

Mission and vision of the Department

Vision of Mechanical Department

To establish the state of the art learning center in Mechanical Engineering which will impart global competence, enterprising skills, professional attitude and human values in the student.

Mission of Mechanical Department

1. To impart quality technical education to the students.
2. To develop comprehensive competence in the students through various modes of learning.
3. To enable students for higher studies and competitive examinations.
4. To facilitate students and industry professionals for continuous improvement and innovation.

Program Educational Objectives:

[1] Use core competence acquired in various areas of Mechanical Engineering to solve techno-managerial issues for creating innovative products that lead to better livelihoods & economy of resources.

[2] To establish themselves as effective collaborators and innovators to address technical, managerial and social challenges.

[3] To equip students for their professional development through lifelong learning and career advancement along with organizational growth.

[4] Serve as a driving force for proactive change in industry, society and nation.

PROGRAM SPECIFIC OUTCOMES

Student should have

- 1) An ability to work professionally in mechanical systems including design, analysis, production, measurement and quality control.
- 2) An ability to work on diverse disciplinary tasks including manufacturing, materials, thermal, automobile, robotics, mechatronics, engineering software tools, automation and computational fluid dynamics.

LABORATORY MANUAL

APPLIED

THERMODYNAMICS - I



DEPARTMENT OF MECHANICAL ENGINEERING

MGM'S

JAWAHARLAL NEHRU ENGINEERING COLLEGE

N-6, CIDCO, AURANGABAD-431003

LIST OF EXPERIMENTS

Sr. No.	Name of Experiment
1	Study of any two boilers
2	Study of boiler mounting and accessories
3	Study of condensers and cooling towers
4	Study of contemporary carburetor
5	Study of fuel pump and fuel injector of I.C. Engine
6	Study of conventional ignition system of I.C. Engine
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8	Trial on reciprocating air compressor
9	Assignment on topic no.1 Air Compressors
10	Assignment on topic no. 5 Vapour Power Cycles

EXPERIMENT NO. 1

Study of any two boilers

Aim:-To study the Babcock and Wilcox boiler and Cochran boiler

Objective: To study about Babcock and Wilcox boiler and Cochran boiler.

BOILER:

A boiler is used to generate steam at a desired pressure and temperature by transferring heat produced by burning fuel to water to change it to steam. It is a term applied to that device which generates steam at minimum pressure of 3.5 bar having minimum capacity of 22.75 litres.

Babcock and Wilcox boiler

Babcock and Wilcox is a water-tube boiler is an example of horizontal inclined tube boiler it also a High Pressure Boiler.

Construction: Babcock and Wilcox boiler with longitudinal drum. It consists of a drum connected to a series of front end and rear end header by short riser tubes. To these headers are connected a series of inclined water tubes of solid drawn mild steel. The angle of inclination of the water tubes to the horizontal is about 15° or more.

Working: The fire door the fuel is supplied to grate where it is burnt. The hot gases are forced to move upwards between the tubes by baffle plates provided. The water from the drum flows through the inclined tubes via down take header and goes back into the shell in the form of water and steam via uptake header. The steam gets collected in the steam space of the drum. The steam then enters through the antipriming pipe and flows in the superheater tubes where it is further heated and is finally taken out through the main stop valve and supplied to the Steam turbine or Steam engine when needed.

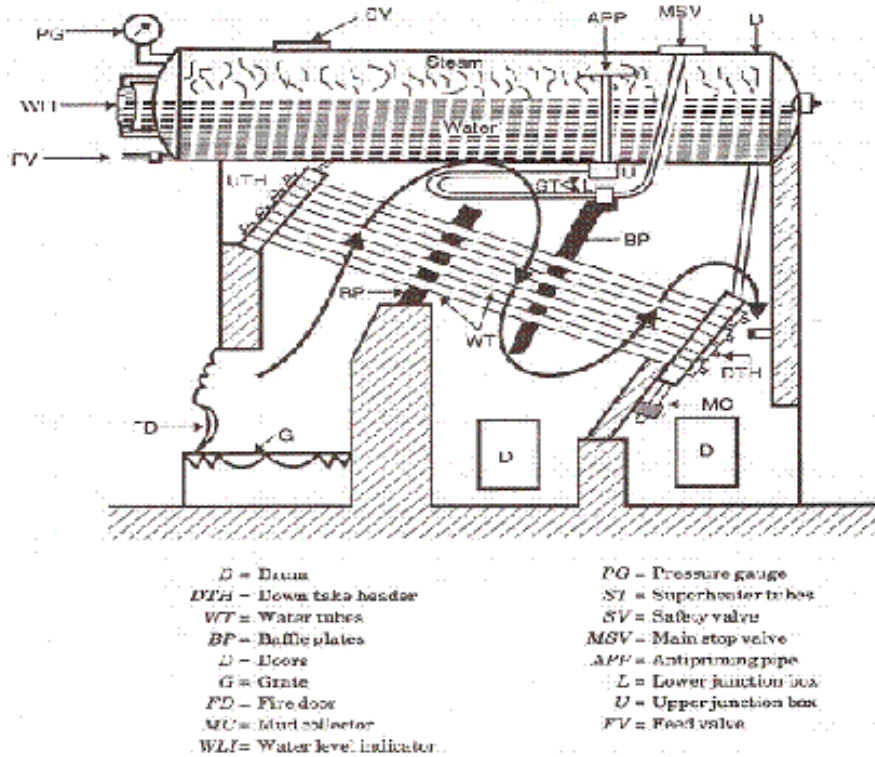


Figure: Babcock and Wilcox boiler

The pressure of steam in case of cross drum boiler may be as high as 100 bar and steaming capacity upto 27000 kg/h.

At the lowest point of the boiler is provided a mud collector to remove the mud particles through a blow-down-cock.

Cochran boiler

It is one of the best types of vertical multi-tubular boiler, and has a number of horizontal fire tubes it also a Low Pressure Boiler.

Construction: Cochran boiler consists of a cylindrical shell with a dome shaped top where the space is provided for steam. The furnace is one piece construction and is seamless. Its crown has a hemispherical shape and thus provides maximum volume of space.

Working: The fuel is burnt on the grate and ash is collected and disposed of from ash pit. The gases of combustion produced by burning of fuel enter the combustion chamber through the flue

tube and strike against fire brick lining which directs them to pass through number of horizontal tubes, being surrounded by water. After which the gases escape to the atmosphere through smoke box and chimney.

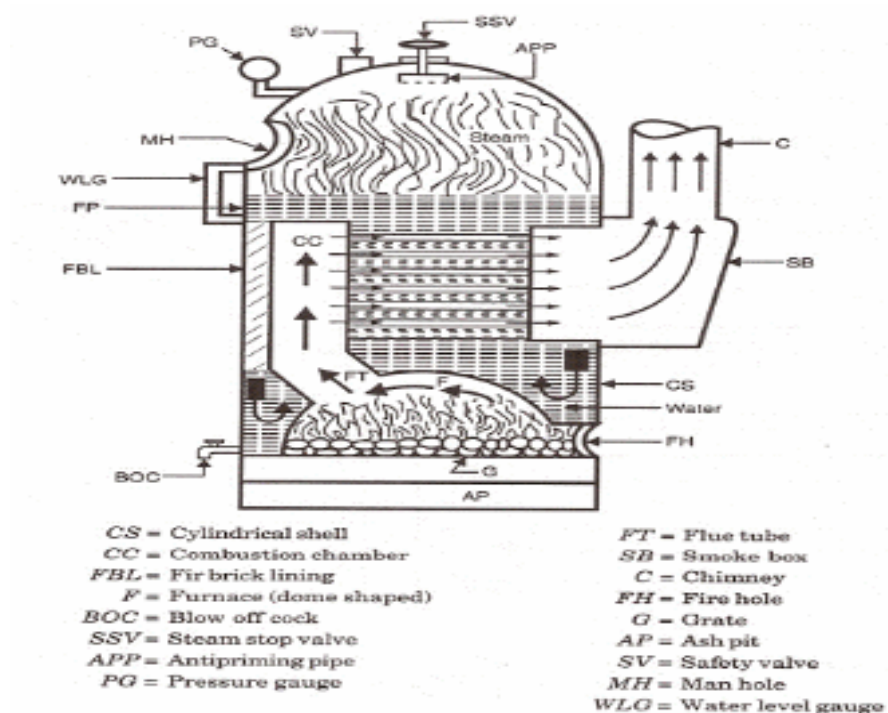


Figure: Cochran Boiler

Specifications:

- Shell diameter 2.75 m
- Height 5.79 m
- Working pressure 6.5 bar (max. pressure = 15 bar)
- Steam capacity 3500 kg/hr (max. capacity = 4000 kg/hr)
- Heating surface 120 m²
- Efficiency 70 to 75% (depending on the fuel used)

EXPERIMENT NO. 2

Study of boiler mounting and accessories

Aim:- To study different boiler mounting and accessories

Boiler mountings and accessories:

Boilers are equipped with two categories of components: boiler mountings and boiler accessories. Boiler mountings are the machine components that are mounted over the body of the boiler itself for the safety of the boiler and for complete control of the process of steam generation.

Various boiler mountings are as under:

- 1) Safety valve
- 2) Water level indicator
- 3) Pressure gauge
- 4) Fusible plug
- 5) Feed check valve
- 6) Blow-off cock
- 7) Steam stop valve

1. Safety Valve:

When there was a sudden drop in steam requirements, the steam pressure in the boiler will increase. The main function of a valve is to prevent under such conditions, an increase in the steam pressure in the boiler exceeding a predetermined maximum pressure for which the boiler is designed. This is automatically done by opening the valve and discharging of the steam to the atmosphere as soon as the pressure inside the boiler increases above the predetermined value. The safety valves are directly placed on the top of the boiler shell. The different types of the safety valves which are commonly used are discussed below.

Spring Loaded Safety Valve: This type of safety valve is commonly used nowa days for stationary as well as mobile boilers. It is loaded with spring instead of weights. The spring is made from a square steel rod in helical form.

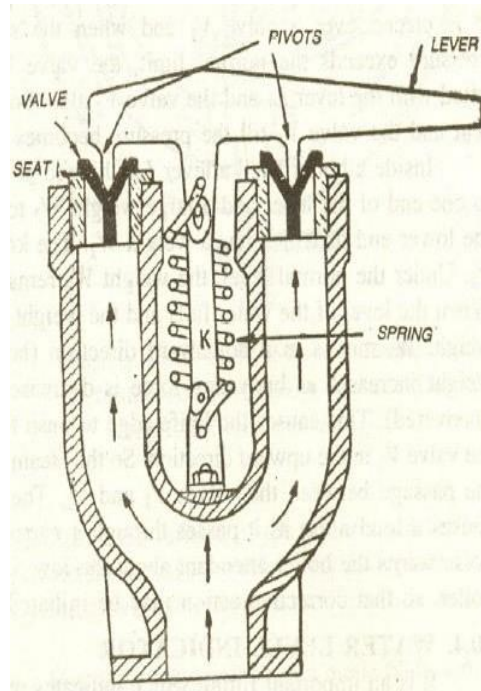


Figure1: Spring Loaded Safety Valve

A spring loaded safety valve commonly used on locomotive boiler is as shown in figure. It consists of two valves, each of which is placed over a valve seat fixed over a branch pipe as shown in figure. The two branch pipes are connected to a common block which is fixed on the shell of the boiler. The level has two pivots each of which is placed over each respective valve. The lever is attached with a spring at its middle which pulls the lever in downward direction. The lower end of the spring is attached to the back as shown in figure. Thus the valves are held tight to their seats by the spring force.

These valves are lifted against the spring when the steam pressure is greater than the working pressure and allows the steam to escape from the boiler till the pressure in the boiler reaches its working pressure. The lever has an extension which projects into the driver's cabin. The driver can release the pressure if required just by raising the lever. The lever is connected loosely by a link to the block. This limits the valve opening and prevents the lever blowing off in case of spring failure.

2. Water level indicator:

It is an important fitting which indicates water level inside the boiler to the observer. Usually two water level indicators are fitted in front of the boiler. The water indicator shows the level of water in the boiler drum and warns the operator if by chance the water level goes below a fixed mark, so that corrective action may be taken in time, to avoid any accident.

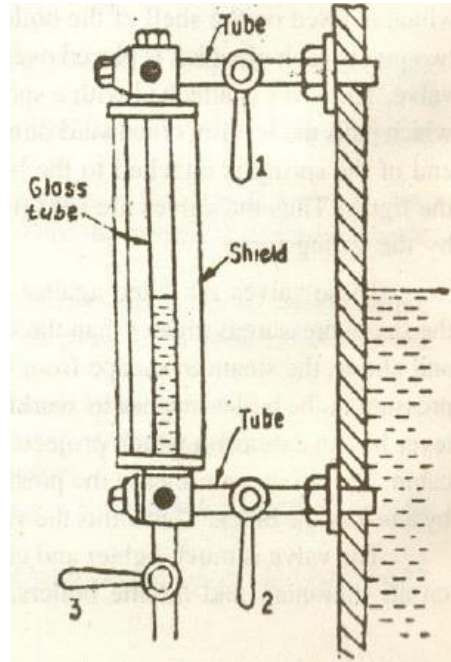


Figure 2: Water Level Indicator

A water level indicator used in low pressure boiler is as shown in figure. It consists of three cocks and a glass tube. The steam cock 1 keeps the glass tube in connection with the steam space and cock 2 puts the glass tube in connection with the water space in the boiler. The drain cock 3 is used to drain out the water from the glass tube at intervals to ascertain that the steam and water cocks are clear in operation. The glass tube is generally protected with a shield.

For the observation of the water level in the boiler, the steam and water cocks are opened and drain cock is closed. In this case, the handles are placed in vertical positions as shown in figure. The steam enters from the upper end of the glass tube and water enters from the lower end of the tube. So the water level inside the boiler will be same as seen in the glass.

The rectangular passage at the ends of the glass tube contains two balls. In case the glass tube is broken, the balls are carried along its passage to the ends of glass tube and steam out of the boiler is prevented.

3. Pressure gauge:

A pressure gauge is used to measure the pressure of the steam inside the boiler. The commonly used pressure gauge known as Bourdon type pressure gauge, is shown in figure.

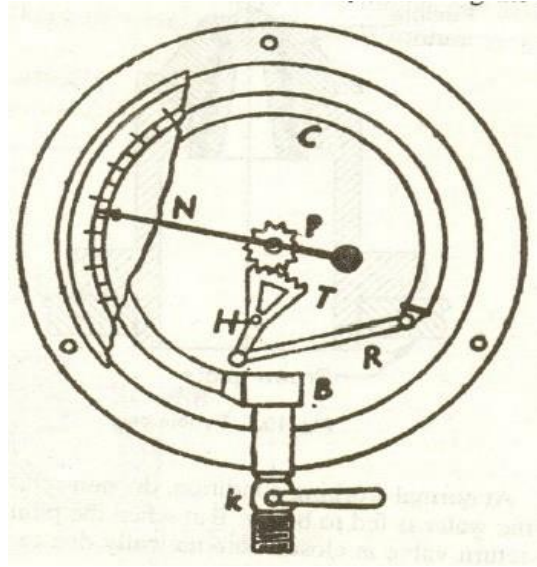


Figure 3: Bourdon Pressure Gauge

It consists of an elastic metallic tube of elliptical cross-section and is bent in the form of circular arc. One end of the tube is fixed and connected to the steam space of the boiler and other end is connected to a sector wheel through a link. The sector remains in mesh with a pinion fixed on a spindle. A pointer as shown in the figure is attached to the spindle to read the pressure on a dial gauge.

When high pressure steam enters the elliptical tube, the tube section tries to become circular which causes the other end of the tube to move outward. The movement of the closed end of the tube is transmitted and magnified by link and sector. The sector is hinged at the point H as shown in the figure. The magnitude of the movement is indicated by the pointer on the dial.

4. Fusible plug:

The main object of the fusible plug is to put off the fire in the furnace of the boiler when the water level in the boiler falls an unsafe level and thus avoid the explosion which may take place due to overheating of the tubes and shell. This plug is generally fitted over the combustion chamber.

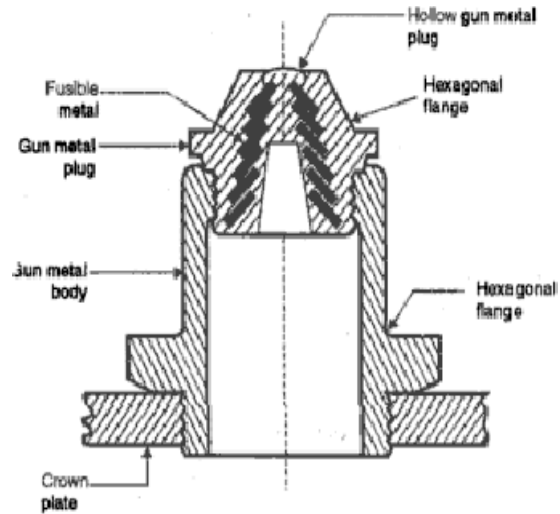


Figure 4: Fusible Plug

A fusible plug which is commonly used is shown in figure. A is hollow gun metal body screwed into the crown of the boiler grate. B is a second hollow gun metal plug screwed into the plug A. the third plug C is locked with plug B by pouring a low melting point metal into groove provided for the same.

Under normal water level condition in the boiler, this plug is covered water which keeps the temperature of the fusible metal below its melting point. But when the water level in the boiler falls low enough to uncover the plug; the fusible metal between the plug B and C quickly melts and plug C drops out. The opening is so made allows the steam to rush the water into the furnace and extinguish the fire. The steam rushing out puts out the fire and gives warning that the crown of the furnace is in danger of being over heated.

5. Feed check valve:

The function of the feed check valve is to allow the supply of water to the boiler at high pressure continuously and to prevent the back flow of water from the boiler when the pump pressure is less than boiler pressure or when pump is fails.

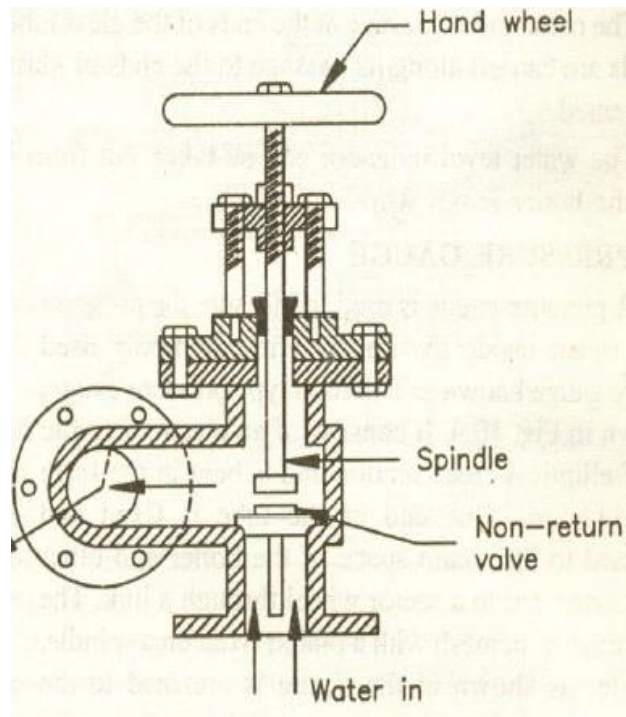


Figure 5: Feed check valve

A commonly used feed check valve is shown in figure. It is fitted to the shell slightly below the normal water level of the boiler. The lift of the non-return valve is regulated by the end position of the spindle (E) which is attached with the hand wheel. The spindle can be moved upward or downward with the help of hand wheel as the upper portion of the spindle is screwed to a nut.

At normal working conditions, the non-return valve is lifted due to the pressure of water from the pump and the water fed to boiler. But when the pump pressure falls below boiler pressure or if the pump stops, non-return valve is closed automatically due to pressure of the water from the boiler and prevents the escape of water from the boiler.

6. Blow-off cock:

The blow off cock is used for dual functions:

1. To empty the boiler when necessary for cleaning, repair and inspection.
2. To discharge the mud and sediments carried with the feed water and accumulated at the bottom of the boiler.

By periodic blow-off, the salt concentration in the boiler is also reduced. Even with a small amount of dissolved salt, over a period of time, due to the evaporation of water, the salt accumulates in the boiler, raising the salt concentration.

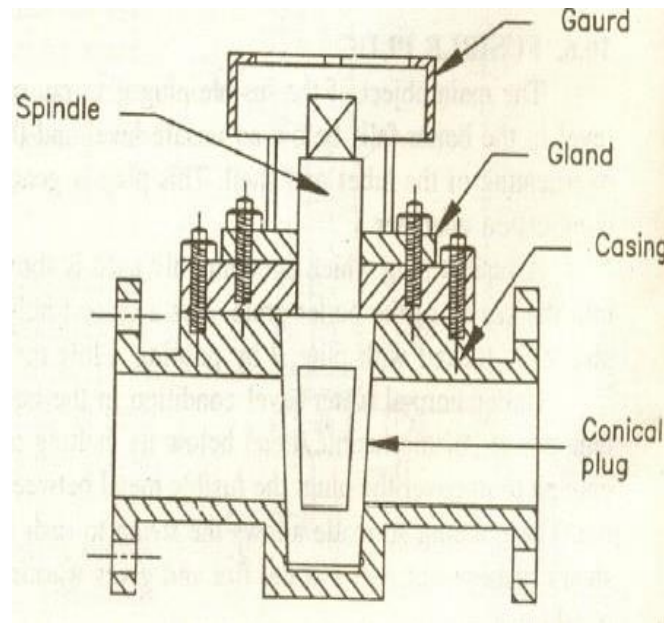


Figure 6: Blow-off Cock

It is fitted to the lowest part of the boiler either directly with the boiler shell or to a pipe connected with the boiler.

A commonly used type of blow off cock is shown in figure. It consists of conical plug fitted accurately into a similar casing. The plug has a rectangular opening which may be brought with the line of the passage of the casing by rotating the plug. This causes the water to be discharged from the boiler. The discharging of water may be stopped by rotating the plug again.

The blow-off cock should be operated only when the boiler is on if the sediments are to be removed. This is because; the sediments are forced out quickly due to the high pressure in the boiler.

7. Steam stop valve:

It is the largest valve on the steam boiler and usually fitted to the highest part of the boiler shell. The function of the stop valve is to regulate the flow of steam from the boiler to the engine as per requirements and shut off the steam flow when not required.

A commonly used steam stop valve is shown in figure. The main body is made of cast steel. The valve, valve seat and the nut, through which the valve spindle works, are made of brass for smooth working. The spindle is passed through a gland to prevent the leakage

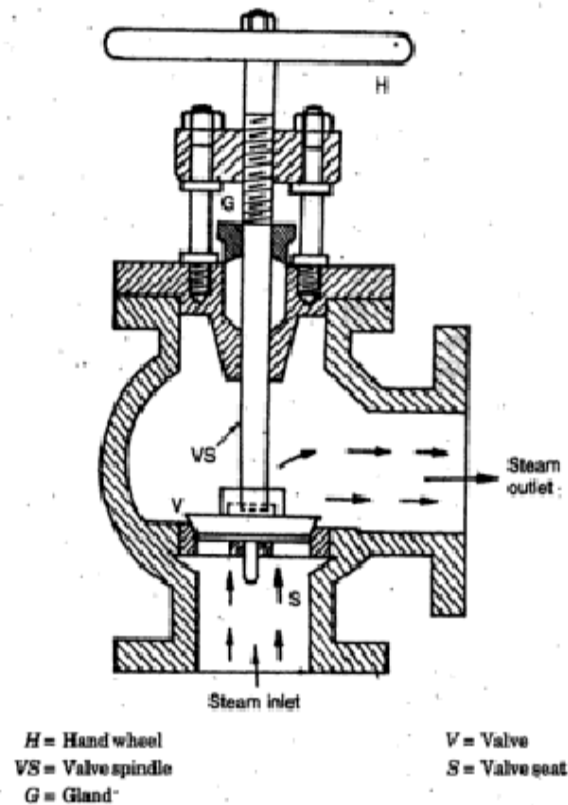


Figure 7: Steam Stop Valve

of steam. The spindle is rotated by means of a hand wheel. Due to the rotation of hand wheel, the valve may move up or down and it may close or open the passage fully or partially for the flow of the steam. In locomotive boiler the flow of steam is controlled by means of a regulator which is placed inside the boiler shell and operated by a handle from the driver's cabin.

Boiler Accessories:

Boiler accessories are auxiliary parts required to increase the overall efficiency of the plant.

These are

- 1) Air preheater
- 2) Super heater
- 3) Economizer

1. Air preheater:-

Air preheater, like economizer, recovers some portion of the waste heat of the flue gases. Air supplied to the combustion chamber is preheated by using the heat in the waste flue gases. Air preheater is placed after the economizer and before the gases enters the chimney.

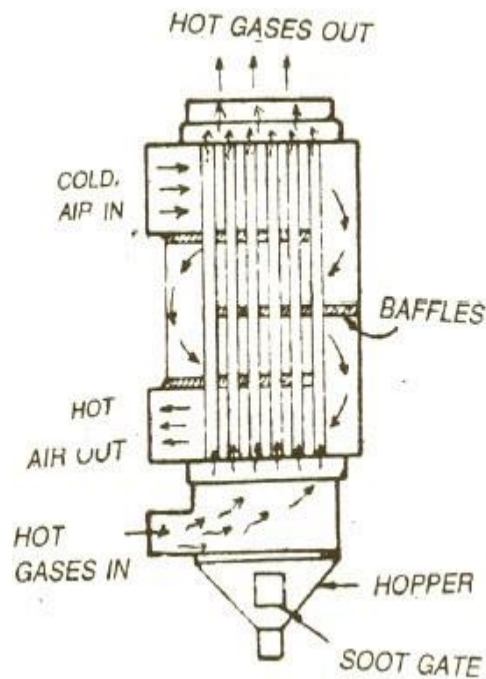


Figure: Air Preheater

A tubular type commonly used in smaller boiler plants is shown in figure. The hot gases are passed through the tubes and air circulates around them. Air is forced to deflect by using baffles as shown in figure and compelled to move in zigzag path for a number of times. This increases the period of contact between the air and hot surface and air is effectively heated. The soot and other material carried with gases are collected in the hopper at the bottom and removed periodically through soot and other material carried with gases are collected in the hopper at the bottom and removed periodically through soot gate.

2. Super heater:- Superheaters are used in boilers to increase the temperature of the steam above its saturation temperature. This is done by passing the steam through a small set of tubes and hot gases over them.

The superheater commonly used in Lancashire boiler is as shown in figure. This superheater consists of two headers and a set of superheater tubes made of high quality steel in the form of U-tube. Superheater is located in path of than 550°C. The superheater is located just before the gases enter the bottom flue.

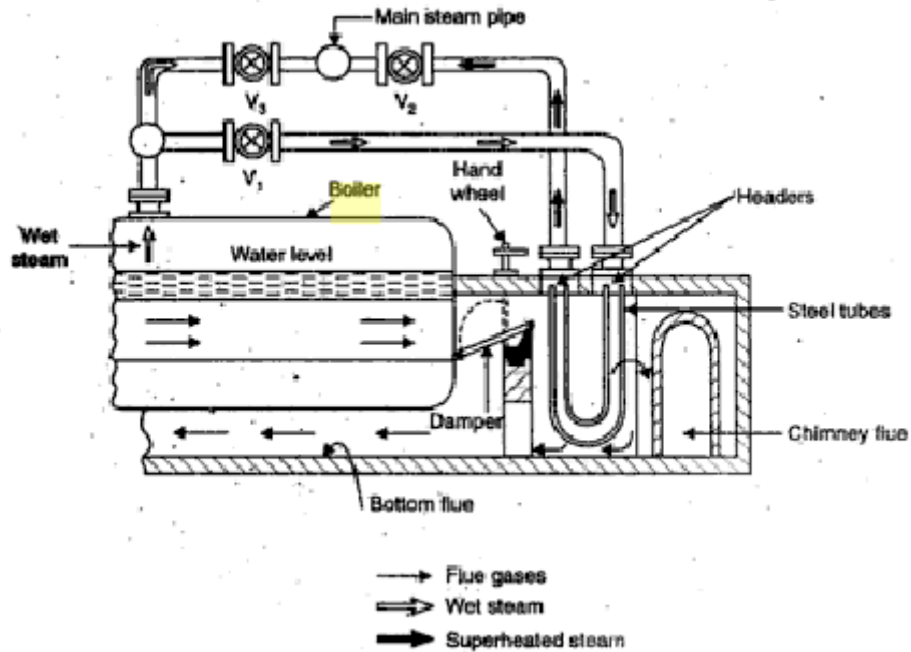


Figure: Superheater

The amount of hot gases passed over the superheater tubes should be in proportion to the amount of superheated steam passing through the tubes. Otherwise, the tubes should be overheated. To avoid this, the amounts of hot gases are divided as shown in figure. The superheater is put out of action by turning the damper, the gases coming out from the central flue pass directly into the bottom flue without passing over the superheater tubes.

The arrangement for getting superheated or wet steam is shown in figure. For getting superheated steam, the valves A and B are opened and valve C is closed. And the damper is kept open as per the quantity of steam flowing through the pipe. For this position the flow direction of the steam is shown in the figure. If wet steam is required, then the valves A, B and gas damper are kept closed, and valve C is kept open. In this case the steam directly comes out from the boiler through the valve C. by adjusting the gas damper the temperature of the steam coming out of superheater is always maintained constant irrespective of amount of steam passing through the superheater.

3. **Economiser:-** The economizer usefully extracts the waste heat of the chimney gases to preheat the water before it is fed into the boiler.

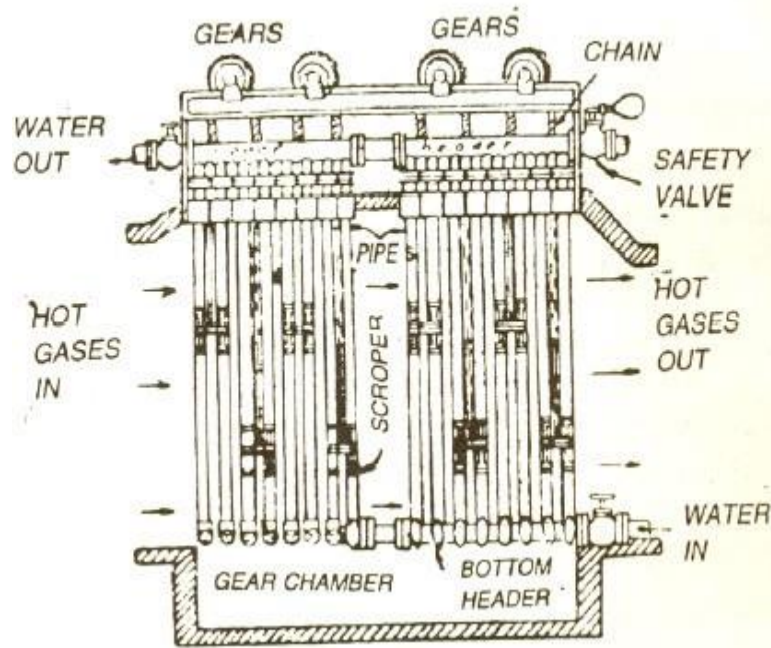


Figure: Green Economiser

A green's economiser commonly used in Lancashire boiler is shown in figure. The economiser consists of vertical cast iron pipes which are fitted with two headers, one at the bottom and other at the top. The feed water is passed through the bottom header, economizer pipes and top header and on to the boiler. The hot gases pass over the external surface of the water tubes. The heat from the hot gases is given to the feed water through the tube surface. A safety valve is fitted on the top header for the safety of the pipes against any highest pressure of water that may be developed. A blow-off valve is also fitted at the lowest point of the economizer to discharge the sediments collected from the feed water.

To prevent the deposition of the soot from the flue gases over the economizer tubes, a set of scrapers is fitted over the pipes as shown in the figure. This is necessary as the deposition of the soot reduces drastically the heat flow rate from the gases to the water. The soot is removed by

moving the scrapers over the pipes up and down continuously with the help of chain and gear arrangement. The soot removed from the pipe is collected in soot chamber situated below the bottom header and removed periodically.

The temperature of the feed water should not be less than 35°C because there is a danger of corrosion of the cold pipe outer surface due to condensation of moisture and SO₂ contained in the flue gases.

EXPERIMENT NO. 3

Study of condensers and cooling tower

Aim:- To study the condenser and cooling tower

Condenser:

A closed vessel in which steam is condensed by abstracting the heat and where the pressure is maintained below atmospheric pressure is known as a condenser.

Condensers are mainly classified as

1. Mixing or Jet condensers
2. Non-mixing or surface condenser

Low level jet condenser-

In a jet condenser the exhaust steam and water comes in direct contact with each other and temperature of the condensate is the same as that of cooling water leaving the condenser. The cooling water is usually sprayed in to the exhaust steam to cause rapid condensation.

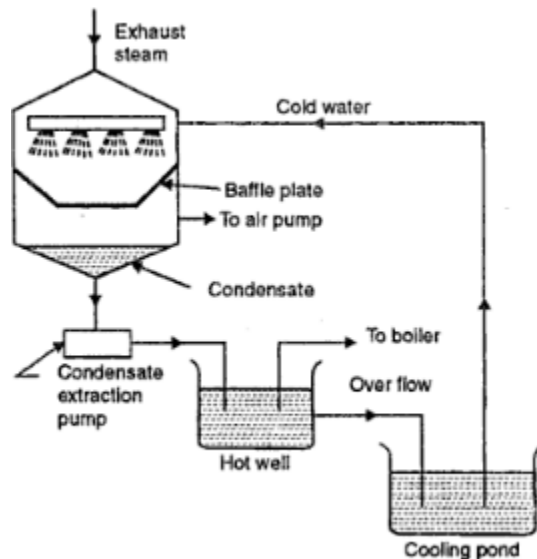


Figure 1: Low level jet condenser

Figure shows a line sketch of a low level parallel flow condenser. The exhaust steam is entering from the top and cold water being sprayed on its way. The baffle plate is provided in it ensures the proper mixing of the steam and cooling water. An extraction pump at the bottom discharges the condensate to the hot well from where it may be fed to the boiler if the

cooling water being used is free from impurities. A separate dry pump may be incorporated to maintain proper vacuum.

High level jet condenser:

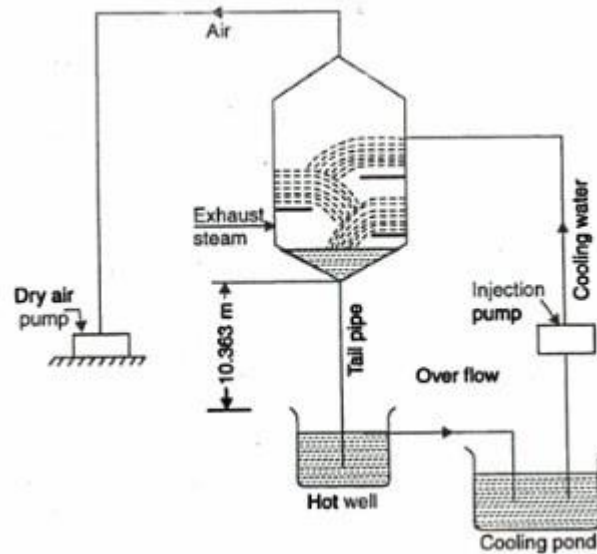


Figure 2: High Level Jet Condenser

Figure shows the high level counter flow jet condenser. In this case the shell is placed at a height 10.363 meters above hot well and thus the necessity of providing an extraction pump can be avoided. However provision of own injection pump has to be made under pressure is not available.

Surface condenser:

Most condensers are generally classified on the direction of flow of condensate, the arrangement of tubing and the position of the condensate extraction pump. The following are the main classification of surface condensers

1. Down flow type
2. Central flow type
3. Inverted flow type
4. Regenerative
5. evaporative

Down flow type:

Figure shows a down flow type surface condenser. It consists of a shell which is generally of cylindrical shape. It has cover plates at the end and furnished with number of parallel brass tubes. A baffle partitions water box into two sections. The cooling water enters the shell at the lower half section and after travelling through upper half section comes out through the outlet.

The exhaust steam entering shell from the top flows down over the tubes and gets condensed and is finally removed by an extraction pump. It is also called cross surface condenser.

Evaporative condenser:

Figure shows an evaporative surface condenser. The underlying principle of this condenser is that when a limited quantity of water is available, its needed to condense the steam can be reduced by causing the circulating water to evaporate under a small partial pressure.

The exhaust steam enters at the top through grided pipes. The water pump sprays water on the pipes and descending water condenses the steam. The water which is not evaporated falls into the open tank under the condenser from which it can be drawn by circulating water pump and used over it again. The evaporative condenser is placed in open air and finds its application in small size plants.

Cooling tower:

When cooling water supply is limited, there is a need to recycle the water through the condenser. Cooling tower is an artificial device used to cool the hot cooling water coming out of condenser more effectively. Cooling towers are desired when positive control on temperature of cooling water is required and space occupied by cooling system is an important factor.

The principle of cooling the water in cooling tower is similar that of the evaporative condenser. Some percentage of total water goes into the in the form of water vapour taking its latent heat from the remaining water and causing a reduction in the temperature of the water.

There are different types of cooling towers. The induced draft cooling towers are commonly used in high capacity power plants. The arrangement of induced draft cooling tower is shown in figure.

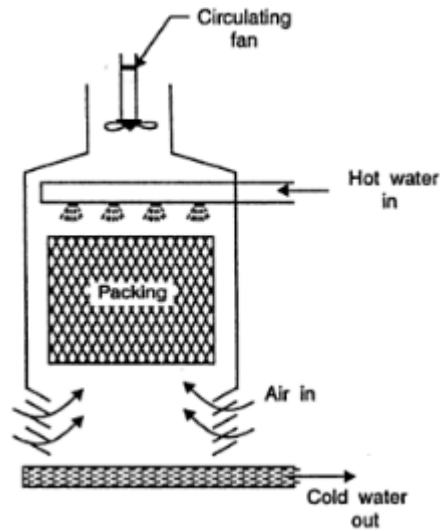


Figure : Cooling Tower

The hot water coming out from the condenser is sprayed at the top of the tower and air is induced to flow through the tower with the help of induced draft fans mounted at the top of towers as shown in the figure.

The amount of water usually lost with induced draft cooling tower range from 1% to 2% by evaporation and 0.5% to 0.2% by drift losses. To compensate these losses make-up water is supplied from external source.

EXPERIMENT NO. 4

Study of contemporary carburetor

Aim:- To study of contemporary carburetor

Apparatus:- Model of simple carburetor

Theory:-

The carburetor consist of a float chamber, nozzle with metering orifice, venture and throttle valve.

The float and needle valve system maintains a constant height of petrol in the float chamber. If the amount of fuel in float chamber drops below the designed level, the float chamber drops below the designed level, the float lowers there by opening the needle of fuel supply valve. When designed level has been reached the float closes the needle valve stop the additional flow from supply system. The float chamber is vented to the atmosphere.

Simple carburetor:

The arrangement of simple carburetor is shown in figure. It consists of float chamber for storing the fuel. The fuel supplied under the gravity action or by pump enters the float chamber through the filter. The arrangement is such that when the oil reaches the particular level the float valve blocks the inlet passage and thus cut off that the fuel oil supply. On the fall of oil level the float descends down consequently intake passage opens and again the chamber is filled with oil. Then the float and float valve maintains a constant fuel oil level in the float chamber. The jet from which the fuel is sprayed into the air stream as it enters the carburetor at the inlet S and passage through the throat or venturi. The fuel level is slightly below the outlet of the jet when the carburetor is inoperative.

As the piston moves down in the engine cylinder, suction is produced in the cylinder as well as in the induction manifold as a result of which air flows through the carburetor. The velocity of air increases as it passes through the construction at the venturi and pressure decreases due to conversion of a portion of pressure head in to kinetic energy. Due to the decrease pressure at the ventury and hence by virtue of difference in pressure the jet issues fuel oil into air stream. Since

the jet has a very fine bore, oil issuing from the jet is in the form of fine spray; it vaporizes quickly and mixes with the air. This air-fuel mixture enters the engine cylinder. Its quantity being controlled by varying the position of the throttle valve.

EXPERIMENT NO. 5

Study of fuel pump and fuel injector of I.C. Engine

Aim:- To study the fuel pump and fuel injector of I. C. Engine.

Apparatus:- Model of fuel pump and fuel injector

Fuel Pump:-

Fuel pump is widely used to supply fuel under high pressure in diesel engines. In this pump, the plunger stroke remains constant but the effective stroke is reduced by the changing the position of helix on the plunger with respect to the fuel inlet port.

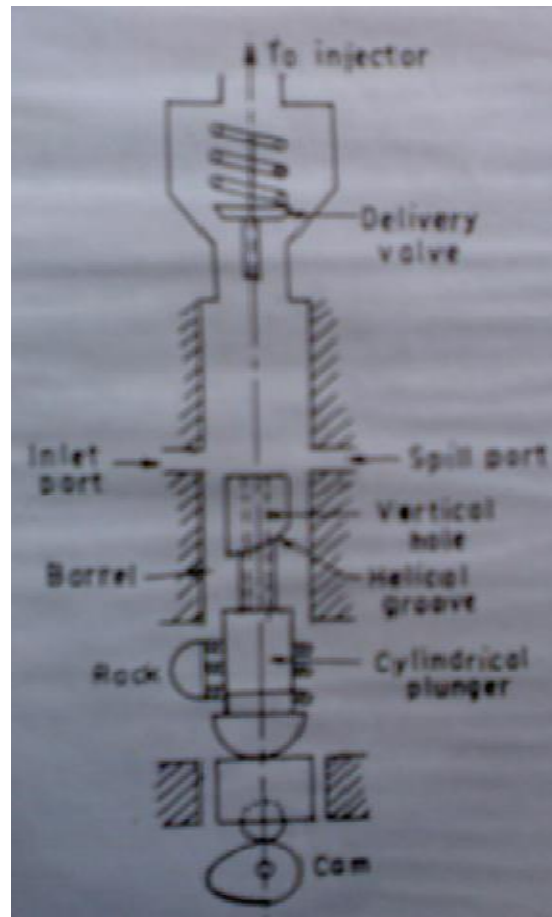


Figure 1: Fuel Pump

The fuel pump is shown in the figure. It has a cylindrical plunger which is closely fitted into the barrel by lapping. The plunger has a constant stroke and reciprocating motion of the

plunger is given by the cam. The vertical hole extends from the top of the plunger to another helical groove. When the inlet and spill port or the bypass ports are closed by the upper edge of the plunger during its ascending motion, the oil above the plunger gets compressed and the delivery valve gets lifted of its seat due to the high pressure developed. Then the fuel is forced through the pipe to the injector. The supply of the fuel to the injector is continued until the helical groove reaches the inlet port. The pump space in this position of the plunger communicates with the spill port through the spiral slot and the vertical groove is thus connected to the atmosphere. The pressure on the spring side is released. The delivery valve falls back to its seat and the supply of the fuel to the atomiser is stopped. At this time, the fuel barrel escapes from the spill port or the by pass port.

During the downward stroke of the plunger, the section is seated and fuel is drawn in to the barrel through the supply port.

The quantity of fuel being supplied to the injector depends upon the position of helical groove. The plunger can be rotated by means of the tooth rack. By tuning the plunger to the right, the effective pumping stroke can be increased i.e. the instant, at which the space communication with the spill port can be delayed and so, more fuel can be supplied to the engine at higher loads. The rack is operated by governor.

Fuel Injector:-

The fuel from the fuel pump is supplied to the fuel injector. The fuel injector has to perform the following functions:

- a) To atomize the fuel to the required degree.
- b) To distribute the fuel in such a way that there is complete mixing of fuel and air.
- c) It must prevent the injection on the walls of the cylinder and piston top surface.
- d) It must start and stop the fuel injection instantaneously.

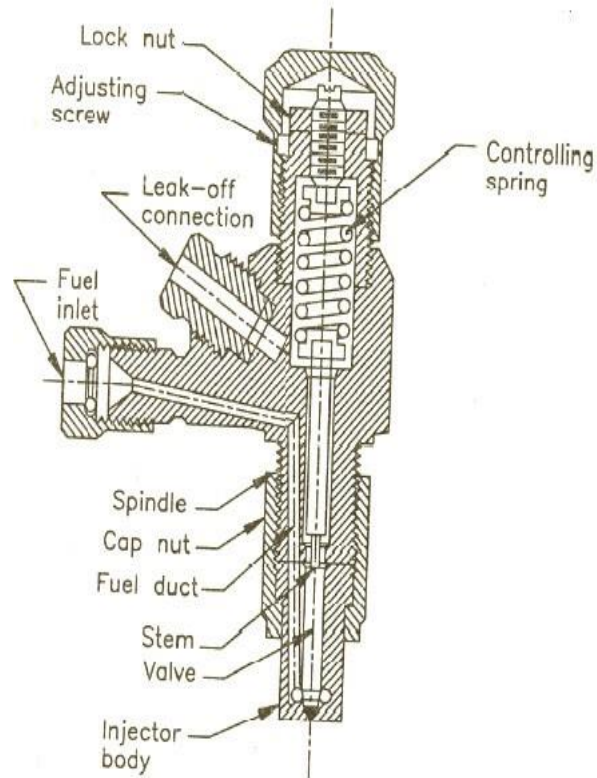


Figure 2: Fuel Injector

A typical spring loaded Bosch fuel injector is shown in figure. The spring loaded valve is lifted by the high pressure oil supplied by the pump and the fuel is injected in to the combustion chamber of the engine cylinder. As the pressure of oil falls, the valve is automatically closed by the spring force. The amount of fuel injected is regulated by the duration of the open period of the valve.

The pressure of the controlling spring can be adjusted by means of the adjusting screw as shown in figure. Any leakage of oil port, the valve and spindle is taken out through the leak off connection as shown in figure.

Conclusion: Hence we study the fuel pump and fuel injector of diesel engine.

EXPERIMENT NO. 6

Study of conventional ignition system of I.C. Engine

Aim:- To study the conventional battery ignition system

Construction:

The function of battery ignition system is to produce high voltage spark and to deliver it to the spark plugs at regular intervals and at the correct time with respect to the crank position. The require component of the system are listed below.

1. Battery of 6 to 12 v.
2. Induction coil.
3. Contact breaker.
4. Condenser.
5. Distributer.
6. Spark plug.

The arrangement of all the components of battery ignition system for four cylinders is shown in figure.

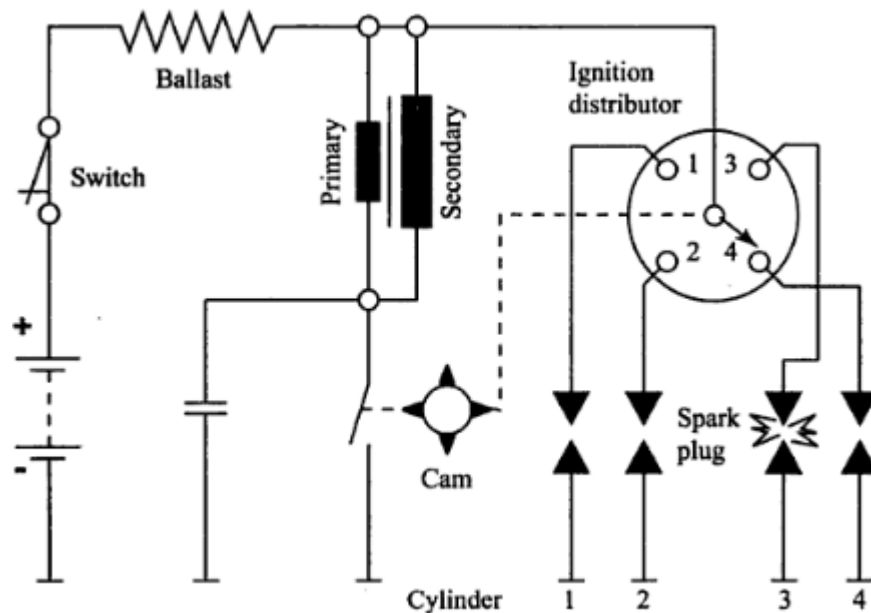


Figure 1: Conventional Battery Ignition System

Working of battery ignition system:

When the primary circuit is closed by the contact breaker a current begins to flow through the primary coil and magnetize core of the coil. The emf is induced in the secondary as the current in the primary increases. The emf induced in the secondary coil is proportional to the rate at which the magnetic flux increases. The emf induced in the secondary due to the growth of current in the primary is not sufficient to produce a spark at the spark plug because the primary circuit has to establish the magnetic flux.

When the primary circuit is opened by the contact breaker the magnetic field collapses. emf is induced in the secondary which is directly proportional to the rate at which the magnetic field of the core collapses which in turn depends on the rate of decrease of the primary current. A condenser is connected across the contact breaker in the primary circuit. This helps to collapse the field very rapidly by absorbing part of the energy of the magnetic field which is thrown back into the primary winding and produces a very high voltage in the secondary. This emf in the secondary is sufficient to ignite the charge by producing a spark. One end of the secondary coil is connected to the ground and the other end is connected to the central terminal of the distributor. The distributor connects the secondary coil in turn to the different spark plugs of the engine in their firing order. The spark plug of a particular cylinder is placed in circuit of the secondary coil with the help of the distributor when the time comes for the charge in that cylinder to be ignited and at the same time the primary circuit is opened by contact breaker. A spark is produced between the points of the spark plug.

The distributor and contact breaker are generally mounted on the same cam shaft which rotates at half speed of the crank shaft. The function of the distributor is to connect the secondary to each cylinder of a multi cylinder engine at the time of ignition. The contact breaker also works simultaneously with distributor and its function is to disconnect the primary circuit exactly at the same time when the spark in the particular cylinder is required. The distributor connects four spark plugs in one rotation of the cam shaft and therefore four contact points are required in a four cylinder engine.

EXPERIMENT NO. 7

Study of lubricating system of I.C. Engine

Aim:-

Introduction

The lubrication system in an automotive engine supplies a constant supply of oil to all moving parts. This constant supply of fresh oil is important to minimize wear, flush bearing surfaces clean, and remove the localized heat that develops between moving parts as a result of friction. In addition, the oil that is supplied to the cylinder walls helps the piston rings make a good seal to reduce blow.

Splash System:

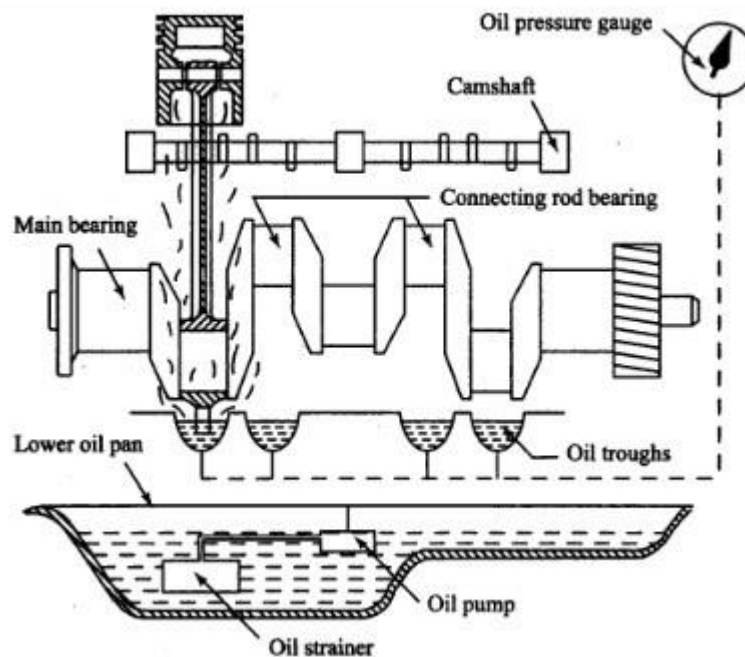


Figure 1: Splash Lubrication System

The splash lubrication system is no longer used in automotive engines, though it is used in small equipment engines. In a splash lubrication system, dippers on the connecting rods enter the oil in the crankcase with each crankshaft revolution, thus splashing the oil. As the oil is thrown upward, it finds its way into the various engine parts. A passage is drilled from the dipper to the

bearing in each connecting rod to ensure lubrication. This system is too uncertain for modern automotive applications. One reason is that the level of oil in the crankcase will greatly vary the amount of lubrication received by the engine; a high level results in excess lubrication and oil consumption and even a slightly low level results in inadequate lubrication.

Combination Splash and Force Feed System:

In the combination system, oil is delivered to some parts by means of splash and to other parts through oil passages, under pressure from a pump in the crankcase. The main and the camshaft bearings are usually the items that are force fed while the connecting rods are fitted with dippers that supply oil to the rest of the engine by splash. Some configurations use small troughs under each connecting rod, kept full by small nozzles that deliver oil under pressure from the oil pump. These oil nozzles deliver an increasingly heavy stream as speed increases. At very high speeds, these oil streams are powerful enough to strike the dippers directly.

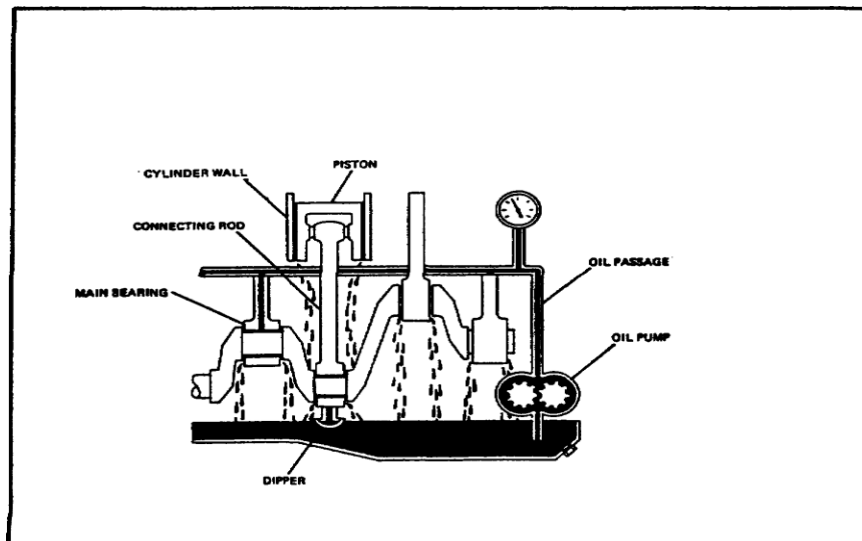


Figure 2: Combined splash and forced feed lubrication system

This causes a much heavier splash so that adequate lubrication of the pistons and the connecting rod bearings is provided at higher speeds. If a combination system is used on an overhead valve engine, the upper valve train is lubricated by pressure from the oil pump.

Force Feed Lubrication System:

A somewhat more complete pressurization of lubrication is achieved in the force feed lubrication system. Oil is forced by the oil pump from the crankcase to the main bearings and the camshaft

bearings. Unlike the combination system, the connecting rod bearings are also fed oil under pressure from the pump. Oil passages are drilled in the crankshaft in order to lead oil to the connecting rod bearings. The passages deliver oil from the main bearing journals to the rod bearing journals.

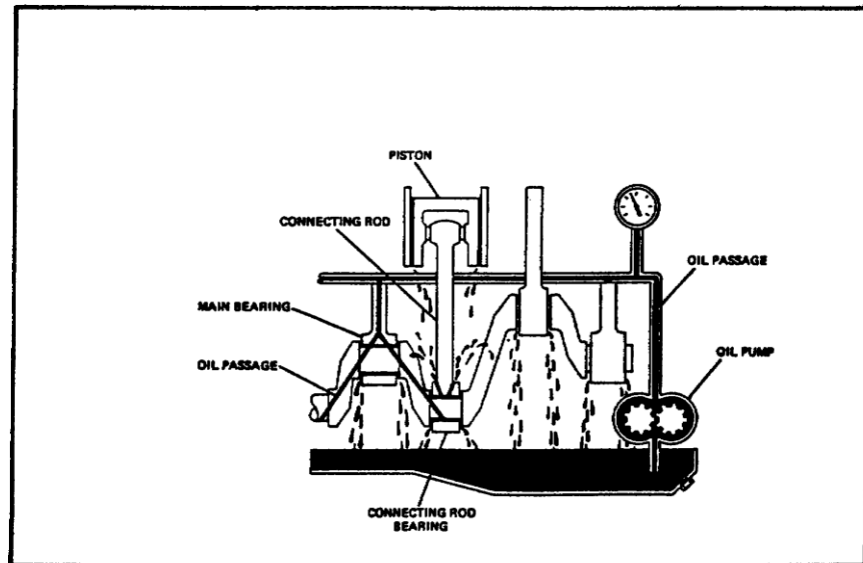


Figure 3: Force feed lubrication system

In some engines, these openings are holes that index (line up) once for every crankshaft revolution. In other engines, there are annular grooves in the main bearings through which oil can feed constantly into the hole in the crankshaft. The pressurized oil that lubricates the connecting rod bearings goes on to lubricate the pistons and walls by squirting out through strategically drilled holes. This lubrication system is used in virtually all engines that are equipped with semi floating piston pins.

EXPERIMENT NO. 8

Trial on reciprocating air compressor

Aim:- To determine mechanical efficiency of an air compressor.

Apparatus:-

1. A two stage twin cylinder air compressor mounted on a storage tank and coupled to a three phase induction motor.
 - a. The unit is supplied with suction filter, safety valve, pressure gauge, etc.
 - b. An energy meter and an orifice meter are provided to measure power input and flow rate respectively.

Procedure:-

1. Examine the connections of three phase motor to mains via energy meter.
2. Empty the tank so that inside pressure is atmospheric.
3. Close the outlet valve and start the electric supply. Pressure inside the tank starts built up.
4. Take manometer reading, pressure gauge reading and time required for every ten revolutions of the energy meter disc.

Observations:-

1. Orifice meter inner diameter (d) =
2. Energy meter constant (C)=
3. Efficiency of the motor =
4. Coefficient of discharge (C_d) =

Reading Table:-

Sr. No.	Time for 10 revolutions	Manometer reading 'h' (mm)	Delivery pressure 'H' (Kg/cm ²)
1			
2			
3			

Calculations:-

Set I:

1. Area, $A = \frac{\pi}{4} \times d^2$

2. Power input, $P_p = \frac{10 \times 3600 \times 0.9}{t \times c}$

3. Discharge, $Q = C_d \times A \times \sqrt{2gh}$

4. Delivery pressure, H=

5. Power output, $P_{output} = Q \times H$

6. Efficiency, $\eta_l =$

Set II:

1. Area, $A = \frac{\pi}{4} \times d^2$

2. Power input, $P_{ip} = \frac{10 \times 3600 \times 0.9}{t \times c}$

3. Discharge, $Q = C_d \times A \times \sqrt{2gh}$

4. Delivery pressure, H=

5. Power output, $P_{output} = Q \times H$

6. Efficiency, $\eta_l =$

Set III:

1. Area, $A = \frac{\pi}{4} \times d^2$

2. Power input, $P_{ip} = \frac{10 \times 3600 \times 0.9}{t \times c}$

3. Discharge, $Q = C_d \times A \times \sqrt{2gh}$

4. Delivery pressure, H=

5. Power output, $P_{output} = Q \times H$

6. Efficiency, $\eta_l =$

Result: - Mechanical efficiency of an air compressor is found to be ____%.

EXPERIMENT NO. 9

Assignment on topic no.1 Air Compressors

Q.1 Derive the expression for work done in single stage, single cylinder air compressor, neglecting clearance volume on work done?

Q.2 Write note on

a) Roots blower

b) Centrifugal compressor

EXPERIMENT NO. 10

Assignment on topic no. 5 Vapour Power Cycles

Q.1 Explain the Rankin cycle with super heating?

Q.2 Explain the effect of Regeneration and reheating on the Rankin cycle?