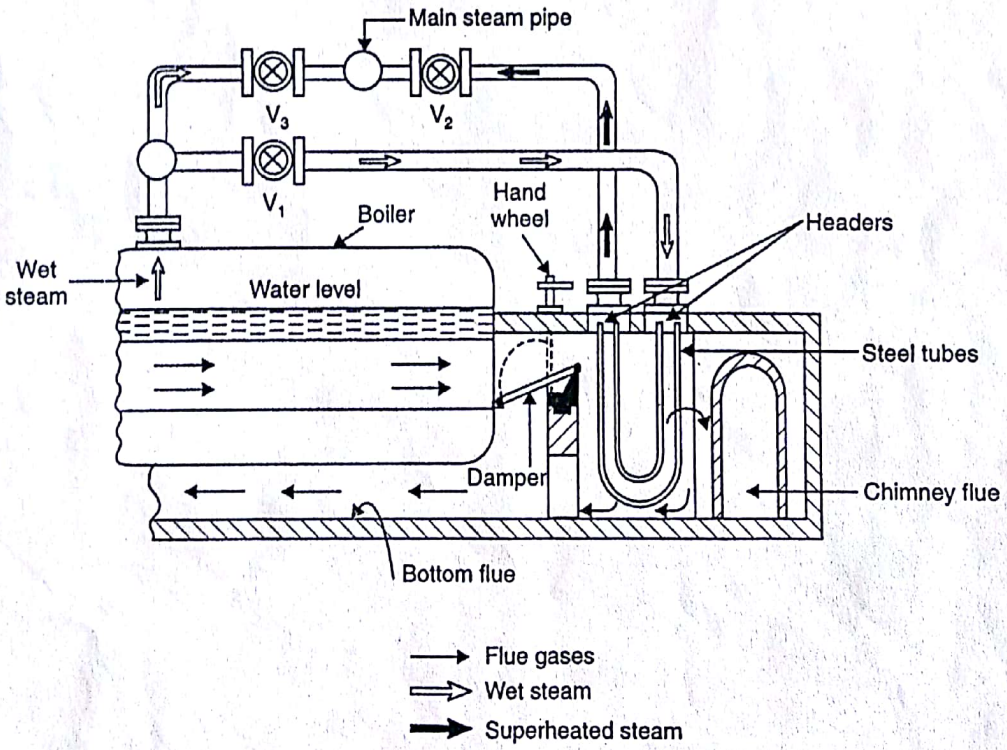


Fig. 2.9 Super Heater

Unit-II Metal Joining; Metal forming, Methods Castings.

(1)

- Welding
  - Pressure
    - Forge
    - Pressure thermit
    - Resistance
      - Spot
      - seam
      - butt
  - Fusion
    - Arc
      - metal
      - carbon
      - Atomic hydrogen
      - Inert gas
    - Gas
      - oxy acetylene
      - oxy other fuel gas
    - Fusion thermit

Arc welding: In welding generation of heat by an electric arc is one of the most efficient methods. Approximately 50% of energy is liberated in the form of heat. This process makes use of the heat produced by the electric arc to fusion weld metallic process. It is one of the most widely used process.

* Generally electrons liberated from cathode, move towards anode and are accelerated in their movements.
* When they strike the anode at velocity, a large amounts of heat is generated.
* Electrons are moving through the air gap between the electrodes also called arc column.
* They collide with the ions in the ionised gas column between the electrodes.
* The positive charged ions move from the anode and impinge on cathode. Thus heat is liberated.
* About 65-75% heat is liberated at anode by striking electrons.
* A temperature order of 6000°C is generated at anode. In order to produce arc, high potential difference is needed.

Principle of arc welding:

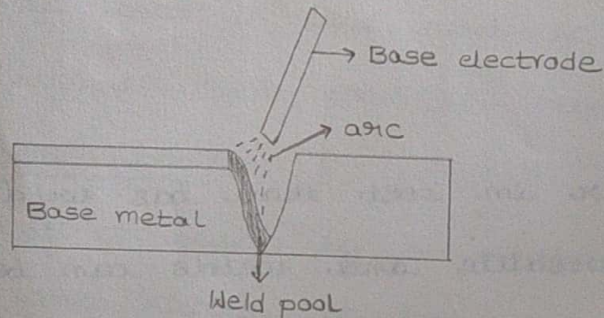
Arc welding:

* Arc welding is based upon formation of an electric arc between a consumable electrode (bare or coated) under base metal.
* The heat of arc is concentrated at the point of welding. As a result it

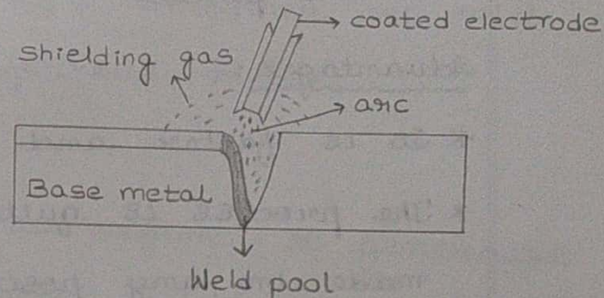
* The slag is removed by chipping hammer. ②

* Air gap between electrode and base metal is 2-4 mm.

* Arc welding involves 20-80 volts and 80-500 Amps



Arc welding



Shielded arc welding

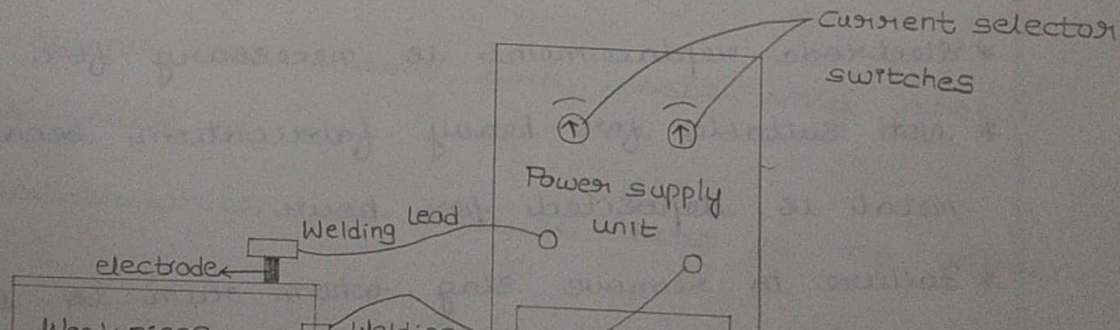
Steps involved in building:

① Preparation of edges

② Holding the work piece in a fixture

③ Striking the arc.

④ Welding the joint.



Applications of arc welding:

* Fabrication of pressure vessals, ships, structural steel work joints in pipe work.
* Construction and repair of machine parts and broken parts.

Advantages:

* It is faster and lower in cost than gas welding.
* The process is quite versatile and welds can be made in any position.
* Suitable for wide range of metals like ferrous and non-ferrous.
* Less sensitive to weld to other process.

Limitations:

* It is not suitable for thin sections.
* It is not suitable for mechanisation.
* Electrode replacement is necessary for long joints.
* Not suitable for heavy fabrication because less metal is deposited per hour.
* Failure to remove slag when run is interrupted will result in

Transformer :

* The purpose of transformer is to change high input voltage and low current to a low voltage (20-80 V) and high current (80-500 Amps).
* Its cost is low and AC gives a smoother or with high current used in mostly ferrous metals.

Generator :

* It is given by a motor or an engine. It generates and supply DC for electric arc welding.

Rectifier :

* The purpose is to change output AC to DC for electric arc welding.
* The output of step down transformer is connected to rectifier which converts AC to DC.

AC plant - advantages :

* It is simple equipment and costs only about 60% as much as DC.
* Low maintanance cost because there is no moving parts.
* No change of polarity whe

DC plant - advantages:

* Ferrous and non-ferrous
* Stable or smoother welding facilitates welding of thin sheets.
* Easy of operation and suitable for overhead welding.
* Safer to use where the risk of an electric shock is great.

Disadvantages:

* More expensive to purchase.
* High maintanance cost because of moving parts.
* Troubles from arc blows i.e. the arc is forced away from the weld pool/point.
* This condition encountered in DC equipment only.

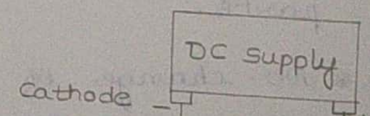
DC polarity:

It is of two types

① Straight polarity ② Reverse polarity

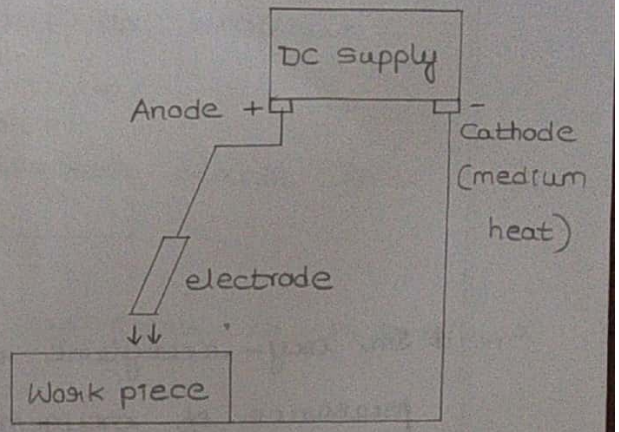
Straight polarity:

* Here electrode is connected to negative terminal and workpiece is conn...



Reverse polarity:

* Here electrode is connected to positive terminal and workpiece is connected to negative terminal.
* It is used for weld non-ferrous metals and cast iron with heavy coated electrodes.
* It is also used in sheet metal welding.



Selection of electrodes:

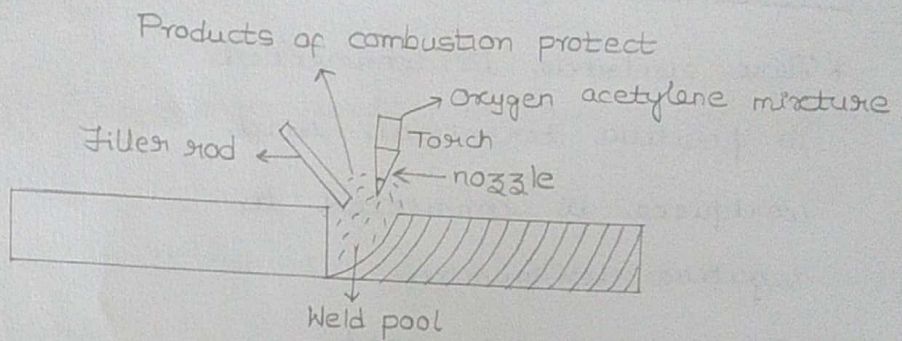
* Type of metal to be welded.
* The position in which the weld is to be done.
* The power source
* The polarity in case of DC.
* Thickness of the base metal.

Gas welding:

Principle:

* In gas welding heat is necessary for

cylinder:



* In oxy-acetylene welding, acetylene is burnt in the presence of oxygen at the tip of the nozzle which is fitted to torch.
* The temperature of this flame is 3250°C and it melts parent metal and filler metal to create weld pool.
* No flux is used in gas welding. The weld pool gets solidified by cooling.

Filler rods:

* Pieces of wires or rods used as a filler material in welding are called filler rods or welding rods.
* Good quality filler rods are necessary to reduce oxidation and to control the mechanical properties.

Specifications as per IS 1278 - 1972

Oxygen cylinder:

* Oxygen is produced by separating the various constituents of air by liquefaction.
* It is made of steam and painted black for identification.
* The oxygen pressure in the cylinder is 17.5 N/mm^2 (or) 175 bars.
* This can store $7m^3$ gas about 80 kg of mass when it is completely full.

Acetylene cylinder:

* Acetylene is a full gas of 92.3% carbon and 7.7% hydrogen
* It is a product of chemical reaction between calcium carbide and water.
* It is produced in 2 methods.

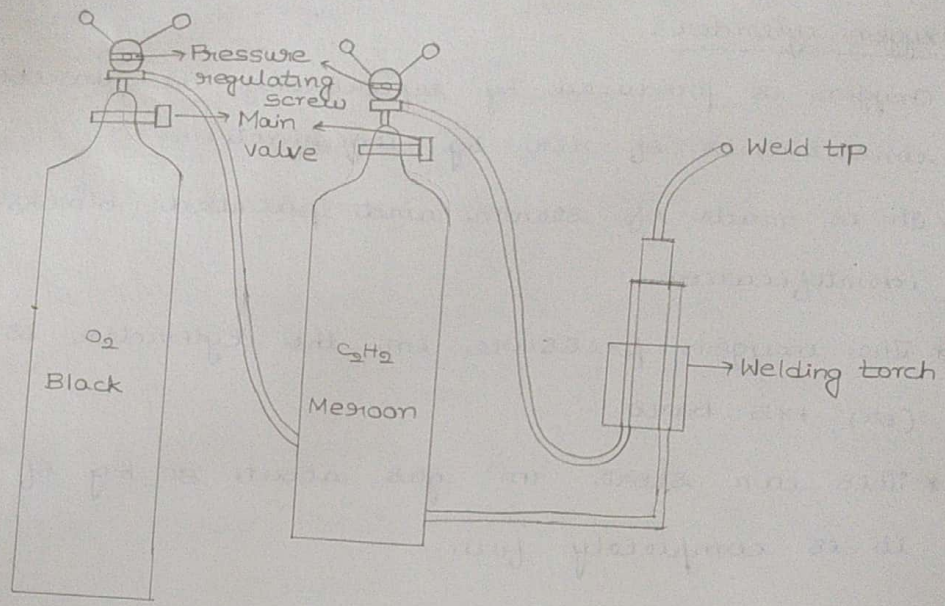
① Water to carbide method:

For high pressure systems, water falls on carbide to produce acetylene at high pressure.

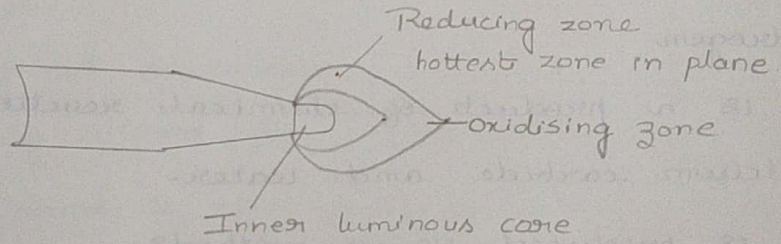
② Carbide to water method:

Temperature ranges:

	Temperature	Applications



Oxy-acetylene flames:



Inner luminous:

* In this partially decomposed product of acetylene and the separated solid particles of carbon.
* It is in the shape of trunkcated cone.

Reducing zone:

Temperature ranges:

S.no	Gas flame	Temperature	Applications.
1.	Oxy-acetylene	3100-3300°C	All ferrous and non-ferrous metals and their alloys.
2.	Oxy-hydrogen.	2400-2700°C	Brazing, silver soldering & under water gas cutting of steel.
3.	Oxy-coal gas	1800-2200°C	Silver soldering and under water gas cutting of steel.
4.	Oxy-liquid.	2700-2800°C	Gas cutting of steel petroleum.
5.	Air-acetylene	1825-1875°C	Soldering & Tsrazing.

Advantages of gas welding:

* Low capital cost.
* High portability and convenience.
* It can be easily altered for brazing, cutting and heating.
* Oxy-acetylene flame is more easily controlled. and can be used for different metals and alloys.
* Welding skills are relatively easy.

Limitations:

Applications:

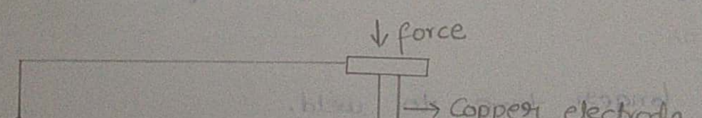
* Oxy-acetylene is a versatile process and can be used for welding all commercial metals & alloys.
* Due to low temperature of gas flame, this process is employed for welding thin sections.
* This process is mostly used in sheet metal fabrication. workshop, aircraft industries, garage and maintanence shops.

Resistance (or) Electric resistance welding:

* In this the welding is obtained at the location of the desired metal by the electrical resistance through the metal pieces to a relatively short duration, low voltage, high ampere. electric current.
* The amount of current can be regulated by the changing the primary turns of the transformer.
* When the area to be welded is sufficiently heated, the pressure varying from 25 megapascals - 55 megapascals is applied to the joining area by suitable electrodes until the weld is solid.

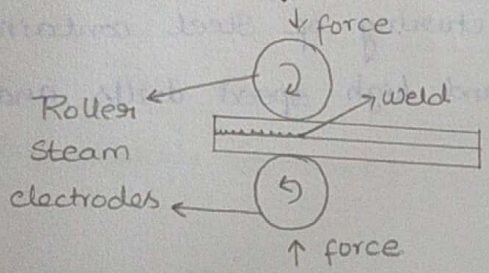
There are various types of welds:

① Spot welding:



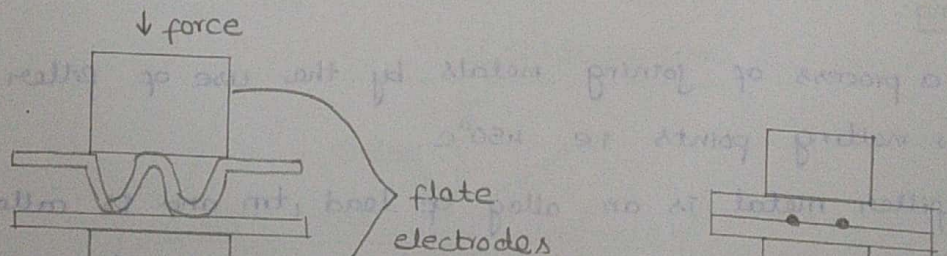
* These two electrodes are connected to primary & secondary bindings of a transformer.
* When we make contact with the plate there is huge amounts of heat is generated between the electrodes and this heat wants be necessary to weld the joints.
* We need to apply some force to complete the welding and the power supply to this welding is AC power supply.

② Seam welding:

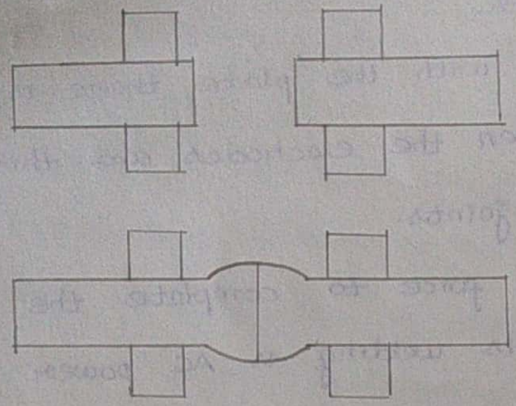


* When the spot welds on two over-lapping pieces of metal are spaced, the process of welding is known as roll spot welding (or) Seam welding.
* This process is best for metal thickness raising from 0.025 - 3 mm.

③ Projection welding:



④ Butt welding



* This is extensively used in manufacturing of steel containers and welding of mild steel stalks and high speed drills and reamers.

Soldering & Brazing

* Soldering and brazing processes differ from the welding.
* In soldering and brazing there is no direct melting of base metal that is to be joined.
* Further, the strength of soldered & brazed joints is much less than the welding joints.

Soldering:-

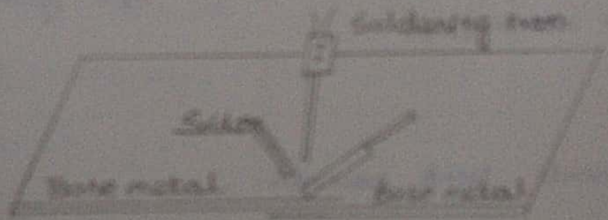
* It is a process of joining metals by the use of filler materials of low melting points i.e. 450°C.
* This filler metal is an alloy of lead, tin and is called solder.
& the melting point of solder is less than the base metal.

Soldering fluxes:

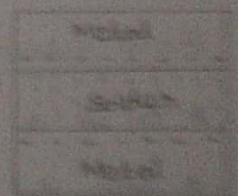
* The strength of soldering joint is primarily depends on the cleanliness of the surfaces to be joined.
* The surface must be free from oil, grease and oxide films which prevent satisfactory adhesion of the solders.
* In soldering operation, flux is used to produce the chemically clean surface to prevent oxidation of the surface to be soldered and to dissolve oxides that settle on the metal surfaces.

Flux	Metal
Zinc chloride (corrosive)	Tin plates, brass and suitable for most metals
Aluminium chloride (corrosive)	Steel
Diluted HCl (corrosive)	Zinc and galvanised work
Resin (non-corrosive)	Electrical work
Tallow (non-corrosive)	Lead

Method of Soldering:



(a) Technique

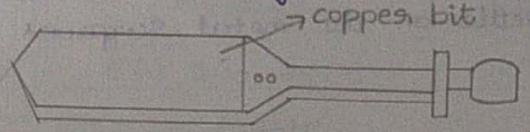


(b) Principle

* Any surplus solder can be removed by heat the work wipe the join with a cloth dipped in the flux.
* The heat required for the solder is given by soldering iron.

Soldering iron:

* Heat is supplied by the soldering iron in soldering and the bit is made with a copper because it is a good conductor of heat and it can transfer heat rapidly.



Advantages:

* Operation is simply & faster than the other process.
* Strong enough for most sheet metal work and electrical, electronic components

Disadvantages:

* Joints are weak and cannot withstand high temperature.

Applications:

* Soldering is employed when liquid type joints with comparatively low mechanical strengths.

Hard soldering:

* It is a permanent joint process.

Brazing:

* Brazing is similar to soldering but it gives much stronger joint.
* It is accomplished at a temperature about 450°c using a no.of. non-ferrous alloys (Brazing alloys).
* Copper - zinc alloy is most widely used as filler material. It is called as spelter.
* Depending upon the composition it has different melting points.
* Its range is 875 to 898°c.

Type.	Composition	Melting temp °c	Applications.
Alluminium alloy	Si = 10% Cu = 4% Remaining Al.	535 - 595	Aluminium alloys.
Silver alloy	Ag = 34% Cu = 25% Zn = 20% Cd = 21%	610 - 670	General brazing alloys.
Copper alloy.	Cu = 60% Zn = 40%	875 - 895	Ferrous alloys.
Nickel alloy.	Cr = 14% Si = 5% B = 3% Fe = 4% Ni (remaining)		

Methods of brazing:

① Torch brazing ② Furnace brazing ③ Induction brazing.

* It is used to fabricate almost any assembling.
* Heat is applied from the torch and the joint brought uniformly upto brazing temperature.
* Borax is usually sprinkled on the joint to assist flow of the molten spelter to the joint.
* After solidification ~~with~~ brazed joint is formed.

Induction brazing:

* The components to be brazed is heated in a coil which is carrying high frequency alternating current.
* Induction heating is used where rapid heating required.

Furnace brazing:

* Here parts to be brazed is heated to a brazing temperature under controlled atmosphere in the furnace.
* The majority furnaces are electrically-heated.

Resistance brazing:

* Here heat required for brazing is developed by resistance at the joint interface.
* High electrical current at low voltage passed through the assembly, heating can be precisely locationised.

Dip and immersing brazing:

Disadvantages:

* It requires costly equipments for heating.
* The colour of brazing joints may not match waste metal.

Applications:

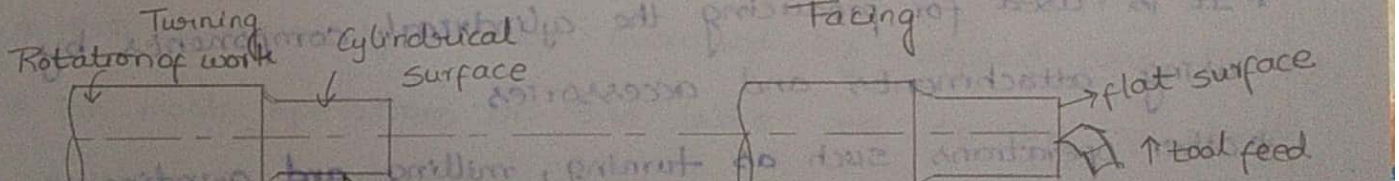
* Brazing is very suitable for joining different metals together.
* The process is used for cycle & motorcycle frames.
* Heat exchangers through away tool tips.

Introduction to machine tools

Machine tools are power driven devices designed to produce a required geometrical surface. The purpose of machine tools is to produce components with greater precision and more complex forms than is possible by the hard tools or by the primary forming process.

Working principle of lathe:

* The work piece is held in a chuck or between the centre and is rotated against the cutting tool.
* The cutting tool removes the material in the form of chips from the workpiece.



Types of lathe:

① Speed lathe ② Engine lathe ③ Bench lathe
④ Tool room lathe ⑤ Capstan and turret lathe
⑥ Special purpose lathe. ⑦ Automatic lathe.

Engine lathe:

* It is a general purpose of lathe.
* The main parts of lathe are lathe bed, head stock, tail stock, carriage, lead screw and feed change gear box. It is shown in the figure.
* The cutting tool is mounted on the tool post and can be fed in the cross and longitudinal direction with the reference of lathe axis.
* Power from motor is transmitted to the spindle by belt drive or gear drive.
* The speed changes in belt drive are obtained by shifting the belt to a different steps of cone pulley.
* In gear headed lathe, the gear ratio is changed by speed leaver.
* It is used for producing the cylindrical components by using attachments and accessories.

Tool room lathe:

* A tool room lathe is similar to engine lathe but it builts more accurately.
* It is used for machining precision and more accurate work.
* It is provided with additional attachements needed for tool and dye making operations.

Capstan and turret lathe:

* These are developments of engine lathe and used for producing a large no.of identical parts.
* Its design same as engine lathe except the tail stock is replaced with hexagonal turret.
* These turret fitted with a series of pre-sets tools with pre-setting tools. This can be operated with semi-skilled operators.

Speed lathe:

* It is of simple construction which consists of a bed on which head stock and tail stock are mounted.
* An adjustable slide is provided to support the cutting tool.
* It has no gear box, lead screw and a carriage.
* Here various speeds are obtained by stepped cone pulley.
* The most operations on this lathe are turning of wood polishing and spinning.

* The special devices are used to coordinate the motion of the tool to produce accurately the shape of template.

Automatic lathes:

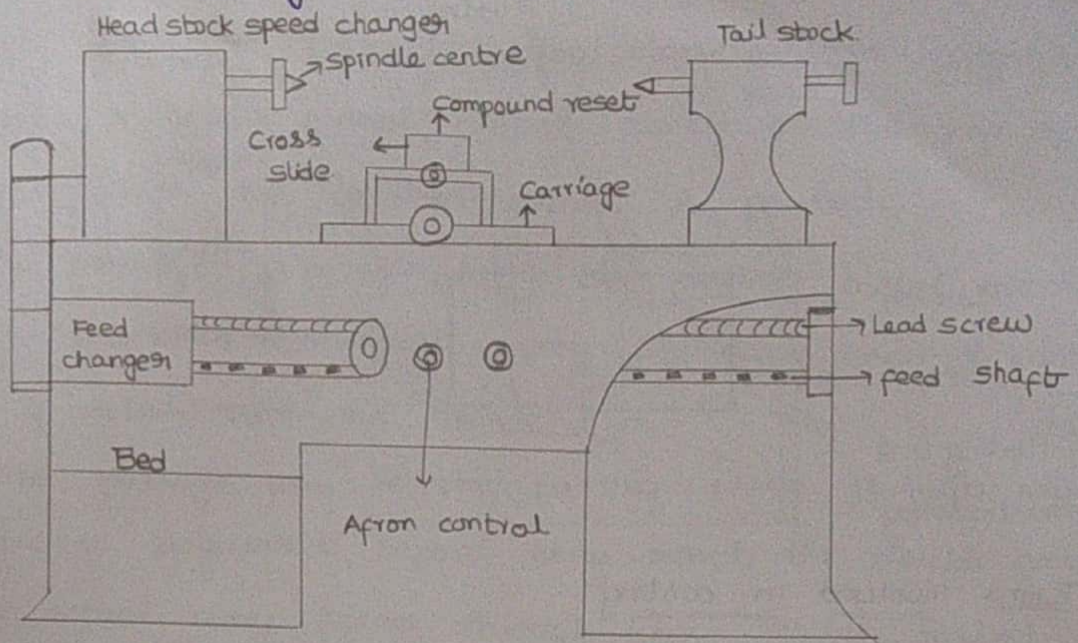
* Automatic lathes are high speed heavy duty lathes and are adopted for mass production.
* It is provided with automatic control for movement of work and cutting tool at a proper rates & sequences.
* These are two lathes.
  1. NC (Numerical controlled).
  2. CNC (Computer Numerical controlled)

Specifications of lathe:

The size of lathe is specified or designated following:

* Height of the center about lathe bed.
* The largest diameter of work that can be revolved over the waste of lathe bed i.e. swing diameter over the bed.
* The largest diameter that can be accomodated over the carriage.
* The maximum diameter that can be turned over the gap of bed i.e the swing diameter over the gap of bed.
* The maximum length of work that can be mounted between the centers.

centres without steady test.



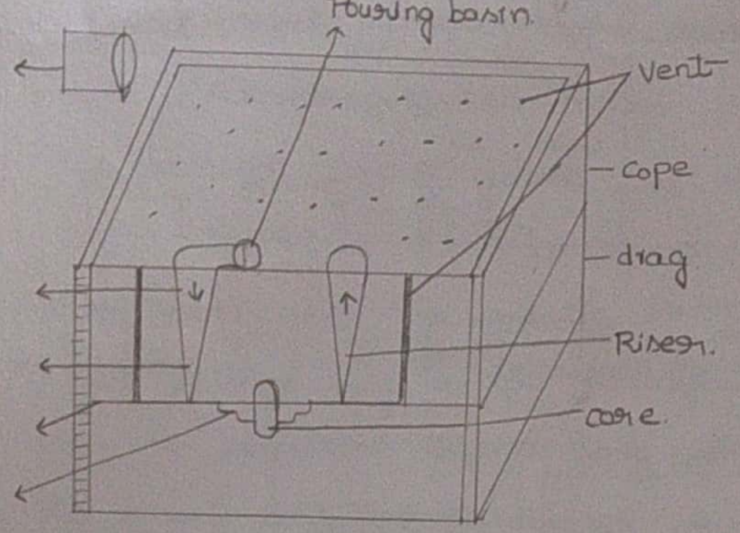
Casting:

* It generally means pouring molten metal into a refractory mould with a cavity of the shape to be made and allowing it to solidify.
* When solidified, the desired metal object is taken out from the refractory mould either by breaking the mould or taking the mould apart.
* The solidified object is called casting.
* The process is also called foundry.

History of casting process:

and burnt sand.

Sand casting:



Terms involved in casting:

Drag: Lower moulding flask.

Cope: Upper moulding flask.

Cheek: Intermediate moulding flask used in three piece moulding.

Pattern: Pattern is a replica of the final objects to be made with some modifications. The mould cavity is made with the help of the pattern.

Parting line: This is the dividing line between the two moulding flasks that makes up the sand mould.

Bottom board: This is a board normally made of wood which is used at the start of the mould making. The pattern is.

the

the

rols.

ch

ity.

ld

he.

le

in

ould

e to.

and burnt sand.

Core: It is used for making hollow cavities in castings.

Pouring basin: A small funnel shaped cavity at the top of mould into which the molten metal is poured.

Sprue: The passage through which the molten metal from pouring basin reaches the mould cavity. In many cases it contr the flow of metal into the mould.

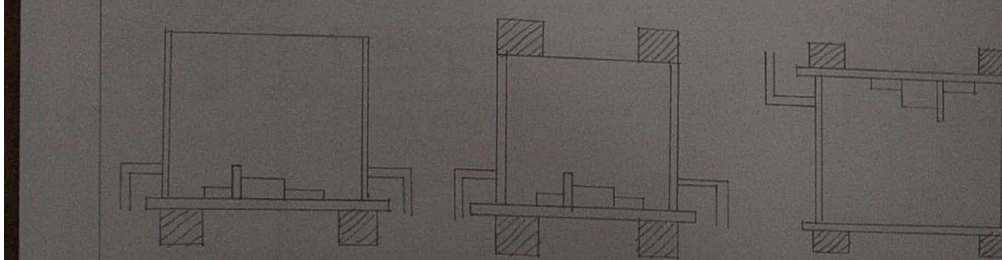
Runner: The passage way in the parting plane through whic molten flow is regulated before they reach the mould cavi

Gate: The actual entry point through which molten metal enters mould cavity.

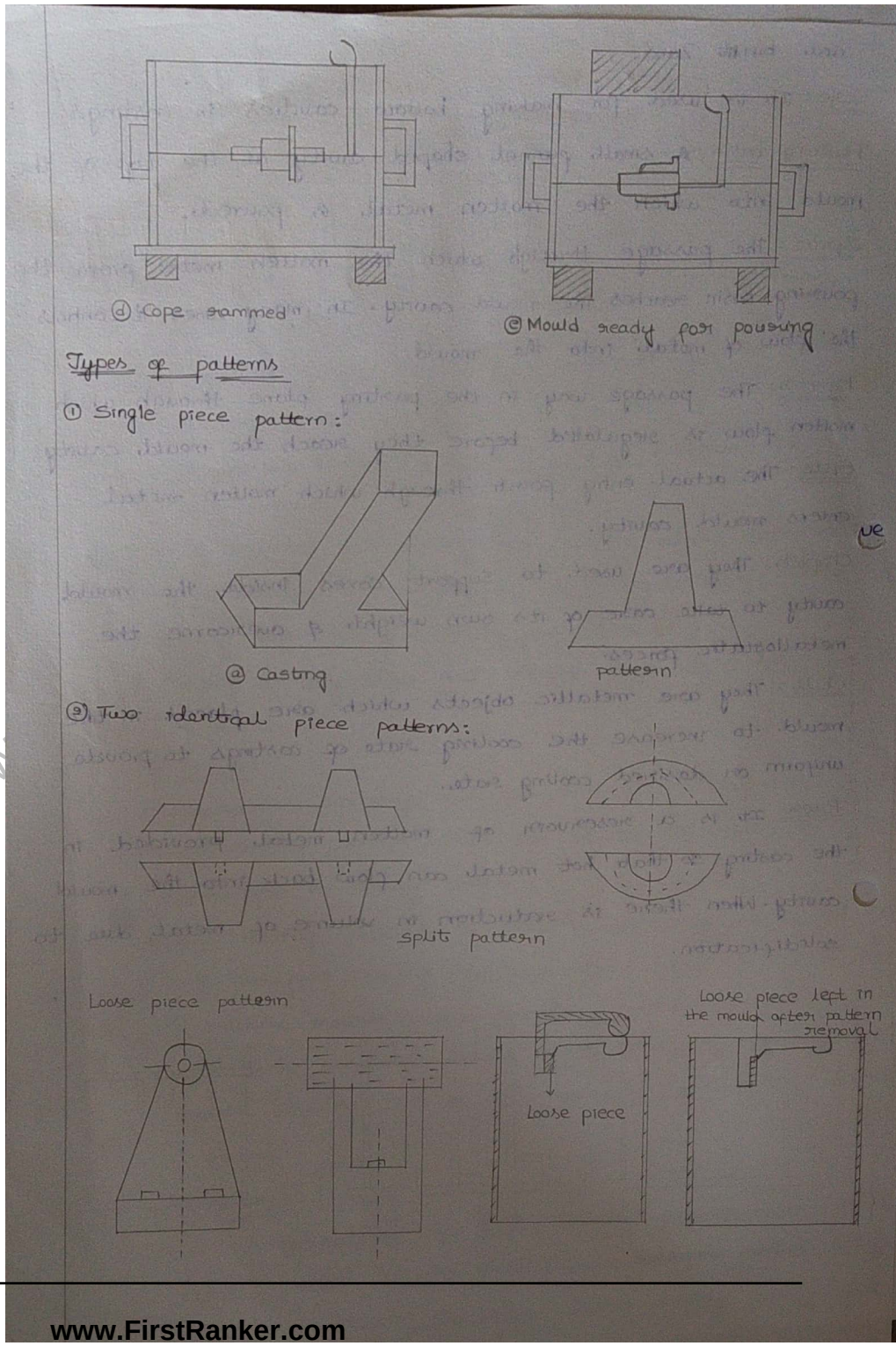
Chaplet: They are used to support cores inside the mould cavity to take care of its own weight & overcome the metallostatic forces.

Chill: They are metallic objects which are placed in th mould to increase the cooling rate of castings to provide uniform or desired cooling rate.

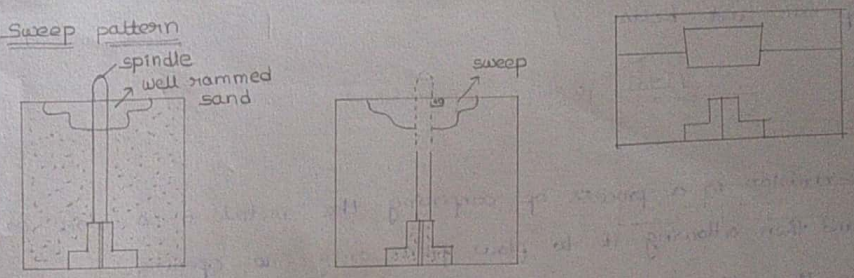
Riser: It is a reservoir of molten metal provided the casting so that hot metal can flow back into the mou cavity. When there is reduction in volume of metal due solidification.



(a) Drag completed (b) Ready for roll-over (c) After roll-ov



Sweep pattern



Advantages:

* Any intricate shapes internal or external can be made with the casting process.
* It is possible to cast practically any material be it ferrous or non-ferrous.
* Tools required for casting are simple and inexpensive.
* Weight reduction in design can be achieved.
* Casting have no directional properties.
* Casting of any size and weight even upto 200 tons can be made.

Limitations:

* Dimensional accuracy and surface finish achieved by normal sand casting process would not be be adequate for final application in many cases.
* Sand casting process is labour intensive to some extent and therefore many improvements are aimed at it such as machine moulding and founding mechanization.
* With some materials it is often difficult to remove defects arising out of the moisture present in sand castings.

Applications:

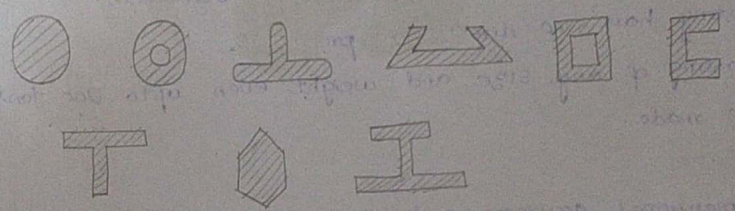
* Typical applications of sand casting process are cylinder blocks, liners, machine tools beds, pistons, piston rings, mill rolls, wheels, housings, water supply pipes and

specials and bells.

Metal forming operations

Extrusion:

* Extrusion is a process of confining the metal in a close cavity and then allowing it to flow from only one opening.
* So, that the metal will take the shape of the opening.
* The operation is identical to the squeezing of toothpaste out of the toothpaste tube. By the extrusion process, it is possible to ma components at which have a constant cross section over any length as can be formed by the rolling process.
* Some typical parts that can be extruded are given below.



UNIT-III

AIR COMPRESSORS AND REFRIGERATIONS

INTRODUCTION:

It is a mechanical component (machine) to compress the air with raise its pressure. The air compressor sucks air from the atmosphere and compresses it then further delivers with a high pressure to a storage vessel. From the storage vessel, it may be transmit by the channel (pipeline) to a place where the supply of compressed air is required. Afterward the compression of air requires some work to be done on it; therefore a compressor must be driven by some prime mover.

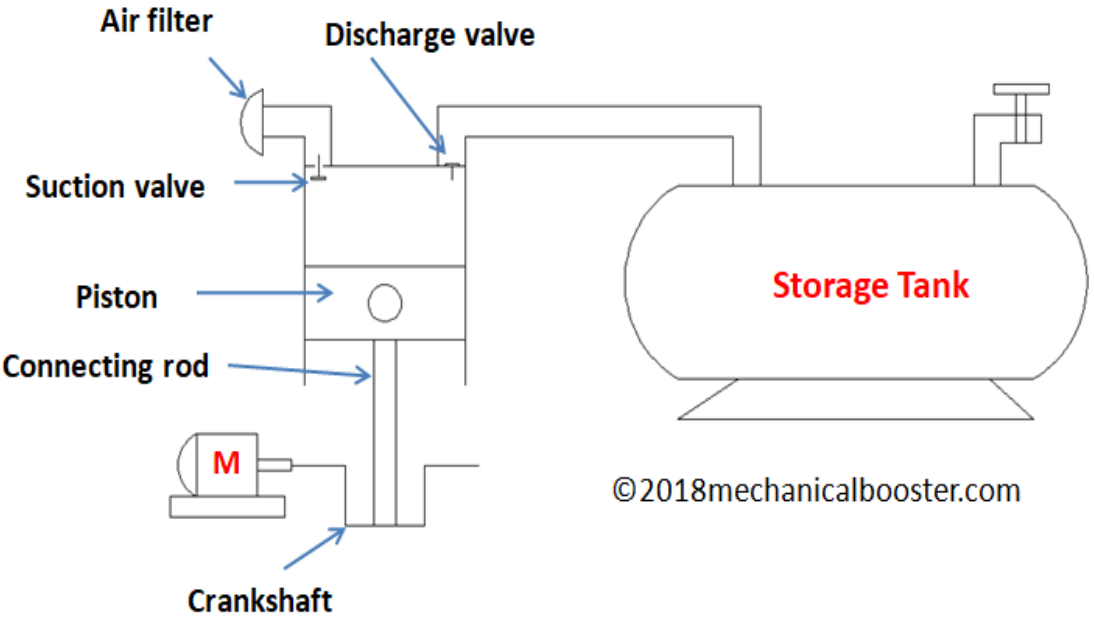
RECIPROCATING AIR COMPRESSOR:

Reciprocating Air Compressor is a positive displacement air compressor in which air is sucked in a chamber and compressed with the help of a reciprocating piston. It is called as positive displacement compressor because air is first sucked in a chamber and then compression is achieved by decreasing area of the chamber. The area is decreased by a piston which does reciprocating motion.

WORKING PRINCIPLE:

In reciprocating air compressor, as the piston moves towards the BDC, the air is sucked into the cylinder from the atmosphere and when it moves towards the TDC, the compression of the air starts and keeps on going and pressure increases. When the pressure increases upto its design limit it pushes the discharge valve to open and the compressed air is delivered to the storage tank.

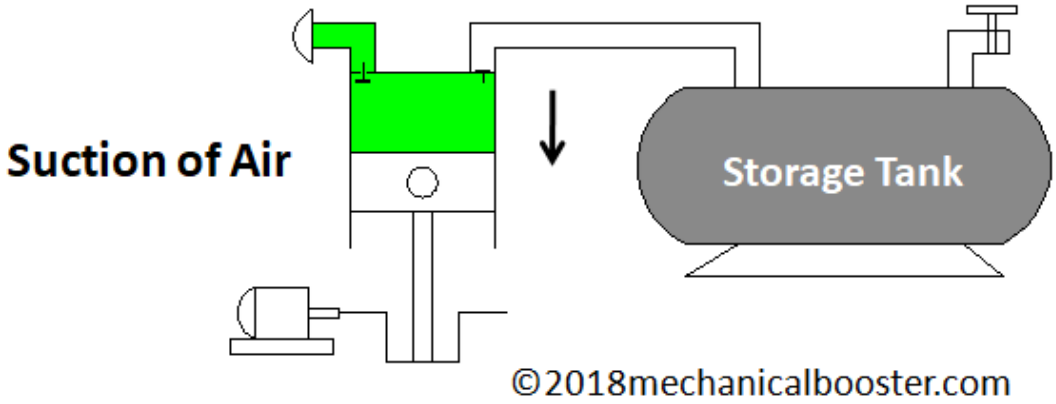
MAIN PARTS:

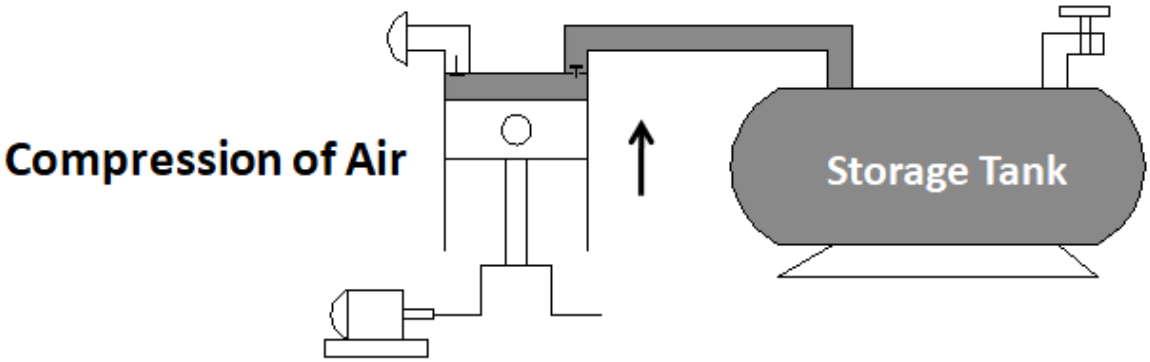


Main Parts of Reciprocating Air Compressor

1. **Piston:** It does reciprocating motion in the cylinder and responsible for the compression of the air.
2. **Cylinder:** It is a chamber in which air is compressed.
3. **Connection Rod:** It connects the piston and crankshaft.
4. **Crankshaft:** It is connected to the shaft of electric motor. And transfers its rotary motion to the piston.
5. **Suction valve:** The air is sucked through suction valve when piston moves to BDC.
6. **Discharge valve:** The compressed air is discharged through the discharge valve to the storage tank.

WORKING





Working of Reciprocating Air Compressor

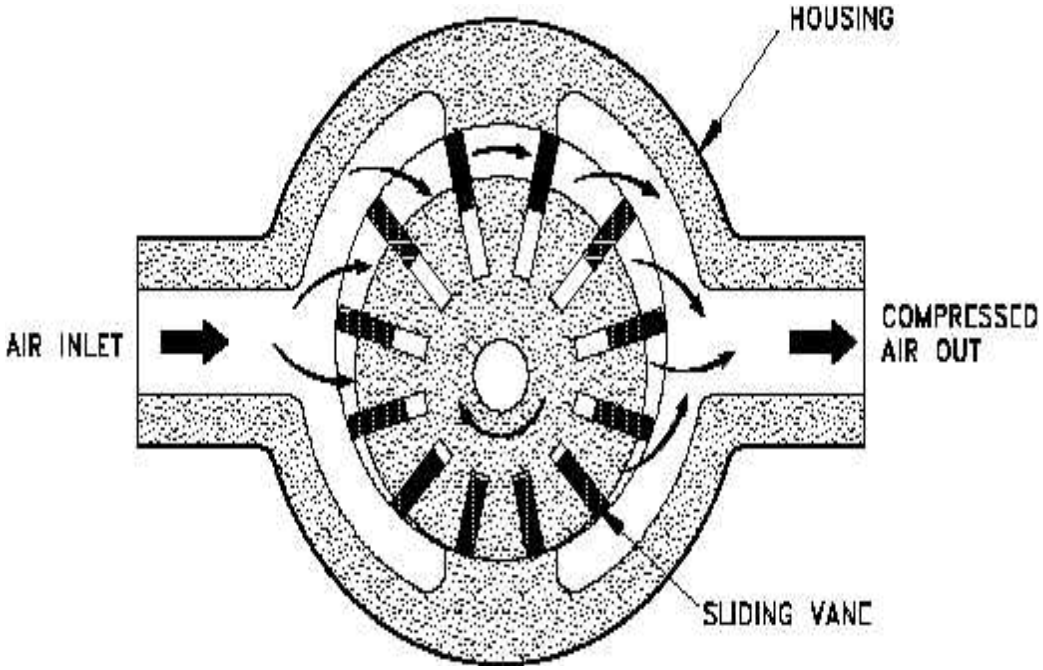
ROTARY AIR COMPRESSOR:

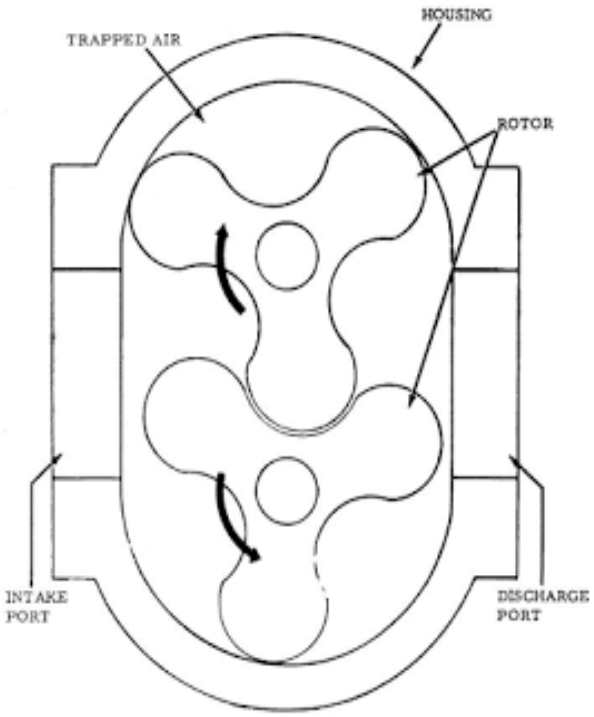
Rotary compressors are the another type of famous screw compressors.It uses two Asymmetrical rotors that are also called helical screws to compress the air.

The rotors have a very special shape and they turn in opposite directions with very little clearance between them.The rotors are covered by cooling jackets.Two shafts on the rotors are placed that transfer their motion with the help of timing gears that are attached at the starting point of the shafts/compressor

WORKING PRINCIPLE

Air sucked in at one end and gets trapped between the rotors and get pushed to other side of the rotors .The air is pushed by the rotors that are rotating in opposite direction and compression is done when it gets trapped in clearance between the two rotors.Then it pushed towards pressure side.





ADVANTAGES OF COMPRESSED AIR:

Pneumatics faces increasing competition from mechanical, hydraulic and electrical appliances on all fronts. But pneumatic devices have fundamental advantages over the other tech-nologies:

Easily transported

Air is available everywhere, and there is plenty of it. Since outlet air escapes into the open, there is no need for return lines. Electrical and hydraulic systems need a return line to the source.

Compressed air can be transported over great distances in pipelines. This allows the installation of central generation stations that can supply points of consumption via ring mains with a constant working pressure. The energy stored in compressed air can be widely distributed in this way.

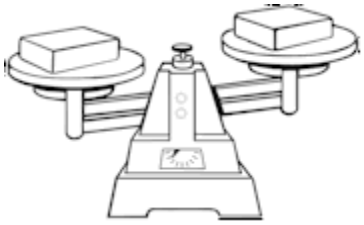
Easily stored

It is easy to store compressed air in purpose-built tanks. If there is a storage tank integrated in a pneumatic network, the compressor only needs to work when the pressure drops below a critical level. And because there is always a cushion of pressure, a work cycle can be completed even if the power network fails.

Transportable compressed air bottles can also be used at locations where there is no pipe system (e.g., under water).

Clean and dry

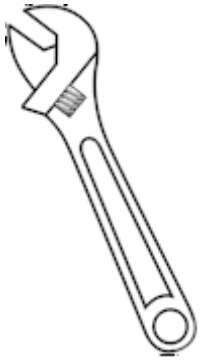
Compressed air does not cause soiling or leave drops of oil if the lines are defective. Cleanliness in fitting and operation are extremely important factors in many sectors of industry, e.g., food, leather, textiles, and packing.



Lightweight

Pneumatic devices are usually much lighter than comparable equipment and machinery with electrical power units. This makes a big difference with manual and percussion tools (pneumatic screwdrivers and hammers).

Safe to use



Compressed air works perfectly even when there are great temperature fluctuations and the temperatures are extreme. It can also be used where there are very high temperatures, e.g., for operating forge presses and blast furnace doors.

Pneumatic devices and lines that are untight are no risk to the safety and serviceability of the system. Pneumatic systems and components in general wear very little. They therefore have a long working life and a low failure rate.

Accident-proof

Pneumatic elements are very safe with regard to fire, explosion and electrical hazards. Even in areas where there is a risk of fire, explosion and extreme weather

conditions, pneumatic elements can be used without large and expensive safety apparatus. In damp-rooms or outdoors too, there is no danger with pneumatic equipment.

Rational and economical

Pneumatics is 40 - 50 times more economical than muscle power. This is a major point, particularly in mechanisation and automation.

Pneumatic components are cheaper than the equivalent hydraulic components.

There is no need for regular medium changes, as with hydraulic equipment, for instance. This reduces costs and the servicing requirement, and increases operating times.

Simple

The design and operation of pneumatic equipment is very simple. For this reason it is very robust and not susceptible to malfunctioning.
Pneumatic components are easy to install and can be re-used later without difficulty. Installation times are short because of the simple design. The fitters require no expensive special training.

Straight-line movements can be executed without extra mechanical parts such as levers, cams, eccentric

disks, screw spindles and the like..

Overload-proof

Compressed air equipment and pneumatic working parts can be loaded until they stop without being damaged. This is why they are considered to be overload-proof.

In contrast to electrical systems, the output of a pneumatic network can be overloaded without risk of danger. If the pressure drops too much, the work cannot be done, but there will be no damage to the network or its working elements.

Fast work medium

The very high flow speeds allow rapid completion of work cycles. This provides short cut-in times and fast conversion of energy into work.

Compressed air can achieve flow speeds of over 20 m/s. Hydraulic applications only manage 5m/s. The pneumatic cylinders reach linear piston speeds of 15 m/s.

Maximum control speeds in signal processing lie between 30 and 70 m/s at operating pressures of between 6 and 8bar. With pressures of less than 1bar it is even possible to obtain signal speeds of 200 to 300 m/s.

Fully adjustable

Travel speeds and exerted force are fully and easily adjustable. Both with linear and rotary movement, force, torque and speeds can be fully adjusted without difficulty by using throttles.

APPLICATION OF AIR COMPRESSOR:

It is used for operating pneumatic drills, riveters, road drills, paint spraying, in starting and supercharging of internal combustion engines, in gas turbine plants, jet engines and air motors, etc. It is also employ in the operation of lifts, rams, pumps etc.

CLASSIFICATION OF AIR COMPRESSORS:

Compressors can be classified according to the pressure delivered:

1. Low-pressure air compressors (LPACs), which have a discharge pressure of 150 psi or less
2. Medium-pressure compressors which have a discharge pressure of 151 psi to 1,000 psi
3. High-pressure air compressors (HPACs), which have a discharge pressure above 1,000 psi

They can also be classified according to the design and principle of operation:

1. Single-Stage Reciprocating Compressor
2. Two-Stage Reciprocating Compressor
3. Compound Compressor
4. Rotary-screw compressor
5. Rotary Vane Compressor
6. Scroll Compressor
7. Turbo compressor
8. Centrifugal compressor

IMPORTANT DEFINITIONS:

1. Inlet pressure: It is the absolute pressure of air at the inlet of a compressor.

2. Discharge pressure: It is the absolute pressure of air at the outlet of a compressor.

3. Compression ratio (or pressure ratio): It is the ratio of discharge pressure to the inlet pressure. Since the discharge pressure is always more than the inlet pressure, therefore the value of compression ratio is more than unity.

4. Compressor capacity: It is the volume of air delivered by the compressor, and is expressed in m3/min or m3/s.

5. Free air delivery: It is the actual volume delivered by a compressor when reduced to the normal temperature and pressure condition. The capacity of a compressor is generally given in terms of free air delivery.

6.Swept volume: It is the volume of air sucked by the compressor during its suction stroke. Mathematically the swept volume or displacement of a single acting air compressor is given by

$Vs = (\Pi/4) \times D2 \times L$

Where D = Diameter of cylinder bore, and L = Length of piston stroke.

7. Mean effective pressure. As a matter of fact, air pressure on the compressor piston keeps on changing with the movement of the piston in the cylinder. The mean effective pressure of the compressor is found out mathematically by dividing the work done per cycle to the stroke volume.

WORKING OF SINGLE STAGE RECIPROCATING AIR COMPRESSOR:

COMPONENTS:

It consists of a cylinder, piston, inlet and discharge valves etc.

Working: when the piston moves downwards (suction stroke), the pressure inside the cylinder falls below the atmospheric pressure. Due to this pressure difference, the inlet valve gets opened and air is sucked into the cylinder, at inlet pressure until the piston completes the suction stroke.

Then the piston moves upwards (delivery stroke), the pressure inside the cylinder goes on increasing till it reaches the discharge pressure. At this stage, the discharge valve gets opened and air is delivered to the container. At the end of delivery stroke, a small quantity of air, at high pressure, is left in the clearance space. As the piston starts its suction stroke, the air contained in

the clearance space expands till its pressure falls below the atmospheric pressure. At this stage, the inlet valve gets opened as a result of which fresh air is sucked into the cylinder, and the cycle is repeated.

It may be noted that in a single acting reciprocating air compressor, the suction, compression and delivery of air takes place in two strokes of the piston or one revolution of the crankshaft.

WORKDONE BY A SINGLE STAGE RECIPROCATING AIR COMPRESSOR:

We have already discussed in the above section, the air is first sucked, compressed and then delivered. So there are three different operations of the compressor.

Thus we can see that there is three ways to obtain the work done as follows:

1. Work is done on the piston during the suction of the air. 2. Work is done by the piston during compression as well as delivery of the air. 3. Work done by a reciprocating air compressor is mathematically equal to the work done by the compressor during suction.

Here we shall discuss the following two important cases of work done:

1. When there is no clearance volume in the cylinder, and

2. When there is some clearance volume.

WORK DONE BY A SINGLE STAGE RECIPROCATING AIR COMPRESSOR WITHOUT CLEARANCE VOLUME:

Consider a single stage reciprocating air compressor without clearance volume delivering air from one side of the piston only. Let P1 = Initial pressure of air (before compression), V1 = Initial volume of air (before compression), T1 = Initial temperature of air (before compression), P2, V2, T2 = Corresponding values for the final conditions (i.e. at the delivery point), r = Pressure ratio (i.e. P2 / P1).

Above diagrams shows the P-V and T-S of a single acting single stage reciprocating air compressor without clearance volume. When return stroke take place, the air is compressed by its major part (i.e. compression stroke BC) at constant temperature. The compression continues till, the pressure (P2) in the cylinder is sufficient to force open the delivery valve at C. After that no more compression takes place with the inward movement of the piston. Now during the

remaining part of compressions stroke, the compressed air is delivered till the piston head reaches the cylinder end. After that, the air is sucked from the atmosphere during the suction stroke AB at pressure P1.

Thus the compression of air may be isothermal, polytropic or isentropic; so we can obtain the work done under these compressions:

1. Work done during isothermal compression:

W = 2.3 m R T1 log r

2 Work done during polytropic compression

(PVn = Constant)

W = (n/n-1) X m R (T2 – T1)

3. Work done during isentropic compression:

W = m Cp (T2 – T1)

POWER REQUIRED DRIVING A SINGLE-STAGE RECIPROCATING AIR COMPRESSOR:

The power required to drive the compressor may be obtained from the usual relation,

P = (W X Nw)/60 watts

If N is the speed of the compressor in r.p.m., then number of working strokes per minute,

Nw = N ... (For single acting compressor) =2N ... (For double acting compressor)

MULTISTAGE COMPRESSION:

In the above section, we have discussed the compression of air in single stage. In other words, air is sucked, compressed in the cylinder and then delivered at a higher pressure. But sometimes, the air is required at a high pressure.

In such cases, either we employ a large pressure ratio (in single cylinder) or compress the air in two or more cylinders in series. It has been experienced that if we employ single stage compression for producing high pressure air (say 8 to 10 bar)

It suffers the following drawbacks:

1. The size of the cylinder will be too large.

2. Due to compression, there is a rise in temperature of the air. It is difficult to reject heat from the air in the small time available during compression.

3. Sometimes, the temperature of air, at the end of compression, is too high. It may heat up the cylinder head or burn the lubricating oil.

In order to overcome the above mentioned difficulties, two or more cylinders are provided in series with inter cooling arrangement between them. Such an arrangement is known as multistage compassion.

ADVANTAGES OF MULTISTAGE COMPRESSION:

1. The work done per kg of air is reduced in multistage compression with intercooler as compared to single stage compression for the same delivery pressure.

2. It improves the volumetric efficiency for the given pressure ratio.

3. The sizes of the two cylinders (i.e. high pressure and low pressure) may be adjusted to suit the volume and pressure of the air.

4. It reduces the leakage loss considerably.

5. It gives more uniform torque, and hence a smaller size flywheel is required.

6. It provides effective lubrication because of lower temperature range.

7. It reduces the cost of compressor.

TWO STAGE RECIPROCATING AIR COMPRESSOR WITH INTERCOOLER:

First of all, the fresh air is sucked from the atmosphere in the low pressure (L.P.) cylinder during its suction stroke at intake pressure P1 and temperature T1. The air, after compression in the L.P. cylinder (i.e. first stage) from 1 to 2, is delivered to the intercooler at pressure P2 and temperature T2.

Now the air is cooled in the intercooler from 2 to 3 at constant pressure P2 and from temperature T2 to T3. After that, the air is sucked in the high pressure (H.P.) cylinder during its suction stroke.

Finally, the air, after further compression in the H.P. cylinder (i.e. second stage) from 3 to 4, is delivered by the compressor at pressure P3 and temperature T4.

ASSUMPTIONS IN TWO-STAGE COMPRESSION WITH INTERCOOLER:

1. The effect of clearance is neglected. 2. There is no pressure drop in the intercooler. 3. The compression in both the cylinders (i.e. L.P. and H.P.) is polytropic (i.e. PVn = C). 4. The suction and delivery of air take place at constant pressure.

INTERCOOLING OF AIR IN A TWO-STAGE RECIPROCATING AIR COMPRESSOR:

Efficiency of the intercooler plays an important role in the working of a two-stage reciprocating air compress. Following two types of inter cooling are important from the subject point of view:

1. Complete or perfect inter cooling:

When the temperature of the air leaving the intercooler (i.e. T3) is equal to the original atmospheric air temperature (i.e. T1) then the inter cooling is known as complete or perfect inter cooling. In this case, the point 3 lies on the isothermal curve as shown in below figures:

2. Incomplete or imperfect inter cooling:

When the temperature of the air leaves the intercooler (i.e. T3) is more than the original atmospheric air temperature (i.e. T1), then the inter cooling is known as incomplete or imperfect inter cooling. In this case, the point 3 lies on the right side of the isothermal curve as shown in below figure:

ISOTHERMAL EFFICIENCY (OR COMPRESSOR EFFICIENCY) OF RECIPROCATING AIR COMPRESSOR:

It is the ratio of work or power required to compress the air isothermally to the actual work required to compress the air for the same pressure ratio.

ηc = Isothermal workdone / Indicated workdone

= { [(2.3 Log (P2 / P1)) / (n / n-1) [(P2 / P1) ^ (n-1 / n) – 1]] }

VOLUMETRIC EFFICIENCY:

It is the ratio of the volume of free air delivery per stroke to the swept volume of the piston. The volumetric efficiency of a reciprocating air compressor is different when it is with or without clearance volume.

REFRIGERATION

REFRIGERATION:

It is a process of removing heat from a low-temperature reservoir and transferring it to a high-temperature reservoir. The work of heat transfer is traditionally driven by mechanical means, but can also be driven by heat, magnetism, electricity, laser, or other means. Refrigeration has many applications, including, but not limited to: household refrigerators, industrial freezers, cryogenics, and air conditioning. Heat pumps may use the heat output of the refrigeration process, and also may be designed to be reversible, but are otherwise similar to air conditioning units. Refrigeration has had a large impact on industry, lifestyle, agriculture, and settlement patterns.

The process of keeping an item below room temperature by storing the item in a system or substance designed to cool or freeze. The most common form of **refrigeration** is provided by systems (i.e. refrigerators) that use a **refrigerant** chemical to remove heat from items stored inside the system

TYPES OF REFRIGERATION:

THE FOUR TYPES OF REFRIGERATION SYSTEMS

- Mechanical-Compression Refrigeration Systems. The most widely used refrigeration cycle method is mechanical compression. ...
- Absorption Refrigeration. Heat is also transferred in absorption refrigeration systems by compressing and expanding refrigerant. ...
- Evaporative Cooling. ...
- Thermoelectric Refrigeration

CONCEPT OF REFRIGERATON:

REFRIGERATION EFFECT

It is the amount of heat that each pound of refrigerant retains from the refrigerated space to deliver helpful cooling. ... This effect is known as Refrigeration.

WHAT IS COP VALUE

The efficiency of refrigeration systems and heat pumps is denoted by its Coefficient Of Performance (**COP**). ... For a heat pump a **COP value** of 4 means that the addition of 1 kW of electric energy is needed to have a release of 4 kW of heat at the condenser

EFFICIENCY

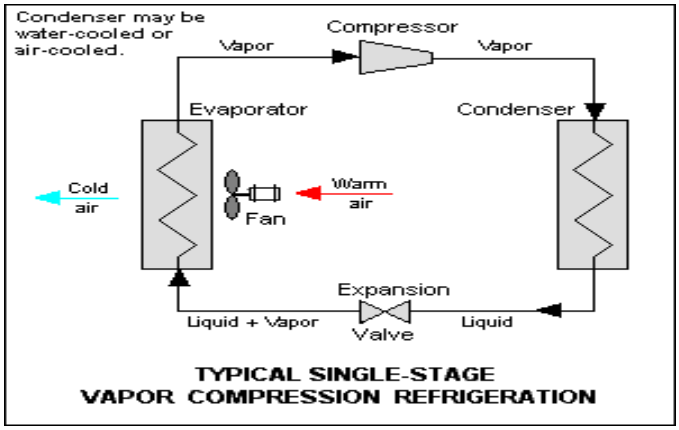
Coefficient of **Performance**, **COP**. The **COP** is a measure of the amount of power input to a system compared to the amount of power output by that system:[2] The **COP** is therefore a measurement of **efficiency**; the higher the number, the more **efficient**

THE COEFFICIENT OF PERFORMANCE OR COP:

(sometimes **CP** or **CoP**) of a heat pump, refrigerator or air conditioning system is a ratio of useful heating or cooling provided to work required.Higher COPs equate to lower operating costs. The COP usually exceeds 1, especially in heat pumps, because, instead of just converting work to heat (which, if 100% efficient, would be a COP_hp of 1), it pumps additional heat from a heat source to where the heat is required. For complete systems, COP calculations should include energy consumption of all power consuming auxiliaries. COP is highly dependent on operating conditions, especially absolute temperature and relative temperature between sink and system, and is often graphed or averaged against expected conditions

PRINCIPLE OF REFRIGERATION:

This is another basic principle of refrigeration. The evaporator transfers heat into the refrigerant; the refrigerant transfers this heat to the condenser; the condenser transfers the heat to a cooling medium



TYPICAL SINGLE-STAGE VAPOR COMPRESSION REFRIGERATION