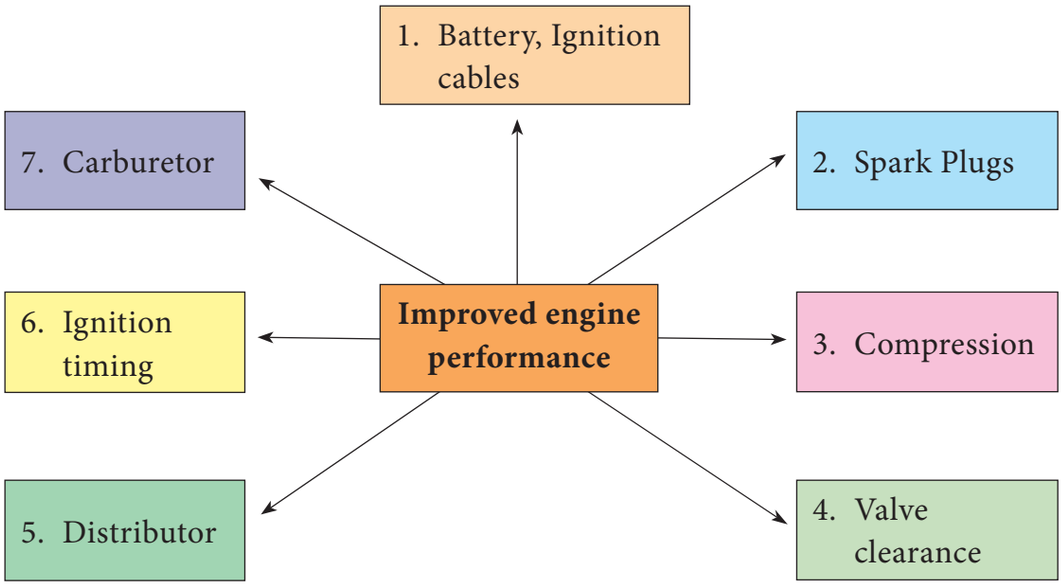


Figure 6.14 Engine tune-up procedure

- The Fuel pump should be cleaned
- The carburettor should be cleaned
- Diesel injection pump should be cleaned well
- Diesel injector should be cleaned well

(5) Lubricating System

- Pressure gas working should be tested
- Oil filter should be cleaned
- Crank case oil level should be tested
- Engine oil pressure should be checked

(6) Cooling unit testing

- Have to check the end play and a leak in the water pump
- Should check the leak in the radiator hose
- Fan belt should be checked

(7) Electrical system testing

- Battery, wire connection should be cleaned
- To test the battery condition, electrolyte test should be performed
- Generator connection should be checked
- Starter switch should be checked

(8) Clutch plate should be checked

(9) With the help of the dynamo the engine performance should be measured

6.15 POLLUTION

In this world, human and many living organisms inhale oxygen from air to survive. So that the air should be clean and make it free from pollution. In doing this we have to know the formation of pollutants and measures to reduce them. Every human inhales nearly 15 kg of oxygen. So if the air is polluted all the living organisms will be affected. Pollutants and its effects are already reffered in Table 6.1.

Pollution Control

To control pollution, the below said three techniques are being used,

a) Reduce pollution before it occurs
b) Reduce the pollutant during their formation stages
c) Reduce pollution once it is formed.

(1) Reduce pollution before it occurs,
- Low compression ratio
- Changing the combustion chamber geometry
- Changing the piston design
- Lean mixture operation
- Maintaining piston and piston ring function

(2) Reduce the pollutant during their formation stages
- Fuel modifications
- Engine modifications
- Modifying the operating parameters for complete combustion

(3) Reduce pollution once it is formed,
- Using burner
- More air supply to inlet manifold

(4) Control of carbon monoxide,
- Lean mixture operation
- After burner
- Catalytic converter

(5) Control of oxides of nitrogen,
- Re inducting the exhaust gas into inlet manifold
- Mixing of non-fired things with fired things

Smoke Control

- To control the smoke we have to maintain the vehicle in good condition and barium salt to the fuel

Various Methods of Reducing Emissions

- Re setting of valve timing
- Inspecting cooling and fuel supply system
- Changing combustion chamber design
- Re inducting the exhaust gas into inlet manifold
- lean mixture operation

Student Activity

1. Students should visit the nearby workshops to study intake and exhuast system of a motorcycle and a car and should have a hands-on experience on engine dismantling and assembling inlet manifold.
2. Students should visit the nearby workshops to dismandle the cylinder head and sketch the components.

Glossary

Purified	-	சுத்தப்படுத்துதல்
Contamination	-	மாசுபடுதல்
Intermittent	-	விட்டு விட்டு
Venturi	-	குறுகிய வழி
Ignition	-	பற்றி எரிதல்
Nozzle	-	நுனிக்குழாய்
Idle Speed	-	நிலையியக்க வேகம்
Inlet Manifold	-	உள்ளிழு பன் மடிமம்
Out let manifold	-	வெளியேந்து பன் மடிமம்
Spark Plug	-	மின்பொறிக்கட்டை

References

1. Rajput R.K. Internal Combustion Engines, Laxmi Publications (P) Ltd, 2006.
2. Ganesan V." Internal Combustion Engines, Third Edition, Tata McGraw - Hill, 2007.
3. B. P. Pundir, "IC Engines Combustion and Emission" Narosa publishing house, 2010.
4. Crouse William, Automotive Emission Control, Gregg Division /McGraw - Hill, 1980
5. Mathur, M.L., and Sharma, R.P., A Course in Internal Combustion Engines, Dhanpat Rai Publications Pvt.New Delhi-2, 1993.

Webliography

1. https://en.wikipedia.org/wiki/Inlet_manifold
2. https://en.wikipedia.org/wiki/Inlet_manifold
3. https://www.doityourself.com/stry/exhaust-manifold-vs-intake-manifold
4. https://sffsymposium.engr.utexas.edu/Manuscripts/2009/2009-67-Ilardo.pdf
5. https://nwmobilemechanicdotcom.wordpress.com/mechanic-research-papers/
6. https://www.magnetimarelli.com/business_areas/powertrain/gasoline-system-pfi/air-intake-manifold
7. https://uta-ir.tdl.org/uta-ir/bitstream/handle/10106/25398/Seshadri_uta_2502M_13339.pdf
8. https://928motorsports.com/installpdf/intakemanifolddesign.pdf

9. http://www.ijettjournal.org/volume-17/number-10/IJETT-V17P295.pdf
10. http://ijesat.org/Volumes/2017_Vol_07_Iss_01/IJESAT_2017_07_01_05.pdf

SAMPLE QUESTIONS

Choose the correct answer

1. How many types of air filters are used in I.C engines?

   a) Two b) Three c) Four

2. How many types of petrol pumps are used in engines?

   a) Two b) Three c) Four

3. How many types of diesel injection pumps are used in engines?

   a) Two b) Three c) Four

4. How many types of feed pumps are used in diesel engines?

   a) Two b) Three c) Four

5. How many types of silencers are used in I.C engines?

   a) Two b) Four c) Five

Answer the following questions

1. What are the pollutions in atmospheric air?
2. What are the effects of air pollution to the human?
3. Give the five parts of intake system?
4. What are the types of Air filters?
5. What are the uses of air filter?
6. What are the uses of oil bath type air cleaner?
7. Draw and explain the construction of A.C mechanical fuel pump?
8. What is carburettor?
9. Write the types of carburettor.
10. Draw and explain the construction diesel injector.
11. Write the types of nozzles.
12. Draw and explain any one nozzle.
13. What are the various types of combustion chambers in diesel engines?
14. What is muffler?
15. Write the types of muffler.
16. Draw and explain any one muffler.
17. What are the methods are used to control the air pollution?
18. Briefly explain about pollution control methods.

Unit 7 Cooling System

Contents

Learning Objectives

- To learn about the air and water cooling techniques involved in two stroke and four stroke engines.
- To learn about various cooling components like cooling fan, cooling water, radiator and water jacket.

7.0 AIM

In internal combustion engines due to the combustion of the fuel air mixture, enormous heat is liberated inside the combustion chamber. From the total heat released, about 30-35% of the heat is transferred as useful mechanical work at the engine's crank shaft. Approximately 30% of heat is carried out by the burned gases. About 25- 30% of the heat is rejected by the cooling medium and the remaining is considered as the unaccounted loss which is due to the friction, radiation etc., The temperature of the combustion products immediately after the combustion of the fuel reaches the value which is even more than 2000°C. Due to the very high temperature the engine components are subjected to very high thermal stress and get expanded due to the more heat of the products. This leads to the burning of engine lubricating oil and more carbon will get deposited inside the combustion chamber. In order to avoid the damage of engine components and burning of lubricating oil the cooling system is essential which helps in sending the heat to the surroundings.

The following are effects of overheating of the engine components.

- Damage of the piston and piston sticking on the cylinder wall.
- Lubricating oil burning and formation of carbon deposits and on the combustion chamber parts and the valves.
- Burning of the engine valves (mainly the exhaust valve)
- Occurrence of Pre ignition, knocking and detonation
- Reduction in viscosity of the engine lubricating oil
- Wear and tear of the engine components
- More fuel consumption.

The following are effects of over cooling of the engine components.

- Power loss
- More fuel consumption
- Reduced Thermal efficiency
- Increase in viscosity of the engine lubricating oil
- Reduced mechanical efficiency

Characteristics of the efficient cooling system:

- From the overall heat produced, the cooling system must reject sufficient amount of heat about 28-30% from the overall heat produced from combustion of the fuel.
- Cooling system should be designed in such a way that the heat to be rejected quickly when the engine is operated at very high temperature.

- During starting, the cooling system should reject only less amount of heat.
- It should transfer the maximum (i.e. sufficient) amount of heat from the engine combustion chamber.

7.1 AIR COOLING SYSTEM

In this type of cooling system, the engine cylinder should be kept in such a way that more air should be in contact with the outer region of the cylinder block. Cooling fins are provided on the outer wall of the cylinder so that the contact surface areas for heat transfer to be more. These arrangements are mostly seen in all motor cycles, scooters and in small engines. Figure 7.1 shows the air cooling system.

When the vehicle moves forward, the air passes over the fins and removes the heat on the engine components and hence the engine gets cooled. In some large engines, blower arrangement is made so that the blower sucks the air from the surrounding air and blows on the surface of the cooling fins of the engine.

The efficiency of the air cooling system depends on the following characteristics,

- The speed of the air which flows on the fins
- Area of the fins that is in contact with air
- Thermal conductivity of the cylinder walls

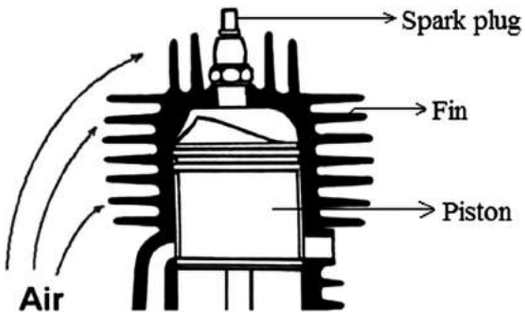


Figure 7.1 Air cooling system

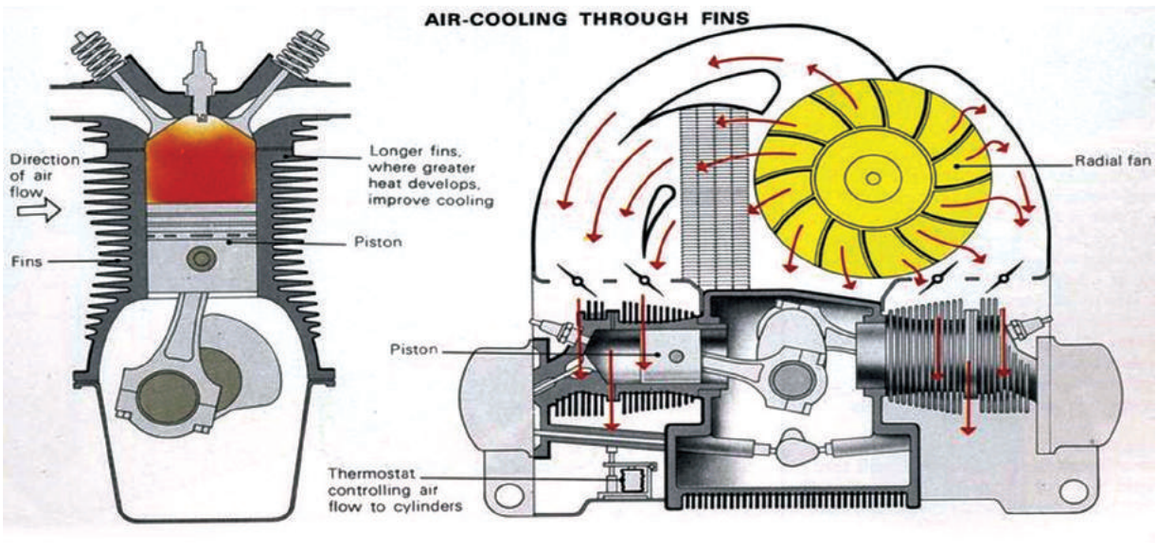


Figure 7.1(a) Air cooling system

- The temperature of the engine fins and the temperature of the cooling air

Advantages and disadvantages of air cooling system:

Advantages:

- In this type due to the absence of radiator fan and pumping unit, engine weight is considerably reduced
- Due to the absence of radiator arrangement, rust and deposits formation are avoided
- Engine occupies only less space
- As the engine needs no water jacket, design of the engine is simple
- The system need no water filling in the radiator
- The engine can be operated at all operating conditions (cold and hot regions)
- Freezing and evaporation of water do not occur as in case of water cooling system

Disadvantages:

- Air cool system is not suitable for CSMO cylinder engines
- As this type of engine is cooled by air, the efficiency of engine decreases
- More noise is produced
- Heat transfer rate is lower with air cooling as compared to water cooling
- Blower arrangement is needed for bigger size engines

7.2 WATER COOLING SYSTEM

In this method, the water is circulated inside the water jackets of the engine cylinder block and the cylinder head and rejects the heat in the cylinder block and head. As the water absorbs the heat from the cylinder it gets vapourized. It may cause insufficient water to be present in the cooling line. Hence excess water must be added to overcome the vapourization loss. In order to overcome this difficulty radiator arrangement is used to cool the hot water coming out from the engine water jackets. There are three types of water cooling systems followed in engines which are,

1. Direct (or) non return cooling system
2. Thermosyphon or natural circulation cooling system

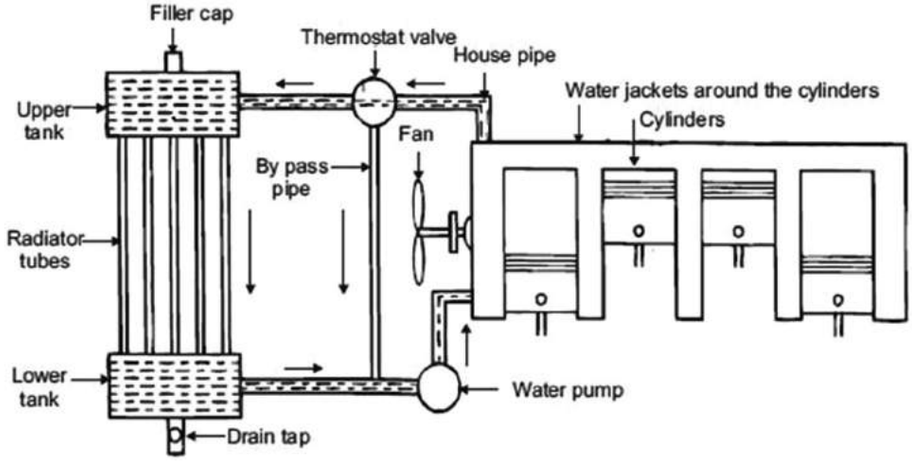


Figure 7.2.1 Water cooling system

3. Pressurized or Pump circulation cooling system

7.2.1 Direct (or) Non-Return System

This method is mostly used where availability of water is more such as in big industrial engines, marine engines etc., In this method the water from the storage tank is sent to the water jackets of the engine where the water absorbs the heat and the hot water is sent out through the outlet path. The pump in the marine engines pumps the sea water into the water jacket and sends the hot water out. This type is not recommended for automotive engines.

7.2.2 Thermosyphon System

We know that the density of hot water is less than that of the cold water. Thermosyphon cooling system works on the principle of circulating water by the density difference in the water. Figure 7.2 shows the thermosyphon system.

In Thermosyphon cooling system, when the engine runs, the hot water in the engine water jacket moves upwards due to the reduction in density. It moves further to the radiator through the hose provided and it is cooled in the radiator. The cold water at the bottom of the radiator enters into the engine and pushes the hot water upwards and occupies the place of the hot

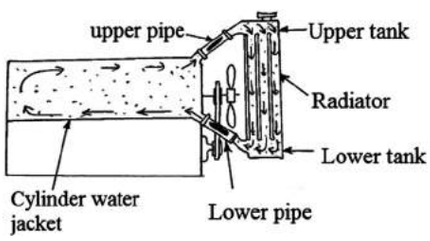


Figure 7.2.2 Thermosyphon system

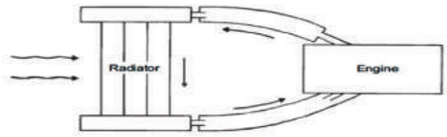


Figure 7.2.2 Thermosyphon system

water. This is called as conventional flow of water. In this type of cooling systems the radiator is placed just above the engine. When the water level is less and when the vehicle claims up or down this system does not work properly. Hence this type of cooling system is not is not used in modern automobiles.

7.2.3 Pump Circulation System

In this system a water pump is used to circulate the water. Hence this method is also called as pump circulation system. Nowadays, in many vehicles this type of cooling system is followed. In this system the conventional flow of water and the pressure of the centrifugal pump are combined and hence the system has the added advantage. Fig 7.2.3 shows the pump circulation cooling system.

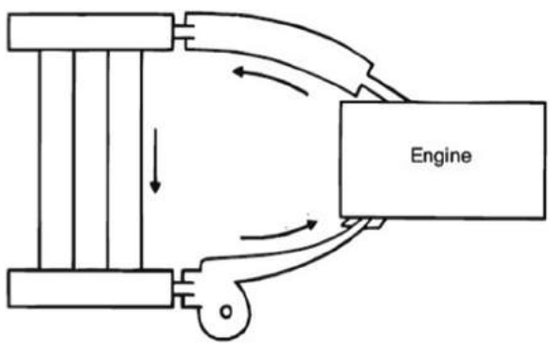


Fig 7.2.3 pump circulation system

The pump present in this system pumps the water into the water Jacket of the engine quickly. The pumped water takes away the heat from the engine cylinder and goes to the radiator. The hot water in the radiator is cooled as it enters into the shells of the radiator and also due to the opposing air coming from the atmosphere. As the air passes through the gaps of the shells,by touching the fins in the radiator the heat is removed from the water. The cooled water is again sent to the engine water jackets by the pump. By this way the pressurised or pump circulation cooling system rejects heat. The power to the water pump is taken from the V-pulley belt drive.

The important components of this system are as follows,

1. Water jacket
2. Water pump
3. Radiator
4. Thermostat valve
5. Fan and fan belt
6. Radiator hose

The following are the Advantages of the water cooling system:

1. The engine noise is reduced and runs smoothly
2. Cooling rate is high
3. The engine can be operated for more time than other type of cooling system engines
4. This is mostly used for multi cylinder engines
5. Temperature is controlled as per the requirement of the engine

Draw backs:

1. Maintenance is difficult
2. Maintenance cost is higher than air cooled engines
3. Water pump, water jacket, radiator and the radiator fan are the components needed.
4. Purified water has to be used.
5. Deposits and corrosion of the engine water jackets are possible when using impure water in this system

7.3 PARTS OF THE WATER COOLING SYSTEM

1. Radiator
2. Pressure cap
3. Thermostat
4. Water pump
5. Fan

7.3.1 Radiator

Radiator consists of three main parts such as upper tank, core and lower tank. The radiator core and connecting tube are placed in between the upper tank and lower tank. In a radiator the upper tank is connected to the upper surface of the engine through a separate hose. The lower tank is connected with the water pump through a separate hose connection.

The hot water coming out from the engine goes to the upper tank of the radiator through the hose connection. The water reaching the lower tank from upper tank of the radiator is cooled by the radiator core. Before reaching the lower tank the water is cooled by the air passing through the fins of the radiator core by the atmospheric air. The atmospheric air is sucked by the radiator fan and hence the hot water is cooled.

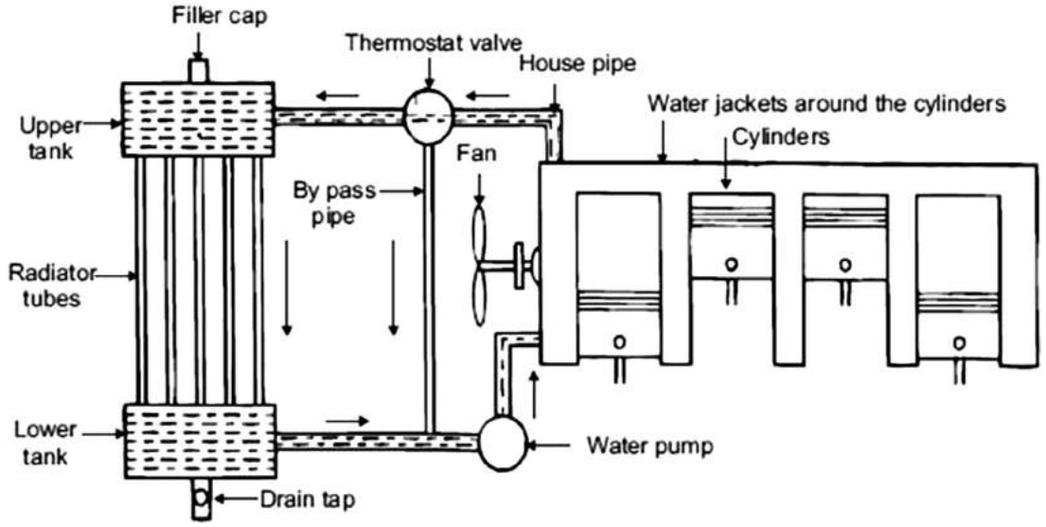


Figure 7.3.1 Radiator

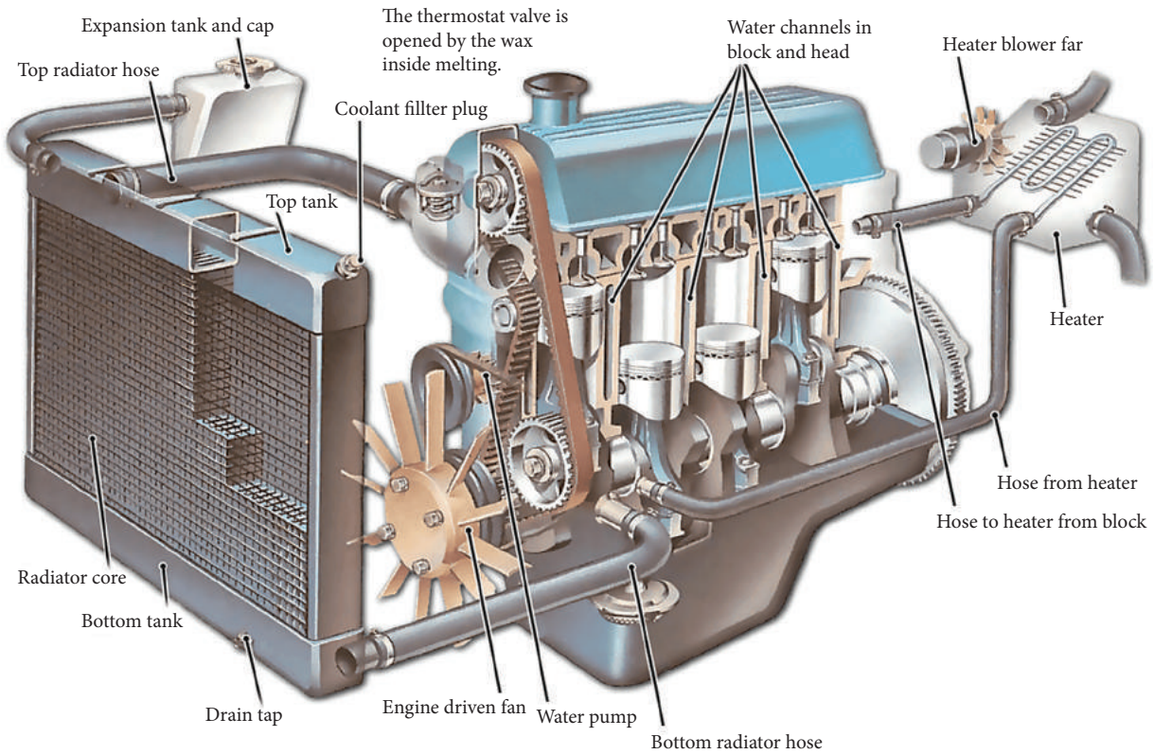


Figure 7.3.1(a) Radiator

Types of radiator:

We can classify radiators in to two types: they are

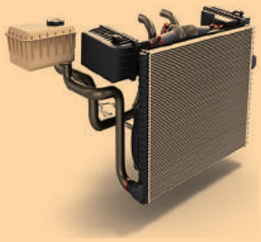
1. Tubular type radiator
2. Cellular type radiator (or) honey comb type radiator

What is a Radiator?

Radiators are heat exchangers used to transfer thermal energy from one medium to another for the purpose of cooling and heating.

In automobiles it is responsible for preventing the car engine from overheating.

It uses coolant (water or oil) to keep the engine running at a healthy temperature.



7.3.1(a) Tubular Type Radiator

Small diameter tubes are used for connecting the upper and lower tank in the radiator. Water gets cooled by flowing through the number of tubes. The outside of the tube walls are attached with cooling fins. The fins and tubes are made up of pure copper. The fins are arranged horizontally with each other. In this type of radiators the cooling process is affected for the entire distance of tube if there is any blockage inside the tubes. This type of radiator is lower in weight and simple in structure and hence used in most of the vehicles.

Figure 7.3.1(a) Tubular type radiator

7.3.1(b) Cellular (or) Honeycomb Type Radiator

In this type of radiator, the hot water coming from the upper tank is allowed to pass through the tubes which are in honeycombed structure and gets cooled before reaching the lower tank. Two honeycombed structure tubes are connected in between the water flowing passage. By this structure, any block occurs inside the tube will not reduce the cooling performance. This type of radiator is mostly used in racing cars. They are costlier than tube type radiators. The figure 7.3.1(b)shows the picture of the honeycomb radiator.

Fig 7.3.1(b) Honey comb type radiator

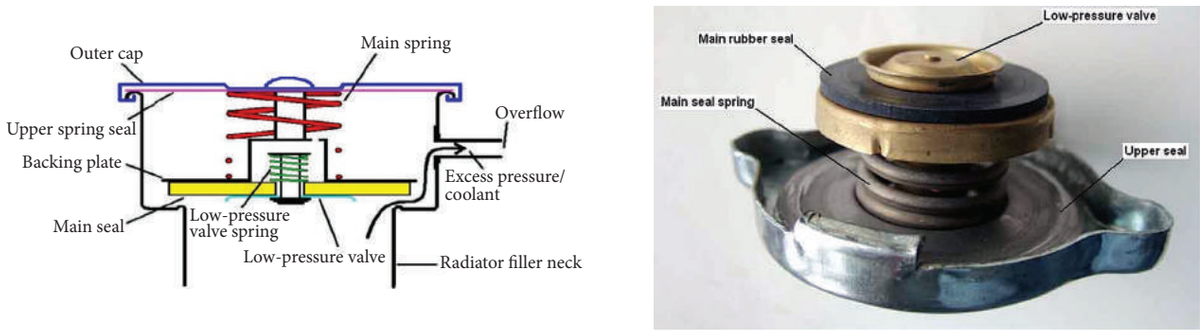


Figure 7.4 Pressure Cap

7.4 PRESSURE CAP

The component used to close the upper tank of the radiator is called as the radiator pressure cap. This cap prevents the flow of evaporated water (steam) outside from the upper tank. It also helps in avoiding flow of water outside the tank when the vehicle is traveling on any bumps and pot holes. In cold climatic countries water inside the radiator gets cooled naturally when the engine is at rest. In such condition vacuum may occur inside the tank. In such situations the exterior air comes inside the tank and replaces the vacuum area. The pressure in the pressure cap is released from the pressure valve by opening the pressure cap when the pressure inside the water tank is increased. When water is cooled the vacuum vale is opened and air is allowed to enter in to the radiator for protecting it.

7.5 THERMOSTAT

A specified temperature must be maintained in the cooling system to operate the engine safely and efficiently. This temperature is generally in the order of 70 deg to 80 deg for petrol engine and 80 deg to 85 deg for diesel engines. To maintain the temperature a thermostat arrangement is used. It blocks the coolant supply until the engine is warmed up. The thermostat valve is placed in between the engine and upper tank of the radiator. Thermostat housing consists of an inlet and outlet valve. Inside the housing the thermostat is placed. There is a bypass line arrangement for passing cooling water after the engine is started and until it reaches the required temperature. Cooling water starts to flow through the tubes by opening the thermostat valve when the engine reaches its specified temperature and the cooling water is sent to the upper tank in the radiator.

Basically there are two types of thermostat valves used in automobiles, they are

1. Bellows type thermostat
2. Wax type thermostat

7.5.1 Bellow Type Thermostat

In this type of thermostat, there is a frame in the upper side and valve in the lower side which is attached to the bellows. Bellows are filled with either alcohol or acetone which is easily evaporating chemicals. These chemicals have lower boiling points such as 70 deg to 80 deg. When the engine's coolant(water)

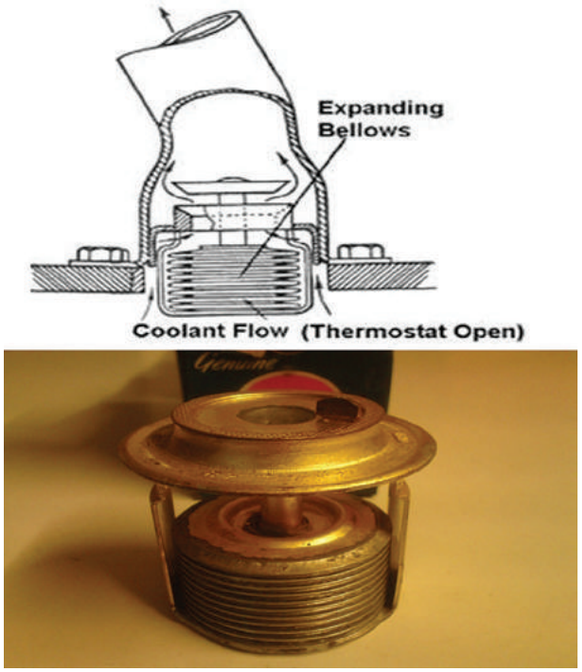


Figure 7.5.1 Bellows Type Thermostat

temperature reaches 70 to 80 deg Celsius, the chemicals inside the bellows get evaporated and allow the bellows to get expanded. The valve connected to the bellows now open and the water from the engine is sent to the upper tank of the radiator. When the cooling water temperature is reduced to 80 deg Celsius the chemicals inside the bellows get cooled and shrink. Now the valve connected to the bellows gets closed by this shrinkage. By this way thermostat controls cooling water circulation. The figure 7.8 shows the arrangement of the bellows type thermostat.

Comparison of air cooled and water cooled system:

Air cooled system	Water cooled system
Air is a medium of cooling	Water is medium of cooling
Fins are used	Water jacket, water pump radiator, thermostat like components are used.
Construction is easy	Construction is difficult
Less space is required for installation.	Needs more space
Produces more noise	Less noise
It runs with all the climatic changes.	In cold climatic countries water will freeze. So this type is not used in such countries.
No sediments or corrosion in the system	Corrosion and sedimentation occur.
Cooling process is not affected by any damage of one or two fins	If there is a water leak, it affects the cooling process.
This system cools the engine randomly.	This system cools the engine uniformly.
Conductivity of temperature is low	High
Not suitable for multi cylinder engines	Suitable for multi cylinder engines
Production and maintenance cost are low	high
Mostly used in two wheelers	Used for Lower, medium and high duty vehicles.

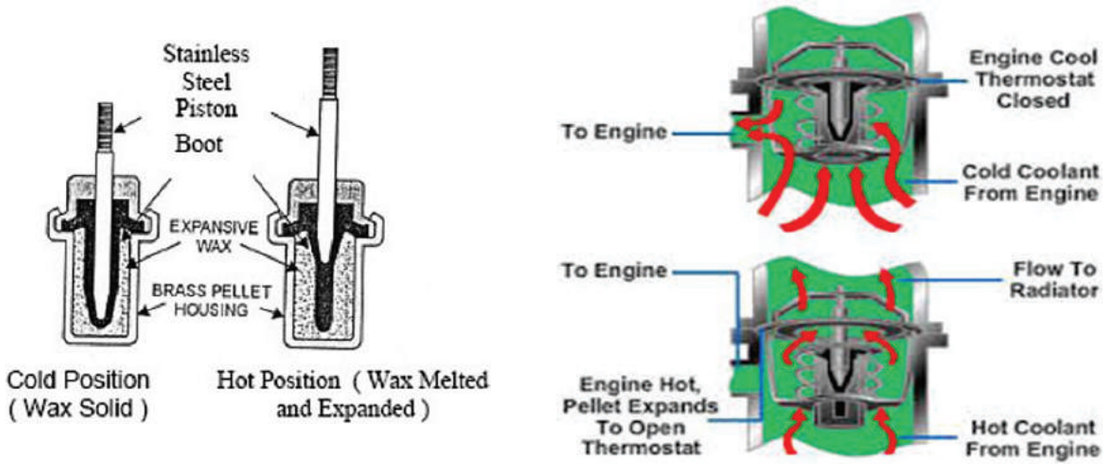


Figure 7.5.2 Wax Type Thermostat

7.5.2 Wax Type Thermostat

In this wax type thermostat there is a container which is filled with wax. This container is made up of high temperature conducting metals such as steel, brass or coppers as the material. The wax inside this container is fully sealed with rubberised material. A conical shaped movable steel pin with wax at one end and body at another end are connected with this type of thermostat. When the temperature of

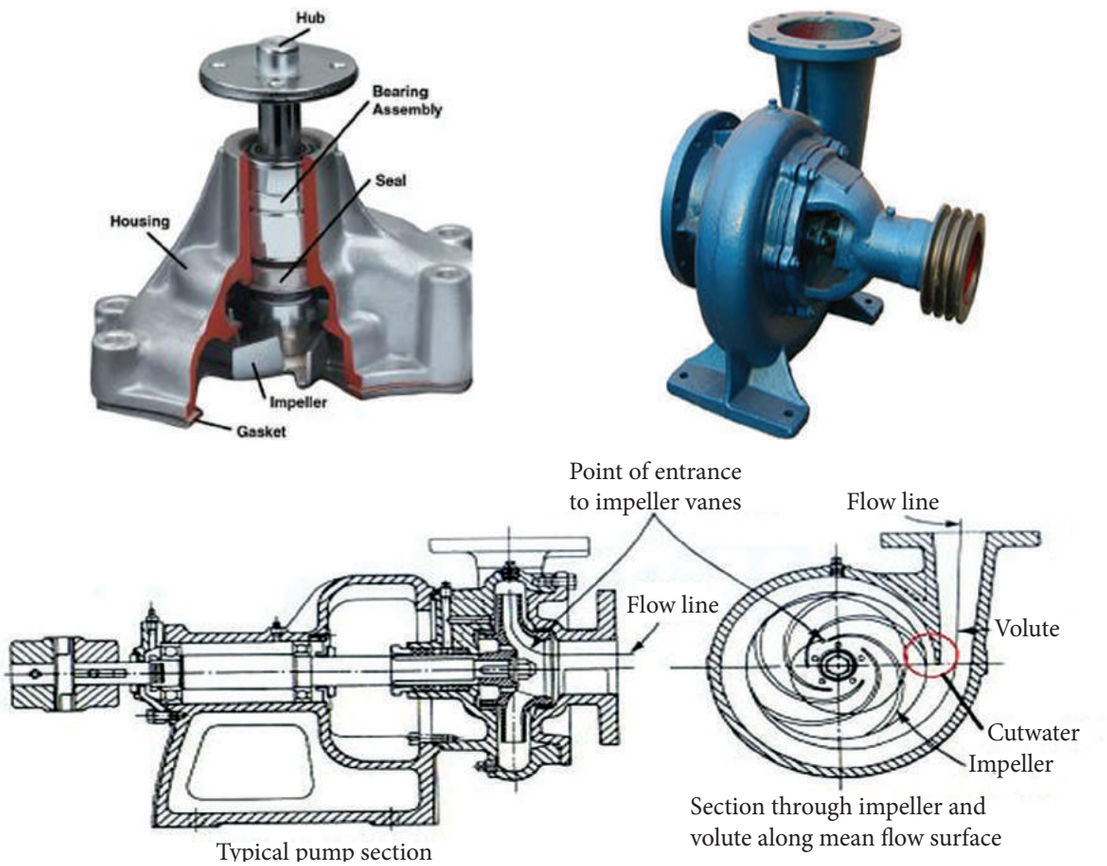


Figure 7.6 Water Circulation Pump

water gets increased, the wax gets melted and expands the bottom of steel pin in the opposite direction and pushes the seal. By compressing the seal against spring force in the container, the container valve opens. When container gets cooled the wax shrinks and reduces the pressure acting on the steel pin and the container comes to its original position. Now the container valve gets closed.

7.6 WATER PUMP

The water pump is placed in between in front of the engine's cylinder block and the radiator. The Pump impeller consists of a shaft, bearings and water seal which are placed inside the housing. Impeller is fixed to the shaft. The impeller has flat or bended vanes with round shape. Water seal is placed to arrest the leakage with the help of bearings.

Working:

When the impeller rotates, the water in between the blades are expelled out due to centrifugal force. The expelled water moves to the engine water jackets through the pipe with high pressure. The power to the impeller is given from the V-pulley arrangement. The water pump increases the circulation of cooling water. Fig 7.6 shows the water pump.

7.7 ENGINE FAN

When the vehicle runs, natural air is enough to cool the water. However during heavy load and during stationary conditions, air from the atmosphere coming by natural means to the radiator is not sufficient to cool the water. Hence fan is required to supply more air to radiator and to engine. Fan will be coupled with water pump pulley. The fan sucks more air and passes to the radiator core and then cools the water. There are many types of cooling fans used, which include,

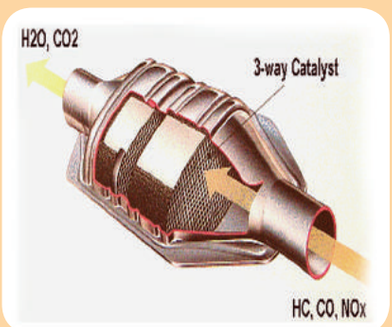
Figure 7.7 Engine fan

What is catalytic converter?

Catalytic converter was invented by Eugene Houdry in 1930.

Inside the converter, the gases flow through a dense honeycomb structure made from a ceramic and coated with the catalysts.

It reduces harmful NOx and CO emissions into harmless one.



1. Suction type
2. Blower type
3. Electrical type

7.8 ANTI-FREEZING SOLUTIONS

During cold climate conditions and at hill stations water generally gets frozen in the water cooling system. Due to this radiator core, water jacket and rubber hoses in the cooling system may get damaged. In addition more power is needed to start the engine. To overcome these difficulties chemical agents are added to the water to prevent it from freezing. These agents are called as anti freezing solutions. Some of the anti freeze solutions used in automobile are,

1. Methanol
2. Methyl alcohol

TMNBAH

Cooling System Capacity ▼	ANTIFREEZE PROTECTION CHART (°F) Quarts Required for Low-Temperature Protection ►									
QUARTS	3	4	5	6	7	8	9	10	11	12
9	5°	-15°	-43°	-76°						
10	10°	-4°	-26°	-54°	-76°					
11	12°	0°	-14°	-40°	-60°					
12	14°	5°	-8°	-28°	-51°					
13	15°	8°	0°	-14°	-44°	-61°	-76°			
14	17°	10°	3°	-8°	-28°	-44°	-60°			
15	18°	12°	5°	-4°	-14°	-35°	-54°	-76°		
16	19°	14°	9°	1°	-9°	-28°	-44°	-60°		
17	20°	16°	11°	3°	-2°	-15°	-31°	-60°		
18	21°	17°	12°	5°	0°	-13°	-26°	-33°	-53°	-76°
19		18°	13°	7°	2°	-10°	-20°	-32°	-50°	-60°
20			14°	9°	3°	-6°	-15°	-26°	-33°	-54°
21			15°	12°	5°	0°	-10°	-22°	-32°	-51°
22			16°	13°	8°	3°	-5°	-10°	-28°	-33°
23			17°	13°	10°	4°	-3°	-8°	-22°	-32°

Figure 7.8 Anti-freezing solutions

3. Glycerin
4. Alcohol
5. Ethylene glycol

The above chemical components must have the requirements such as easily soluble in water, should withstand very high temperature, non-corrosiveness and should not deposit on the radiator core and rubber hose.

7.9 MAINTENANCE OF COOLING SYSTEM

The following are the check lists for the proper maintenance of the cooling systems

1. If there is any blockage occurs inside the radiator, water tubes and water jackets they have to be cleaned by flushing process.
2. The fan belt has to be replaced if it is exhausted or cracked.
3. The shape of fan blade has to be checked whether it is ok or not.
4. The cells must be straightened in the radiator if they are blended.
5. If there are any unwanted materials or insects nest are present in the radiator blades, they must be cleaned by using compressed air.
6. If there is any damage or hole occurs in the radiator tubes (rubber), it has to be replaced.
7. Fine tight must be given to the radiators tube clips.
8. Leakage in the radiator pipe, jar, tank, water pump, thermostat valve and drain gauge must be checked and leak proof has to be ensured.

9. Current status of thermostat valve has to be checked.
10. The radiator has to be inspected whether it is fixed properly or not.
11. The radiator gate valve has to be checked for its position which is closed properly.

Troubles and remedies of cooling system:

Loss of cooling liquid:

Causes	Remedies
1. Clips in the radiator hose pipes may have released.	Have to fine tight the clips
2. There may be tearing occurred in the rubber tubes.	Has to be replaced.
3. There may be a leakage occurred in the radiator cap portion.	Has to be corrected by using altering process.
4. Cylinder head jacket may get defected.	Hasto change to a new one.
5. Water pump or water seal may be damaged.	Gasket or seal should be replaced with a new one.
6. Thermostat valve may be defected.	Hasto be changed with a new one.
7. Drain gauge in the radiator may be loosen or broken.	Has to be tightened or has to be changed with new one.

Engine over heating:

Causes	Remedies
1. There may be a reduction in water level in the radiator.	Has to be filled with required quantity of water.
2. There may be water leakage during cooling process.	Leakage should be avoided by repairing the pipe line.
3. Water pump may get damaged.	Has to be repaired.
4. Fan belt may be loosened or teared.	Has to be tightened at loosened area or has to be changed with a new one.
5. Thermostat valve may get damaged.	Has to be changed with a new one.
6. There may be a chance for blockages inside the radiator water tubes.	Blockages should be cleaned by using reverse flushing process.
7. There may be blockages in water jackets due to corrosion and sedimentation.	The water jackets have to be cleaned by removing blockages.

8. There may be blockages in the radiator fins.	Have to be removed or cleaned.
9. There may be an auto ignition.	Has to be corrected.
10. There may be changes in valve timing and ignition timing.	Has to be corrected.
11. There may carbon deposition in the cylinder head, valves, piston and combustion chamber.	Need to be cleaned by De carbonizing technique.
12. There may be defects in break or clutch	Have to be corrected.
13. The vehicle may be over loaded.	Enough amount of goods to be carried.
14. There may be blockages in the exhaust tail pipe.	Have to be removed.
15. Engine bearing may get damaged or broken.	Has to be changed with a new one.
16. There may be blockages in air cleaner or air inlet manifold.	Have to be removed or corrected.
17. Fuel injection timing may be incorrect.	Has to be checked and corrected.

Over noise from water pump:

Causes	Remedies
1. Impeller in the water pump may be loosened.	Has to be tightened.
2. Pulley in the pump shaft may be loosened.	Has to be tightened.
3. Impeller may rotate unevenly inside the pump housing.	Has to be fixed at the right place.
4. Bearing in the water pump may damage or lubricating oil may not be there in the bearing.	Oil has to be applied or changed with new bearing.
5. Impeller may be broken.	Has to be checked and corrected.

Rapid wear on fan belt:

Causes	Remedies
1. Belt may be under over tight	Has to be adjusted for exact tension.
2. Belt may be affixed with improper length.	The belt that is recommended by the manufacturer has to be used.
3. There may be a deposition of oil or grease in the belt.	Clean the belt with petrol and fix it.
4. Belt may not be fixed properly to the pulley.	Affix the belt properly on the pulley.

Over noise from radiator fan:

Causes	Remedies
1. Fan belt may be fixed with heavy tight.	Has to be adjusted for exact tension.
2. Fan belt may be worn out.	Has to be changed with a new one.
3. Fan pulley may be loosened.	Has to be tightened.
4. There may be high amount of ply in the water pump shaft.	Has to be adjusted for correct scale of ply.
5. Fan blades may be expanded.	Have to be changed with a new fan.
6. Water pump pulley may leave its position and hanged on the radiators body.	Has to be checked and repaired.

Student Activity

I. Students have to follow the following safety precautions:

1. Students should visit the nearby workshops to study the process of engine cooling with external fins and should have a hands-on experience on engine dismantling and assembling.
2. Students should visit the nearby workshops to study the process of cooling engines with water and should a report with the sketch of radiator tank, water pump and thermostat valve.

Glossary

Decarbonizing	-	கரி நீக்குதல்
Pressure Cap	-	அழுத்த நிறுத்தி மூடி
Centrifugal Pump	-	மையவிலக்கு தூக்கி
Thermostat	-	வெப்ப கட்டுப் படுத்தி
Water Pump	-	தண்ணீர் தூக்கி
Freezing	-	உறைதல்
Water Jacket	-	தண்ணீர் உரைகள்
Deposition	-	கசடு படிதல்
Blockages	-	அடைப்புகள்
Corrosion	-	அரிப்பு

References

1. Rajput R.K. Internal Combustion Engines, Laxmi Publications (P) Ltd, 2006.
2. Ganesan V." Internal Combustion Engines, Third Edition, Tata McGraw - Hill, 2007.
3. Duffy Smith, Auto Fuel Systems, Good Heart Wilcox Company Inc., Publishers, 1987.
4. Eric Chowanietz, Automobile Electronics, SAE International, 1995.
5. Internal Combustion Engine Handbook: Basics, Components, Systems and Perpectives, Richard Van Basshuysen and Fred Schafer (Editors) SAE International USA and Siemes VDO Automotive, Germany, 2002.

Webliography

1. https://en.wikipedia.org/wiki/Internal_combustion_engine_cooling
2. https://en.wikipedia.org/wiki/Oil_cooling
3. https://en.wikipedia.org/wiki/Water_cooling
4. https://en.wikipedia.org/wiki/Radiator
5. http://www.standardradiators.com/
6. http://www.gwradiators.com/
7. https://shop.bsigroup.com/ProductDetail/?pid=000000000030062370

SAMPLE QUESTIONS

Choose the correct answer

1. Which chemical is used to prevent freezing of cooling water?
   a) Ethyl glycol
   b) Acetone
   c) Methane
2. Which valve is located in radiator pressure cap?
   a) Pressure valve
   b) Thermostat valve
   c) Pressure and vacuum valve
3. How many types of radiators according to the flow of water and Air?
   a) Two
   b) Three
   c) Four
4. Which is used to prevent engine over cooling?
   a) Water pump
   b) Radiator
   c) Thermostat
5. What is the effect if low water level in radiator?
   a) Engine if over heated
   b) Fan belt wear quickly
   c) More noise in water pump

THRXYE

Answer the following questions

1. What are the disadvantages due to the over heat of the engine?
2. What are the disadvantages due to the over cool of the engine?
3. What are the advantages and disadvantages of the Air Cooling system?
4. What are the different types of Water Cooling system?
5. What are the important parts of the Pump circulation system?
6. What are the merits and demerits of the water cooling system?
7. What are the parts in the cooling system?
8. Name the types of the radiator.
9. What is meant by radiator pressure cap?
10. What is meant by Thermostat valve?
11. Tabulate the difference between Air cooling and water cooling system.
12. Explain the working principles of water pump.

Unit 8

Engine Lubrication System

Contents

TMX7C5

Learning Objectives

- To learn about the various grades of lubricating oils used (SAE 20, SAE 40, SAE 90, SAE 120) in cars, buses and trucks.
- To learn the importance of engine oil and lubrication system to avoid friction and overheating.

8.0 INTRODUCTION

The process of using lubrication oil to reduce friction between two moving parts is called as lubrication. Metallic contacts between two moving pats lead to friction, heat, wear, noise and seizure of the engine. To overcome this problem, lubricating system is needed in all automobiles. Lubrication is also helpful for smooth functioning of the moving parts in contact. Automobiles have many moving and rotating parts. If lubrication system is not present in vehicles, the durability of the components will be reduced due to wear and tear caused by friction. Hence to increase the life time of the engine, lubrication system is essential in automobiles.

8.1 ADVANTAGES OF LUBRICATION

The Engine Lubrication system

1. Reduces the friction between moving parts.
2. Reduces the damage of parts due to moving in contact.
3. Removes/Decreases the heat due to friction.
4. Cleans the tiny metal particles and dust that are present between two moving parts.
5. Acts as a seal between piston ring and cylinder to provide compression.
6. Reduces the vibrations and makes the parts of the engine to function silently.
7. Increases the strength of engine.
8. Prevents rusting.
9. Helps in increasing the lifetime of engine components.

8.2 PROPERTIES OF LUBRICATING OIL

The lubricating oil or paste used for reducing friction is known as lubricant. The related properties of the Engine Lubricants are

1. Viscosity.
2. Oiliness or Adhesiveness.
3. Fluidity.
4. Volatility.
5. Flash point.
6. Fire Point.
7. Stability.
8. Corrosiveness.
9. Cleanliness.
10. Emulsification.
11. Cloud point.
12. Foaming.

What is SAE International?

- SAE stands for Society of Automotive Engineers.
- It is a global association of more than 1,28,000 engineers and technical experts in the field of aerospace and automotive industries for the benefit of society.

8.2.1 Viscosity

Viscosity of a liquid is the ability that describes a fluid's resistance to flow. Oils with high density are highly viscous in nature. Viscosity decreases with increase in temperature of lubricating oil and increases with decrease in temperature. Society of Automotive Engineers has classified the lubricating oils based on the nature of viscosity. Viscosity of the oil increases with increase in SAE unit. Viscosity is more important among the properties of lubricating oil. It is measured by using the instrument called as viscometer. Viscosity is always measured along with the temperature. For example: SAE 40 at 210° F. This represents that the oil at 210° F has 40 units of viscosity. The higher the viscosity, the higher the SAE viscosiy grade number is.

8.2.2 Oiliness or Adhesiveness

Oiliness and adhesiveness are the properties of making an oily layer at the surfaces of metals in contact. This property should be high for lubricating oil. It is helpful in making the thin oil layer even at high temperatures in minute gaps.

8.2.3 Fluidity

Fluidity is the property of easy flow of lubricating oil in very small gaps. It helps in making a soft layer on the surfaces of junctions even at high temperature.

8.2.4 Volatility

Volatility is the ability of the oil to evaporate at high temperatures developed due continuous functioning of engine. Lubricating oil should have low volatility even at very high temperatures. Otherwise during the functioning of engine lubricating oil will evaporate which may lead to wastage of the lubricating oil, sometime even causing fire accidents.

8.2.5 Flash Point

The flash point is the minimum temperature, at which the oil produces the flash when an ignition source is brought close to the oil vapour and the flash will not continue when the ignition source is removed.

8.2.6 Fire Point

The fire point is the temperature at which the vapour of the oil continues to burn for atleast 5 seconds after ignition by open flame. The fire point will be generally at 10^0 to20^0C above the flash point. Lubricating oils should have higher fire point, to avoid evaporation and ignition.

8.2.7 Stability

During engine's functioning, the lubricating oil should reduce the friction without any oxidation. If lubricating oil is oxidised, it produces acids which leads to dirt and corrosion of the engine parts.

8.2.8 Corrosiveness

During engine's functioning, several parts of the engine are subjected to corrosion due to the chemicals present in the lubricating oil. Hence, lubricating oils should have very less amount of acids and chemicals which will cause corrosion. This is called corrosiveness.

8.2.9 Cleanliness

Lubricating oils should possess the property of cleanliness so that dusts and unwanted materials in the lubricant could be removed. This property helps in cleaning the carbon deposits in the lubricant due to burning of fuels. This is called cleanliness. Normally inorganic lubricants have this property more than organic lubricants.

8.2.10 Emulsification

If lubricating oil is dissolved in water, it results in emulsification. If it dissolves in water, it will lose the property of lubrication. To prevent this additives are added along with the lubricating oil.

8.2.11 Cloud Point

The Temperature at which lubricating oil first changes its phase from liquid state to solid state is known as cloud point.

8.2.12 Foaming

During lubrication action, lubricating oils will have large amount of very small air bubbles to be present. This process is called foaming. It may lead to oxidation and also these bubbles get deposited on the friction surface and prevent the lubricant to flow through the surfaces.

8.3 TYPES OF LUBRICANTS

The lubricants used in machines and automobiles are listed below:

1) Solid lubricant.

2) Semi solid lubricant.

3) Liquid lubricant.

8.3.1 Solid Lubricant

Lubricant materials available in solid state are called as solid lubricants. The solid substance like fibre, graphite, carbon, mica, vax are some of the examples for solid lubricants. They are used in places where liquid lubricants can't be used and also used in high temperature places. See Figure shown in 8.3.1 Solid Lubricant

8.3.2 Semi Solid Lubricant

Lubricant materials present at the state in-between solid and liquid are called semi solid lubricants. The places at high stress and where liquid and solid lubricants cannot be used, semi-solid lubricants are used. In automobiles, in all the bearings other than engine bearing the semi solid lubricants are used. The following table shows the examples for semi solid lubricants and their applications in automobiles. See Figure shown in 8.3.2, Semi Solid Lubricant.

Figure 8.3.1 Solid Lubricant

Figure 8.3.2 Semi Solid Lubricant

Table 1. List of Semisolid lubricants and their applications.

S. No	Lubricant Materials	Using Places
1	Calcium based grease	In joints of vehicles, In cooling pumps.
2	Sodium based grease	Suitable for high temperature, to prevent corrosion.
3	Aluminium based grease	In chain joints, in vehicle joints.
4	Lithium based grease	In all joints of vehicles, in base joints of vehicles

8.3.3 Liquid Lubricants

Lubricants in liquid state are called as liquid lubricants. They are suitable for operating the engines at the required temperature and also for high speed engine's operation. The following are the examples for the liquid lubricants. See Figure shown 8.3.3 Liquid Lubricants.

1) Animal oils.
2) Vegetable oils.
3) Mineral oils.

Figure 8.3.3 Liquid Lubricants

8.3.3.1 Animal Oils

Animal oils are produced from fats of the animals. They mostly vaporise easily and have the tendency to produce gum

What is a Piston Valve?

- Piston valve was developed in 19th century.
- It is a device used to control the motion of a fluid along a tube or pipe by means of the linear motion of a piston.
- They are ideally recommended for critical and hazardous media, including Steam, Heat transfer oils, acids and gases.

like products when used. Hence they are not generally used in motor vehicles.

8.3.3.2 *Vegetable Oils*

They are obtained from vegetable seeds. For example: Linseed oil, castor oil and palm oil. Except castor oil all the vegetable oils easily get converted into gum like materials. At high temperatures viscosity of the castor oil decreases. Castor oils were used in old vehicles. However it is not used in modern vehicles.

8.3.3.3 *Mineral Oils*

These are the oils mostly used in all vehicles. These lubricating oils are obtained as lubricants in the separating processing of petroleum refining. Their important properties do not vary significantly even at high temperatures. They do not dissolve in water, acid free and corrosion free. Hence they are largely used in all automobiles.

8.4 TYPES OF LUBRICATION SYSTEM

All the parts of engine such as crankshaft, bearings, crank pin, both ends of connecting rod, piston pin and inner wall of cylinder, piston rings, valve mechanism, timing gears and camshaft bearings are made to function along with the engine. Hence the above parts must be lubricated to avoid friction in these moving parts. The following are the types of lubricating systems used in engines.

Lubricant Systems:

1. Petrol oil (mist) lubricating system.
2. Splash lubricating system.
3. Pressure lubricating system.
4. Semi pressure lubricating system.

- Oil sump
- Oil pump
- Pick-up screen
- Pressure regulator
- Oil filter
- By-pass valve
- Oil galleries
- Dipstick
- Pressure indicator

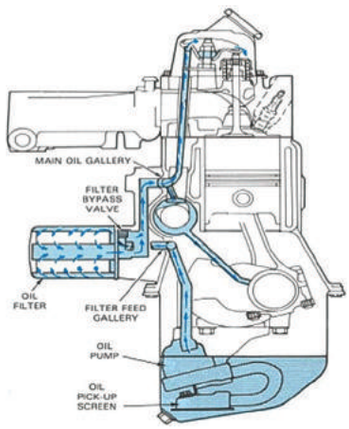


Figure 8.4 Parts of Lubrication System

8.4.1 Petroil System

This type of lubricating system is used in small vehicles like in two wheelers (e.g. TVS 50 and other mopeds and also in Motor cycles with two stroke engines. In this system lubricating oil is of about 2% to 3% is mixed along with petrol and used. It is a simple lubricant system commonly used in two stroke two wheelers and small size engines.

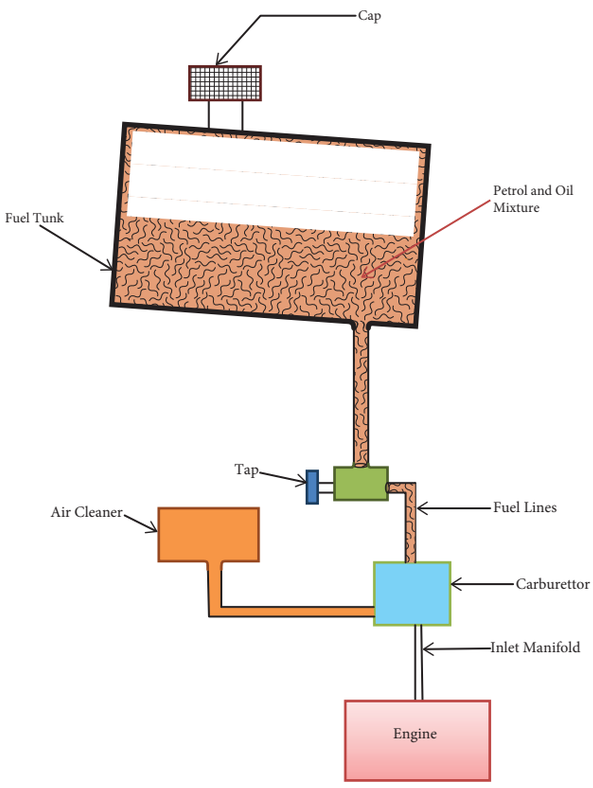


Figure 8.4.1 Petroil Lubrication System

8.4.2 Splash Lubrication System

In this system, at the bottom of the crank case, oil sump will be present and filled with the lubricating oil. The engines with this type of system have dipper or scoop like arrangement fitted at the bottom of the connection road. When the piston moves towards bottom dead centre, the scoop placed at the connecting rod dips into the oil sump and scoops the oil. When the piston moves up the oil in the scoop will be splashed on all over the interior of the crankcase, into the piston and to the exposed portions of the cylinder wall and other components. See Figure shown in 8.4.2 Splash Lubrication System

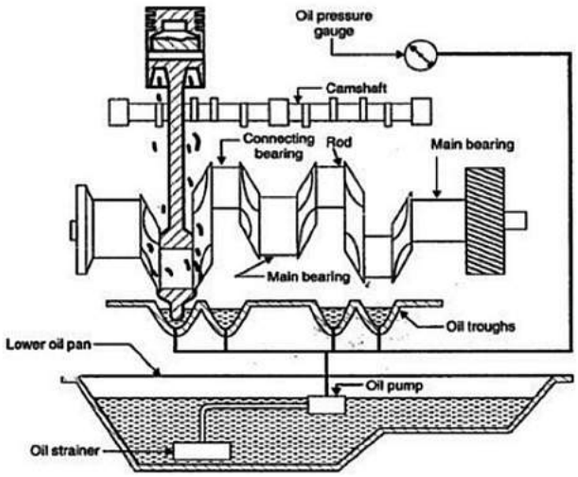


Figure 8.4.2 Splash Lubrication System

8.4.3 Pressure Lubrication

Sending the lubricating oil at high pressure using a pump to all the parts of engines is called pressure lubrication. In this system oil is kept at the base of crank case. During operation of the engine, oil pump sucks the oil from sump through the strainer. This oil is subjected to high pressure of about 200 kPa to 400 kPa and then sent to the oil filter. It is then filtered in the oil filter and sent to main gallery. From the main gallery the oil is sent to main journal bearings and sub journal bearings of the crank shaft for lubrication. The oil is then sent to the piston pin and piston rings via the oil hole of connecting

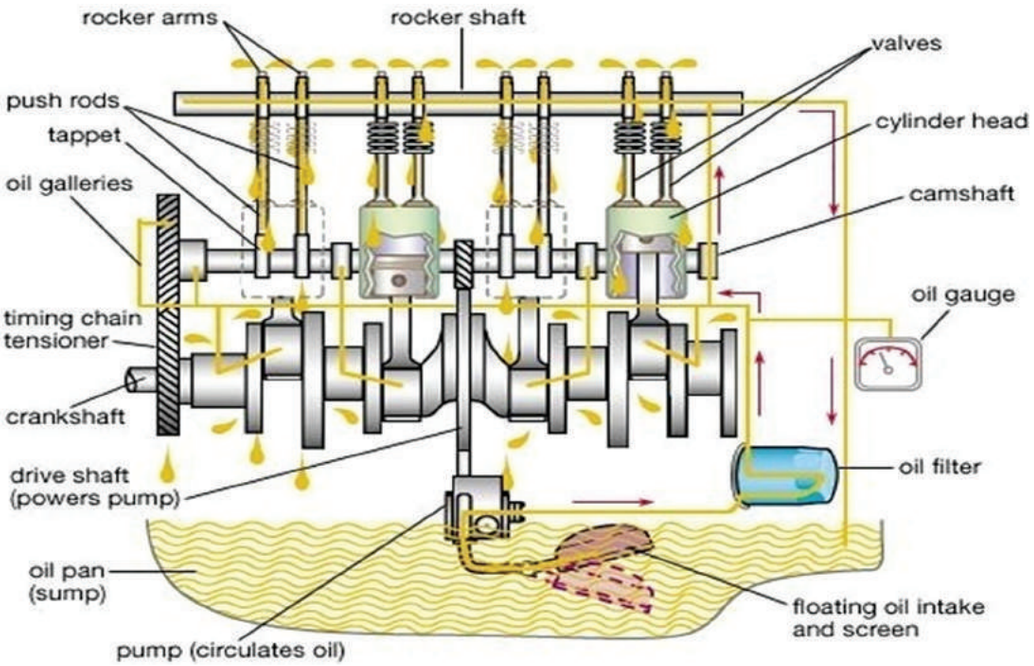


Figure 8.4.3 Pressure Lubrication System

rod. To lubricate the cam shaft and training gear from the gallery, the oil is sent to the rocker arm from oil holder and overhead valve by valve mechanism. In this system the oil pressure can be known and most of the engines use this type of system. See Figure shown 8.4.3 Pressure Lubrication System.

8.4.4 Semi-Pressure Lubrication System

It is the combination of splash and pressure lubrication system. This lubrication system is used in four stroke engines.

8.5 PARTS OF LUBRICATION SYSTEM

8.5.1 Oil Filters

This is used to filter the lubricating oil coming out from the oil pump which contains impurities and dust. The filters used in automobiles are, see fig shown in 8.5.1 Oil Filter.

1. Cartridge filters.
2. Edge filters.
3. Centrifugal filters.

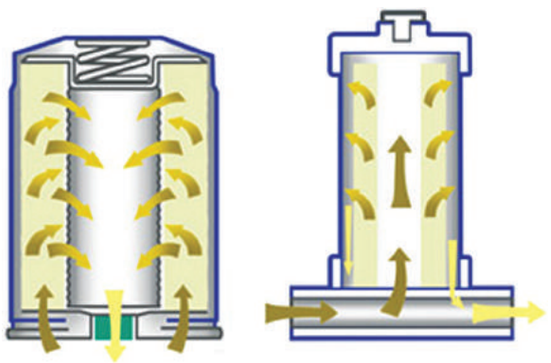


Figure 8.5.1 Oil Filter

8.5.1.1 Catridge Filters

It is used in almost all automobiles. This filter cleans very minute dust particles in the oil up to 5 microns. The oil is passed through the filter and taken out

at the outlet by which the dust particles of more than 5 microns are removed. This type of filter uses cloth or fibre material. There is a need for replacement of cloth or the filter material from time to time. See fig shows in 8.5.1(a) Catridge Filters.

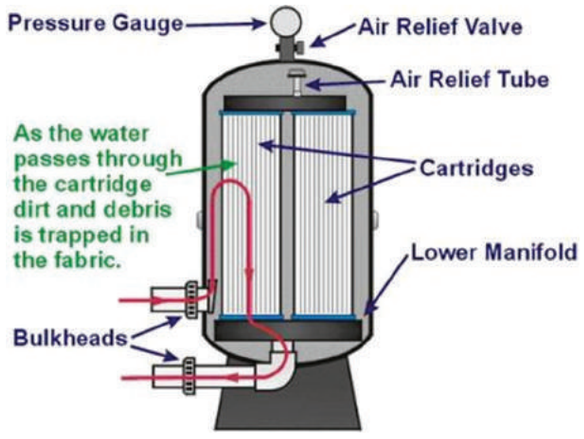


Figure 8.5.1(a) Cartridge Oil Filter

8.5.1.2 Edge Type Oil Filters

This filter contains a soft disc made up of brass material. This filter is divided into two parts. One part is attached to the spindle which is at the centre of the filter and the other part is supported by the square rod at the edge of the filter. The gap in between the disc is in few microns. When the oil flows through the each disc, the dirt gets deposited on the upper surface of the discs and then it passes out through the outlet. During this, the dirt in the spindle and square rod gets deposited at the bottom of filter body. See fig shows in 8.5.1(b) Edge Type Oil Filters.

8.5.1.3 Centrifugal Type Oil Filters

In this type of filter, the impure oil coming from the oil pump reaches the hollow spindle at the centre of a rotor. The hollow sphere is surrounded by the pillars. The oil coming from the pillars fills the rotor and then goes through the tube of the rotor and comes out via jet at the base of the tube. Because of this, the rotor casting rotates in the opposite direction. During the rotation of the rotor

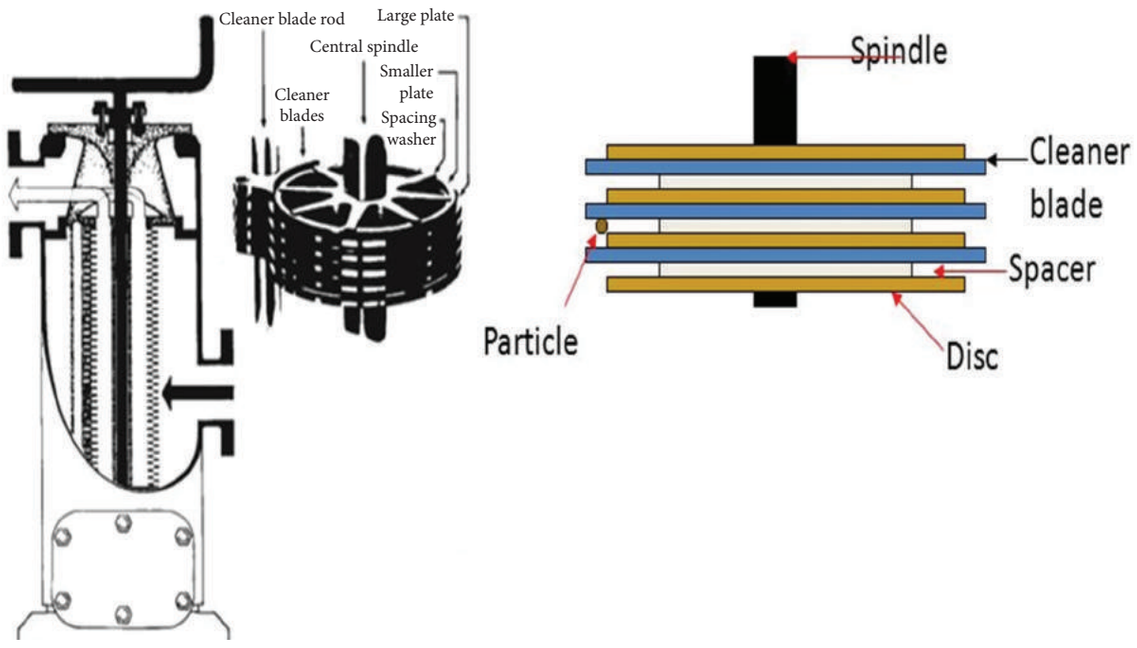


Figure 8.5.1(b) Edge Type Oil Filters

casing, the impurities in the oil from the jet get sprayed from the stationary casing due to centrifugal force. Finally the purified oil comes out through the outlet. See fig shows in 8.5.1(c) Centrifugal Type Oil Filter.

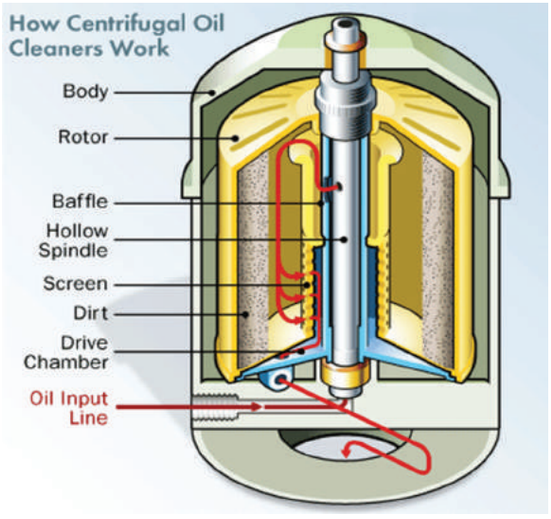


Figure 8.5.1(c) Centrifugal Type Oil Filter

8.5.2 Oil Pump

In lubrication system after the oil strainer, oil pump is placed which is the very important component of the system. Sending the oil with high pressure to the engine parts is the function of the oil pump. The oil pump is located at the crank case below the oil level. It is generally operated from the tip of distributer shaft. It gets the power from the skew gear of camshaft through distributer extension shaft. The speed of the oil pump increases with increase in the speed of the engine. This increases the pressure in the shaft. High pressure is controlled by using a pressure relief valve. The pump supplies sufficient oil to all the engine parts. Minimum pressure for the oil is maintained as 100 kPa. Normally to lubricate the engine, the lubricating oil of about 15 to 20 litres is circulated per minute. The oil is sent in large amount at high pressure through the oil pump. Hence selecting the suitable oil pump is very important. Due to bearing damage caused by friction and leakage of the oil from the engine parts there will be reduction in pressure of the oil. Hence to reduce damage of the components and to maintain sufficient pressure, suitable oil pump is needed. Figure shown in 8.5.2 Oil Pump.

Figure 8.5.2 Oil Pump

TYPES OF OIL PUMP:

The following are the types of oil pumps generally used in automobiles,

1. Gear pump.
2. Rotor pump.
3. Plunger pump.
4. Vane pump.

8.5.2.1 Gear Pump

In present automobiles, gear type oil pumps are generally used. This pump is a very simple one. It has two parts called as drive gear and driven gear. These two gears rotate together in a housing. Sufficient gap is maintained between the inner side of

housing and the tip of gear. In gear pumps two types of gears are generally used, they are 1) Spur gear and 2) Helical gear. To reduce noise in pump, helical gear is preferred.

During functioning of engine, the drive gear gains the power from the skew gear of the camshaft via distributor extension shaft. The driven gear attached to it also rotates due to the rotation of the drive gear as it is in mesh with the drive gear. However the rotation is opposite. Because of opposite rotation of the two gears, inner side of the pump creates vacuum. Due to this vacuum the oil in the sump tries to fill the empty space. The oil sucked into the housing of the pump through the inlet. In this way, the oil passes through the gears and housing gaps to fill the empty space via inlet. The oil pressure is increased here to about 2 kg/cm^2 to 4 kg/cm^2 and it comes out through the outlet. Since outlet is connected to the oil gallery, the oil is circled through all the moving parts of engine. Figure 8.5.2(a) shows the view of the gear type oil pump.

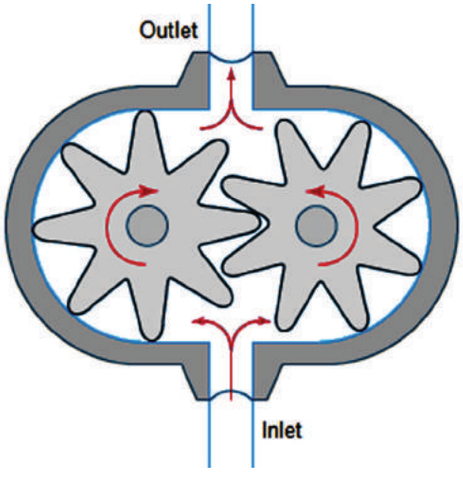


Figure 8.5.2(a) Gear pump

8.5.2.2 Rotor Pump

Rotor pump is similar to the gear type pump. But in this pump two rotors are present instead of gears. These two rotors are attached to the inner side. One of the rotors is called inner rotor and the other called as outer rotor. The inner rotor rotates inside the outer rotor. The outer rotor has one lobe more than that of the inner rotor. The rotating arrangement of the rotors in this pump varies. So the size of the gap in between the two rotors varies. Inner shaft is rotated by attaching to the skew shaft of the cam shaft through the distributor extension shaft. Hence both the rotors rotate. Because of opposite rotation of the two rotors, inner side of the pump creates vacuum. Due to the vacuum pressure, the oil in the sump is forced to enter into the empty space. The oil attains high pressure of about 2 kg/cm^2 to 5 kg/cm^2 at the pump and comes out via the outlet port. Figure 8.5.2(b) shows the view of a rotor pump

1. This pump has 25% more power than gear pump and the construction is very simple.
2. For every rotation as less number of lobs is meshing it is noise free operation.

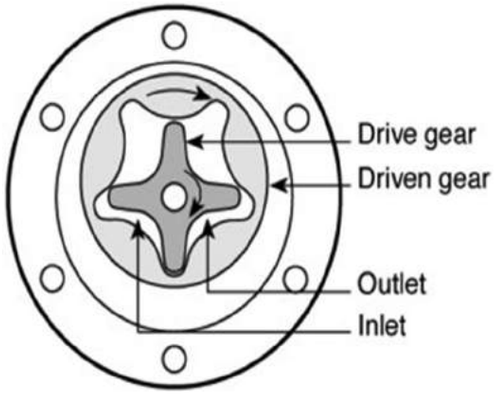


Figure 8.5.2(b) Rotor pump

8.5.2.3 *Plunger Pump*

This pump consists of the essential components such as barrel, plunger and two one way spring loaded ball valves etc., The plunger is designed to operate in reciprocating motion inside the barrel. Power required to drive the pump is drawn from the eccentric disc coupled with the cam shaft or by means of a small connecting rod coupled with the crank shaft of the engine. Among the two spring loaded ball valves in the pump, one is connected to the inlet of the barrel whereas the other one is connected to the outlet of the barrel. The figure 8.5.2(c) shows the view of a plunger type oil pump.

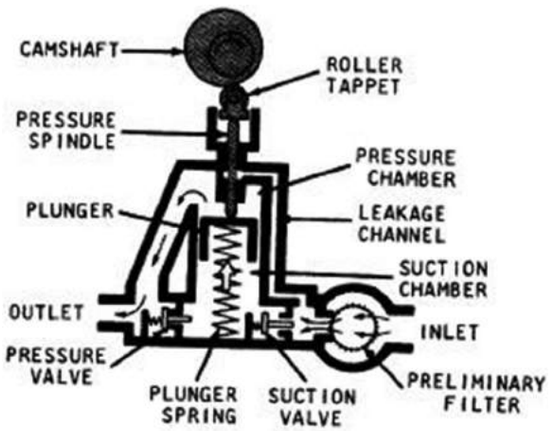


Figure 8.5.2(c) plunger pump

When plunger moves in the upward direction, a partial vacuum is created in the bottom portion of the plunger. So the inlet valve is opened and the oil is sucked and allowed to occupy the vacuum portion. When the plunger moves in downward direction the oil pressure gets increased in the barrel. Now the outlet valve is opened and inlet valve is closed. So the pressurized oil in the pressure chamber is expelled out through the outlet valve. This type of pump is generally not used in automobiles as it does not produce enough amount of pressure. This type of pump is used in stationary oil engines and in few automobile engines.

8.5.2.4 *Vane Pump*

This type of pump has a circular housing. Inside which an eccentric motor is present. The rotor shaft is connected to a skew gear. Surface of the rotor has equally spaced slots, which has many vanes connected. This vanes move to and fro in the slots. Two rings are placed at the center so that the vanes are kept close to the housing. Figure 8.5.2(d) shows the arrangement of the van pump.

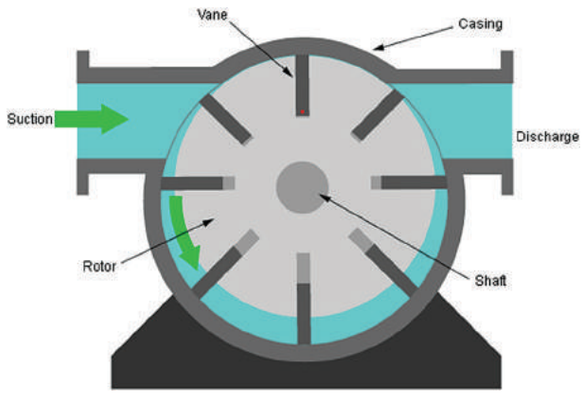


Figure 8.5.2(d) Vane Pump

When the pump is started the shaft rotates and due to the centripetal force vanes are forced outwards. Due to which oil enters into the casing through the inlet. Now the vanes move in the small space between the housing and eccentric rotors. When the vanes move again to the same place the oil in that place moves out through the outlet.

8.6 PRESSURE RELIEF VALVE

The oil pump is designed in such a way to send the fixed amount of oil when

the engine runs at the idling speed. So that when the engine speed gets raised, pump speed also get raised and sends oil with high pressure. This causes more oil to get wasted if the oil seals and joints are damaged. To avoid this, pressure relief valve is fixed in this pump. This valve releases the excess pressure developed inside the pump. The following are the different types of pressure relief valves used in automobiles.

Based on design it is classified into two types they are

1. Ball type pressure relief valve
2. Plunger type pressure relief valve

8.6.1 Ball Type Pressure Relief Valve

In this type a ball valve, spring and adjustment screw are present. The ball valve will be placed in its seat supported with a spring. All these above components are placed inside the pump housing. The figure 8.6.1 shows the view of the ball type pressure relief valve.

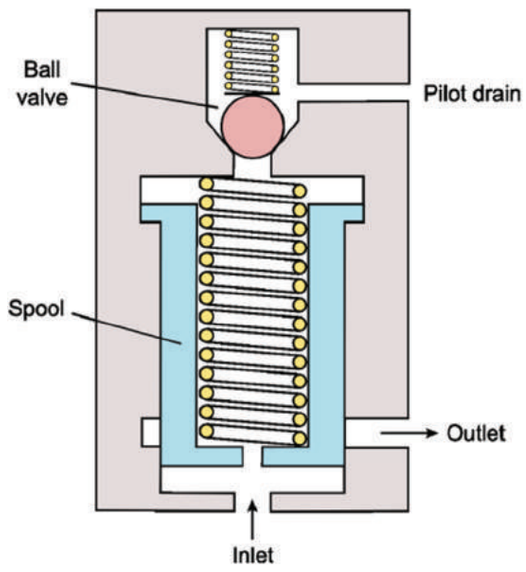


Figure 8.6.1 Ball Type Pressure Relief Valve

Working:

When the engine is off, the spring forces the ball to seat on its seat tightly. When the engine is started, based on the oil pressure and the spring tension the ball value will be in the opened or closed position. When the engine speed is increased, the pressure of oil is also increased. The increased pressure once if it reaches the fixed level, it presses the spring so that it moves the ball from the seat and releases the pressure and the excess oil reaches the inlet via bypass or to the oil sump.

Adjusting Screw And Lock Nut:

Adjusting screw is used to maintain the required level of pressure. If the screw is tuned inwards it increases the spring tension and allows more pressure to open the ball valve. If the screw is tuned outwards it reduces the spring tension and makes the pressure of oil to open the ball valve easily. Normally for the engines when runs at 1000 rpm at 43 degree Celsius the spring tension will be of 2.5 kg/cm^2.

8.6.2 Plunger Type Pressure Relief Valve

It is similar to the ball type valve but has a plunger, spring and adjustment shims. The plunger is placed on the seat with the help of the spring tension (Fig 8.6.2).

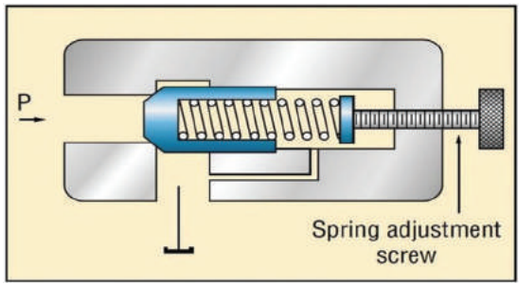


Figure 8.6.2 Plunger Type Pressure Relief Valve

When the engine is off, the spring makes the plunger to sit on the seat. Once the engine is started, depending on the pressure and spring tension, spring will open or close the path by moving the plunger. When the engine speeds up, the oil pressure also increases and if the increasing pressure level reaches beyond the fixer level the spring presses the plunger from its seat so that the extra oil will reach the inlet via bypass or reaches the oil sump.

With the help of the adjusting shim and lock nut the tension of the spring can be adjusted. By adding or removing the shim the spring tension is increased or decreased

Oil Dipstick or Oil Level Indicator:

Oil dipstick is used to measure the oil level in the oil sump. A cap is placed at the top and the Steel rod or a blade is placed at the bottom. This rod will have two Limits as maximum and minimum level lines. Apart from this many small graduations are drawn below the minimum level line; oil should be maintained above minimum level line.

The dip stick is inserted through the engine block into the oil sump. Before starting the engine the dipstick has to be taken out and checked for the oil level and should be seen that the oil level should not go below the minimum level. Lubricating failures and reason for failures have to be taken in care for proper maintenance of the engine

8.7 FAILURES IN LUBRICATING SYSTEM

Following are the some of the failures in lubricating system

1. Low engine oil level
2. Interior cracks
3. Poor lubrication efficiency
4. Blockage of filters
5. Impurities in the Engine oil

8.8 REASONS FOR FAILURE IN LUBRICATING SYSTEM

There are many reasons for failures of lubricating system

1. Internal and external leakage of oil leads to reduced oil level
2. Low pressure in oil, the oil pump may get damaged
3. Failure of oil pump belt or chain
4. Blockage in filter or bend in pipe
5. More blocks in oil filter
6. Damaged compounds
7. Broken or burnt gasket
8. Broken or worn out Piston rings

8.9 METHODS TO TROUBLESHOOT

1. By correcting the oil leakage
2. By changing the gaskets in oil sump
3. By changing the head gasket
4. By changing the paper gasket cover
5. By changing the drain block
6. By changing the piston rings
7. By maintaining the correct oil level

Student Activity

1. Students should visit the nearby workshops to study the process of engine lubrication system.
2. Students should dismantle any on of the lubrication system and sketch the complete system and then describe their function in detail.

Glossary

Solid Lubricant	-	திடநிலை உயவு பொருள்
Liquid Lubricant	-	திரவநிலை உயவு பொருள்
Fluidity	-	உயவு திரவம் படர் நிலை
Flash Point	-	வெடிப்பு நிலை
Fire Point	-	எரிதல் நிலை
Corrosion	-	துருப்பிடித்தல் / அரித்தல்
Foaming	-	நுரைத்தல்
Animal Oil	-	விலங்கு உயவு எண்ணெய்
Vegetable Oil	-	தாவர உயவு எண்ணெய்
Mineral Oil	-	தாது பொருள் உயவு எண்ணெய்

References

1. Rajput R.K. Internal Combustion Engines, Laxmi Publications (P) Ltd, 2006.
2. Ganesan V." Internal Combustion Engines, Third Edition, Tata McGraw - Hill,2007.
3. Duffy Smith, Auto Fuel Systems, Good Heart Wilcox Company Inc., Publishers, 1987.
4. Eric Chowanietz, Automobile Electronics, SAE International, 1995.
5. Internal Combustion Engine Handbook: Basics, Components, Systems and Perpectives, Richard Van Basshuysen and Fred Schafer (Editors) SAE International USA and Siemes VDO Automotive, Germany, 2002.

Webliography

1. https://en.wikipedia.org/wiki/Automatic_lubrication_system
2. http://www.lubrita.com/news/78/671/How-The-Lubrication-System-Works-In-An-Engine/
3. https://www.youtube.com/watch?v=mmmcj53TNic
4. https://www.grc.nasa.gov/www/k-12/airplane/lubesys.html
5. http://www.machinerylubrication.com/Read/28819/engine-lubrication
6. https://schoolworkhelper.net/car-oil-lubrication-system-overview/

SAMPLE QUESTIONS

Choose the correct answer

1. The oil pressure level of outlet oil in the oil pump?
   a) 2kg/cm^2 to 4 kg/cm^2
   b) 3kg/cm^2 to 4 kg/cm^2
   c) 5kg/cm^2 to 7kg/cm^2
2. Types of lubrication methods in engine.
   a) 2
   b) 3
   c) 4
3. Which lubrication system is mostly used in now a days?
   a) Petroil system
   b)Pressure lubrication system
   c) Splash system
4. The outlet oil from the oil pump is goes to.
   a) Main gallery
   b) Main bearing
   c) Oil filter
5. How many types of lubricants in the engine?
   a) 2
   b) 3
   c) 4

Answer the following questions

1. What is the necessity of the lubrication?
2. What are the properties of a Lubrication oil?
3. What is meant by S.A.E.?
4. What is meant by Fluidity?
5. What is meant by Volatility?
6. What is meant by Viscosity?
7. What is meant by Flash point?
8. What is meant by Foaming?
9. What are the types of the lubricant?
10. What are the solid lubricants?
11. What are the liquid lubricants?
12. What are the types of the lubrication system?
13. What are the different parts in the lubrication system?
14. What are the types of filters?
15. What are the types of oil pump?
16. Explain the working of any one type of the Oil pump with a sketch.
17. Mention any five types of troubles in the lubrication system and rectify them.
18. Explain the defects and remedies in the lubrication system.

Unit 9 Fuel Supply System

Contents

TNAQ2P

Learning Objectives

- To learn the process of fuel filling in self-propelled vehicles.
- To learn about important components like carburettor, pump, etc.

9.0 INTRODUCTION

In this chapter we study about the Fuel injection system (types, parts)-Air fuel ratio-Carburettor- types (simple, solex) and Types of Diesel engines pump, Types of Governors, Advance mechanisms, Reasons for knocking (measures to control knocking), Injector and Different types of fuel supply system i.e DTSI, CCTI, VT, PGMFI, MPFI. Fig 9.0 shows the general layout of Fuel Supply System.

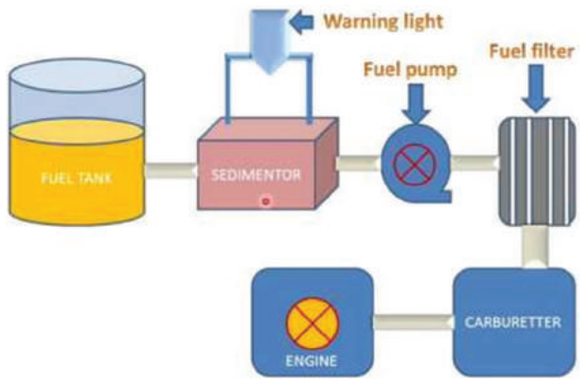


Figure 9.0 Fuel Supply System

9.1 FUEL SUPPLY SYSTEM IN PETROL ENGINE

The petrol from the petrol tank and the air from the air filter is mixed completely in correct ratio in order to make the fuel burn completely (stoichiometric air fuel ratio). The mixed fuel is sent in to the engine cylinder continuously according to the speed, load and torque of the engine in exact pressure.

Fig 9.0 shows the general layout of Fuel Supply System in Petrol Engine.

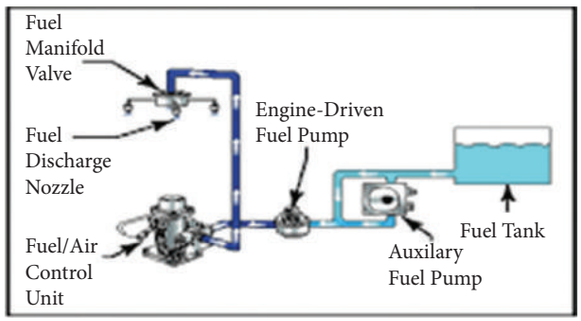


Figure 9.1 Fuel Supply System in Petrol Engine

9.2 TYPES OF FUEL SUPPLY SYSTEM

1. Gravity system
2. Vacuum feed system
3. Pump system
4. Injection system

9.2.1 Gravity System

In this method the petrol tank is kept just above the engine setup. So that the petrol in the tank reaches the Carburettor due to the gravity force. The air from the air filter and the petrol from the tank mixes and supplied in to the inlet manifold of the engine. This methods are commonly used in two wheelers like moped, scooter and motorcycles. This method can't be used in multi cylinder and heavy duty engines because as it has to be placed near the

fuel tank there is the possibility of catching fire. Fig 9.2.1 shows the Gravity System.

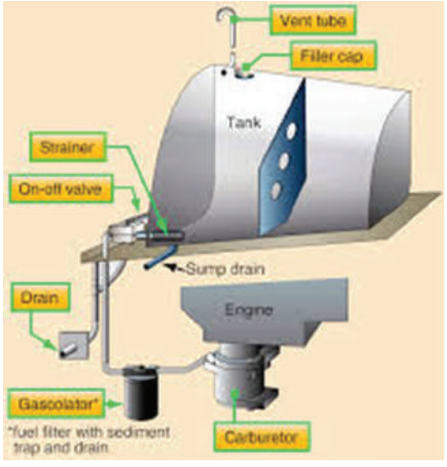


Figure 9.2.1 Gravity System

9.2.2 Vacuum Feed System

This method is actuated by the Vacuum in the engine. The vacuum created in the inlet manifold sucks the petrol from the tank and saved in the small substitute tank from there it is sent to the Carburettor by gravity method. But this method is not used in engine now a days.

9.2.3 Pump System

In this method the petrol from the tank is pumped by a pump. The pump may be mechanically or electrically actuated. In this method the tank can be fixed at any place in the engine and the pump can pump the fuel from the tank. So it is not necessary that the engine should be placed below the petrol tank as in the two former methods. The fuel can be supplied continuously even in any level. There is no chance of catching fire. So that all the vehicle now a days use this method only.

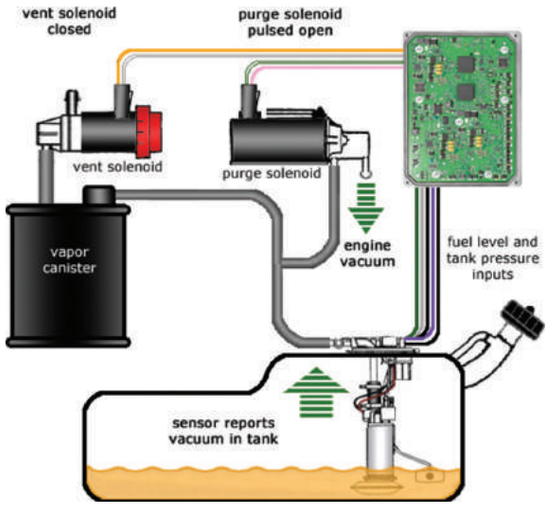
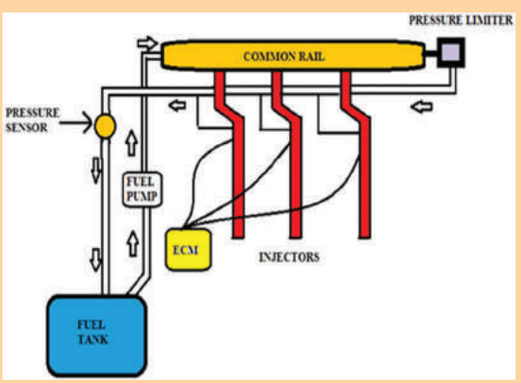


Figure 9.2.3 Pump system

DO YOU KNOW? What is Direct injection system?

- In a direct injection engine, the fuel skips the waiting period it would have to endure inside a standard engine and proceeds straight to the combustion chamber.
- It was used mainly during World War II in aero-engines such as the Junkers Jumo 210, the Daimler-Benz DB 601 and BMW 801.
- With gasoline engine it needs fuel, air (oxygen) and spark in order to operate.



9.2.4 Injection System

In this method the atomized fuel(petrol) is injected into the compressed air. So it is called as injection type. The diesel injectors are being done in this method only. Any how technology development in new vehicles as like diesel engine, the petrol is being injected in the petrol engine with the help of electronic circuits. Fig 9.2.4 shows the Injection System.

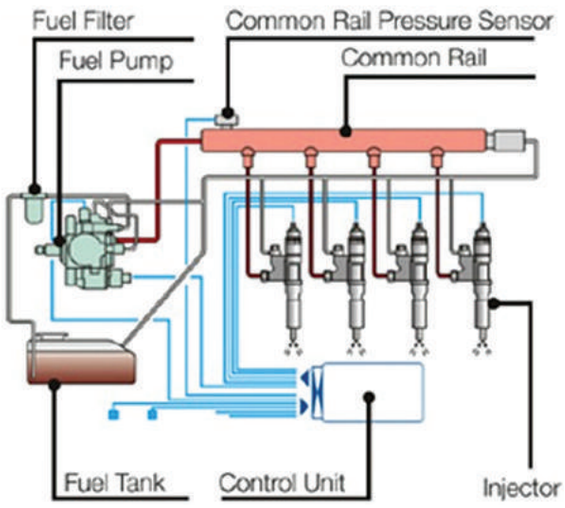


Figure 9.2.4 Injection system

9.3 FUEL SUPPLY SYSTEM COMPONENTS (PETROL ENGINE)

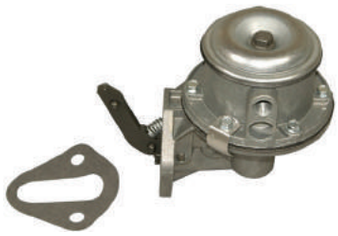
Now a days pump system only used in petrol engine. So the components used for that system can be clearly explained as follows,

1. Petrol Tank
2. Fuel Petrol Filter
3. Air Filter
4. Fuel Petrol Pump
5. Carburettor
6. Fuel Gauge
7. Inlet Manifold

Petrol Tank

Petrol Filter

Air Filter



A.C. Mechanical Fuel Pump

Carburettor

Fuel Gauge

Inlet Manifold

Figure 9.3 Components of Fuel Supply System

In the above said components petrol tank, petrol filter, air filter and inlet manifold are clearly explained in earlier chapter. So that petrol pump, Carburettor, fuel gauge can be seen clearly.

DO YOU KNOW? Carburettor?

- The first carburettor was invented by Samuel Morey in 1826.
- A carburettor meters out and mixes fuel with air for a proper combustible mixture.
- carburettors last longer than fuel injection systems and are favoured in motor sports.

9.3.1 Fuel Petrol Pump

The work of the petrol pump is to suck the petrol from the petrol tank with pressure and send it to Carburettor. Generally by the way of working it can be classified in to the types. They are,

1. AC mechanical petrol pump
2. SU Electrical petrol pump

9.3.1.1 AC mechanical petrol pump

The power required to drive the pump is taken from the eccentric in the cam shaft. So it is placed near cam shaft in cylinder block. When the engine starts the crank shaft starts to rotate. The cam shaft is actuated by the timing gear connected to it. The eccentric in the cam shaft operates the rocker arm in the pump. As the rocker arm moves upwards the diaphragm to it pushes the pull rod downwards. At that time the Vacuum is created in the pump chamber and the inlet value is being opened as a result. By which the petrol is being sucked in at this time the outlet valve is at clocked stage.

As the cam shaft further rotates the rocker arm is released from the eccentric pressure. So that with the help of the spring the pull rod moves the diaphragm to older stage. As a result the petrol in the pump chamber pressed out of the outlet valve and reaches floating chamber.

When the float chamber in the carburettor is filled with petrol, the needle valve closes the inlet path. So that the petrol can't come out of the outlet valve. So that the pressure is raised inside the pump chamber and the pressure makes the diaphragm and pull rod to stay down itself. At that time even the pull rod won't be actuated as a result the petrol won't come out of petrol chamber.

By this condition, the engine continuous to rotate the petrol is being supplied so that the petrol in the float chamber gets reduced and the needle valve is being opened, which makes the fuel to come out from the tank. So that the pressure in the pump gets reduced and starts to work as earlier. So that all operating conditions of engine the pump works smoothly

and supplies needed fuel. The petrol pressure exerted from the mechanical type is directly proportional to the spring in the diaphragm.

Usually in the mechanical petrol pump the pressure in the petrol depends on the tension in the spring of the diaphragm. Generally the pressure of the petrol coming out from the petrol will be in the range of 1 kg/cm^2. Fig 9.3.1.1 shows the diagram of A.C. Mechanical Fuel Pump.

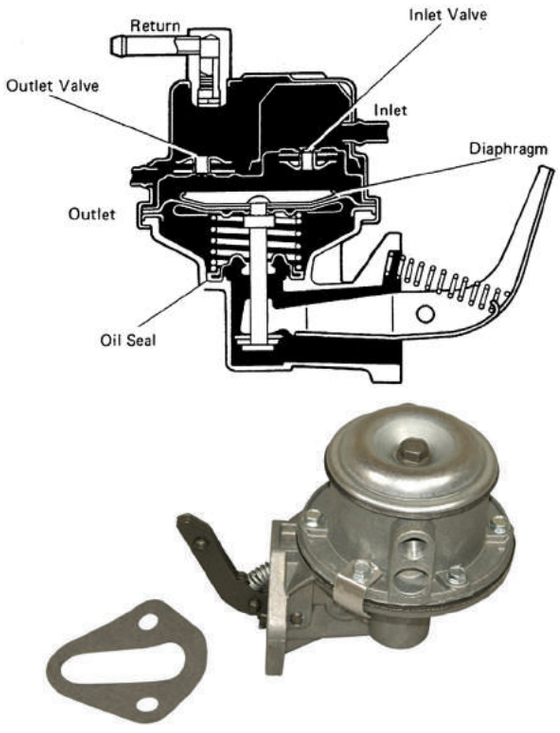


Figure 9.3.1.1 AC Mechanical Petrol Pump

9.3.1.2 SU Electrical fuel pump

As like the AC mechanical petrol pump SU electrical petrol pump also will be actuated by the diaphragm action. But in this pump, electricity is used to move the diaphragm up and down instead of eccentric. When the driver switch ON the ignition, the electricity is passed from the battery to the solenoid winding due to that the solenoid windings get demagnetised. Due to which the armature in the diaphragm moves upward. So that Vacuum is being created in pump chamber, by that time the suction valve gets opened and petrol sucked inside. At this stage, the armature moves upwards and the breaker point moves away and the electricity is disconnected. Then, by the spring action the diaphragm moves to the original position due to which the petrol in the pump chamber comes out by outlet valve and reaches float chamber in carburettor. If the fuel in the float chamber is full then the needle valve closes the inlet valve due to this the high pressure in pump chamber the spring restrict the action of diaphragm. When the level of fuel in the float chamber is reduced the needle valve gets opened and fuel (petrol) from the pump gets in as before. Fig 9.3.1.2 shows the diagram of S.U. Electrical Fuel Pump.

Figure 9.3.1.2 SU Electrical Fuel Pump

9.4 AIR FUEL RATIO (AFR)

For the various load and speed of the engine, the air and fuel should be mixed and supplied in the required manner with

the help of the carburettor and sent into the engine. The air-fuel ratio won't be same for all the time. It should be varied in different ratio according to the needs. For example (i)starting, (ii)slow speed, (iii)idling, (iv) ordinary speed, (v)high speed, (vi)cold or hot climate starting engine are the conditions at which the air-fuel ratio is to be varied and can be varied by three stages. Namely,

- Rich mixture
- Chemically correct (or) stoichiometric mixture
- Lean mixture

9.4.1 Rich Mixture

To burn 1 kg of fuel petrol completely, nearly 15 kg of air is being supplied. If the fuel in the air-fuel mixture is 1kg and air is 15kg it is said to be rich mixture.

Example, 10:1 (10 % air and 1 % fuel). Form the example, the mixture has high burning capacity. At the below given conditions the engine needs rich mixture.

- During starting (A:F = 5:1)
- Idling (A:F=10:1)
- While overtaking (A:F =12:1)

9.4.2 Chemically Correct (or) Stoichiometric Mixture

In the air-fuel mixture if the air is more and petrol is less, then it is called Chemically correct (or) stoichiometric mixture.

Example, 16:1 (16 % of air and 1% of fuel)

In normal and ordinary speed the engine is being operated at normal mixture.

9.4.3 Lean Mixture

If the fuel exceeds beyond the stoichiometric limit, then it is called lean mixture. Example: (18:1). The vehicle will operates at lean mixture in case of low load and high speed.

9.5 CARBURETTOR

The carburettor is the important component in the petrol engine. It makes the liquid form of petrol in to vapour form and mixes it with required amount of air and sends into the cylinder. It also atomises the fuel for easy mixing with air. This process is called carburetion.

9.5.1 Function of Carburettor

1. It stores the required amount of petrol in the float chamber
2. It vaporizes the fuel and mixes with air
3. Carburetion is done as per engine load and speed
4. Rich mixture is supplied to engine during starting and high speed conditions
5. When the engine is at idling stage it mixes less amount of fuel to the air and sends to the engine
6. According to the load and speed of the engine the air-fuel mixture is sent to the engine.

9.5.2 Requirements of Carburettor

1. For the required engine and load the air-fuel mixture should be mixed correctly and sent it to the engine cylinder.
2. During cooling and heating conditions, carburettor should able to start the engine easily.

3. It should not affect the fuel economy
4. Screw arrangement should be made properly for the various speed and load of the engine

9.5.3 Types of Carburettor

Carburettor can be classified as follows

9.5.3.1 Down draught carburettor

(I) In this type of carburettor the air would come from induction manifold to downward direction due to gravitational force. It will be placed above the induction manifold. Most of the vehicles use the down draught type carburettor. The fig 9.5.3 shows the down draught carburettor.

9.5.3.2 Up draught carburettor

In this type, air-fuel mixture goes from bottom to top of the induction manifold. The fig 9.5.3 shows the up draught carburettor.

9.5.3.3 Side draught carburettor

In this type, air-fuel mixture goes from one side to another side way. This is placed side of the induction manifold. Figure 9.5.3 shows various types of Carburettor.

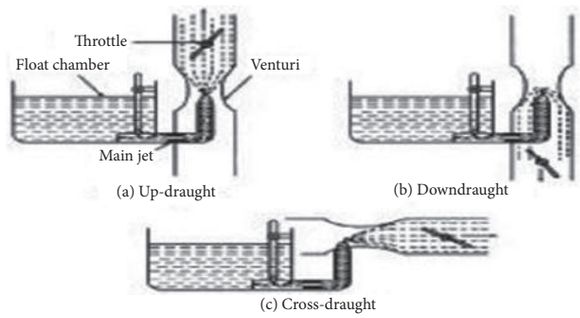


Figure 9.5.3 Various Types of Carburettor

Semi down draught carburettor:

This type of carburettor is the combination of down draught and side draught carburettor .in this type petrol-air mixture will be slightly slanting position.

(II) According to working of carburettor,

a) Constant choke carburettor:

In this type by keeping the area of the orifice constant and changing the pressure using venturi, carter, solex and zenith are the types coming under constant choke carburettor

b) Constant Vacuum carburettor:

By changing the area of orifice and keeping pressure as constant. This type of carburettor is called constant Vacuum carburettor comes under this type.

(III) According to number of barrel,

1. Single barrel carburettor:

Generally in four cylinder engines single barrel carburettor is being used. it contains only one barrel along with fuel jet, venturi, choke valve and the throttle valve.

2. Dual or multi barrel carburettor:

In this each barrel has the separate parts that are associated with the system. For each barrels there will be a separate connection to inlet manifold. This type of carburettor mixes the air fuel ratio uniformly.

9.5.4 Simple Carburettor

Without any of the advanced technologies in the system supplies the air

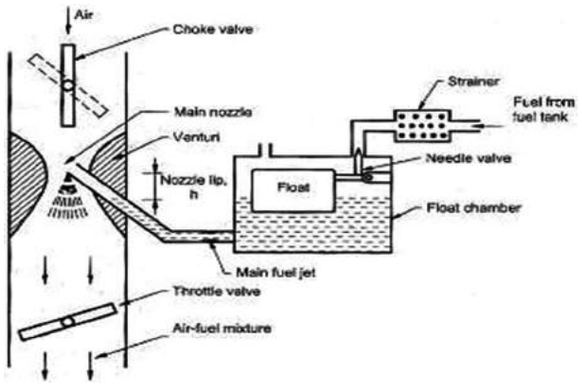


Figure 9.5.4 Simple Carburettor

fuel (petrol) ratio correctly according to the load and speed of the engine in a carburettor works it can be called as simple carburettor. Figure 9.5.4 shows the Simple Carburettor.

The parts of simple carburettor

1) Float chamber
2) venture (or) choke tube
3) main jet
4) choke valve
5) throttle valve

Working:

In float chamber there be a float and a needle valve, usually the float will be thin copper plate or plastic material of less weight and it will be made such that there will be Vacuum inside.

The inlet petrol from the fuel pump will be attached to the top position of the float chamber. So that when the petrol comes into the float chamber when it reaches the certain level the float moves upwards. When the float chamber is full the need valve in the float block the petrol line. Like the same way when the petrol level reaches down the float comes down and allows petrol to come in. so that the level is maintained inside the chamber always.

The level of the petrol in the float chamber will be 5mm less than needle height. So that when the engine at rest and while climbing hills it won't allow petrol to over flow in the mixing chamber.

To control the amount of air fuel mixture from the carburettor to the engine, there will be throttle valve in the carburettor. This valve will be connected to the accelerator cable with suitable arrangements. So that when the driver presses the accelerator pedal the amount of air fuel mixture goes inside the engine accordingly.

During the suction stroke of the engine more air will be sucked inside via air filter. In the air flow passage there will be venture with convergent type. When the air crosses the venture the pressure reduces and speed is increased around the main nozzle. So that when the petrol enters the nozzle with less pressure it can be vaporized easily and mixes with the air. It crosses the throttle valve inlet manifold and inlet valve and reaches the engine cylinder.

In cold climate when engine is started the choke valve is being closed using the choke cable. So that the air flow passage is closed for some time at that time the petrol and less amount of air in the mixing chamber and enters the nozzle as rich mixture. So that it will be easy to start engine as petrol high and less air (rich mixture).

Drawbacks of simple carburettor:

1. Starting difficulty:

To start the engine rich mixture is needed to the engine, but simple carburettor will supply only the lean mixture.

To supply rich mixture we need to use any of the following setup adjustable area jet (or) separate air passage.

2. Idling difficulty:

After the engine starts without the movement of the vehicle the engine alone working is a stage called "idling stage". To maintain the engine at idling stage the suction in the venturi is very less so that it can't take required amount of fuel from the main nozzle. So that there is difficulty to run engine in slow speed.

3. Running difficulty:

When the engine speed is high (or) getting slow, the simple carburettor won't work properly. So to avoid the running difficulty we need to adopt any one of the following methods.

1) Extra air compensation valve
2) Restrict air fuel compensation valve
3) Jet compensation valve
4) Main jet compensation valve.

4. Acceleration difficulty:

When the throttle valve opens suddenly more amount of air is sucked inside, so that there is a delay in petrol supply. So that the lean mixture will be supplied to the engine so the engine struggles at load. To compensate this acceleration pump is being used.

5. Weather difficulty:

If a carburettor is set in hot climate it will give lean mixture during cold climate. In the same way if it is set at cold climate it will give rich mixture during hot climate. To overcome this problem a climatic control device is being installed in advanced carburettors.

6. Icing difficulty:

The venturi part in the carburettor is the place where the petrol gets vaporized. So at that place the cold region is formed by removing hot region. So that at the cold climates and in hill regions the petrol in the carburettor gets freezes. To avoid this idling port and throttle regions of carburettor is heated using exhaust gas, also the hot water from the radiator is poured on to the carburetor which avoids petrol freezing.

7. Altitude difficulty:

At higher altitude regions the pressure will be less which makes air concentration very less. So that will give rich mixture to the engine. Some additional arrangements are made to supply lean mixture to the engine.

9.5.5 Solex Carburettor

To meet the fuel requirments of the different operating conditions of the engine in most of the transportation vehicles like petrol cars the solexcarburator is used. This is one of the down draft type carburetors. With respect to the engines speed and torque the fuel air mixture is prepared by this carburettor and sent through the intake manifold to the

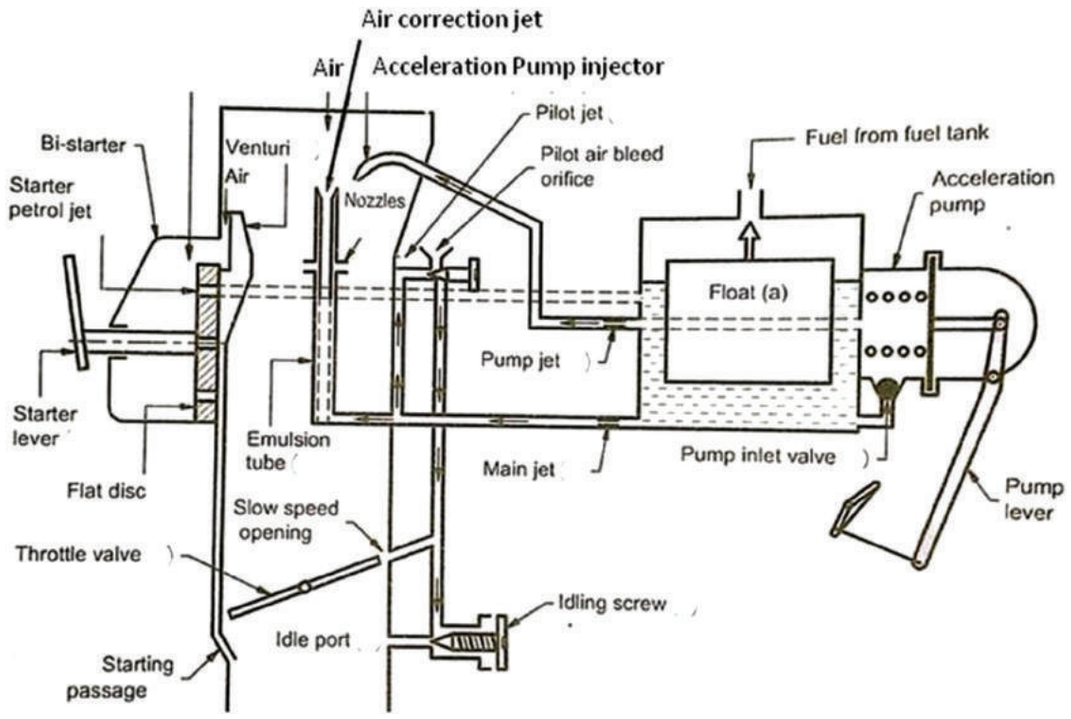


Figure 9.5.5 Schematic view of the Solex Carburettor

engine combustion chamber. The schematic view of the Solex carburettor can be seen in Fig. 9.5.5.

This carburetor has different additional circuits to be present for the complete operation of the engine. The important circuits are

1. Float circuit
2. Starting circuit
3. Idling and low speed circuit
4. Normal running circuit
5. Accelerating pump circuit

1) **Float circuit:** Float circuit is used for balancing or maintaining the fuel level uniformly in the carburetor with the help of needle valve placed above on the float. When the float moves down, the fuel (petrol) from the fuel tank automatically enters into the float chamber. If the petrol fuel level is increased inside the chamber then the float moves upward and the needle valve closes the fuel flow inlet path. By this way the float circuit maintains the petrol fuel level uniformly. Fig 9.5.5(a) shows the float circuit.

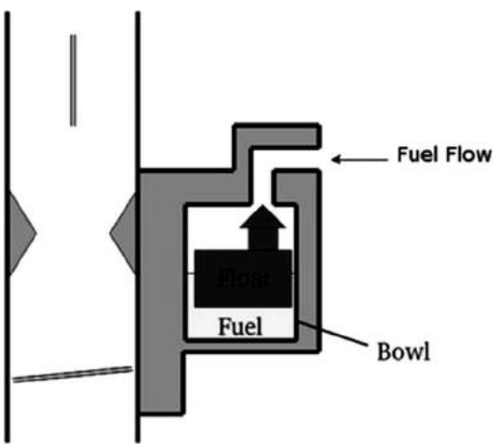


Fig.9.5.5(a) Float Circuit

2) **Starting circuit:** The bi-starter valve adapted in this circuit is actuated by using starter lever. It consists of two different sized holes.

The required amount of rich mixture for starting the engine is given by the starting petrol jet. In the two holes presented in the starter valve one is connected with starter petrol jet and another hole is connected with the starting passage. While starting the engine, for sending rich mixture the bigger size hole in the starter valve is connected to the starting passage. Hence the amount of petrol fuel mixed with the air gets increased and results in formation of rich mixture and enters into the mixing chamber. After the engine is started the starter lever must come to the balanced state. Hence a small hole in the starter valve coupled with the petrol jet is closed and hence the level of petrol fuel is reduced. When the engine comes to its normal operation the startor lever is brought to its off position.

3) **Idling and low speed circuit:** During idling stage the engine will not be accelerated. So the venturi is completely closed by the throttle valve. Hence the vacuum created inside the intake manifold is passed to the idle port located below the throttle valve. Hence the petrol fuel from the idlejet is mixed with air which coming from air jet and finally the mixture is sent to the engine through idle port. Idling and low speed circuit can be seen in Fig 9.5.5(c) Idling and Low Speed Circuit.

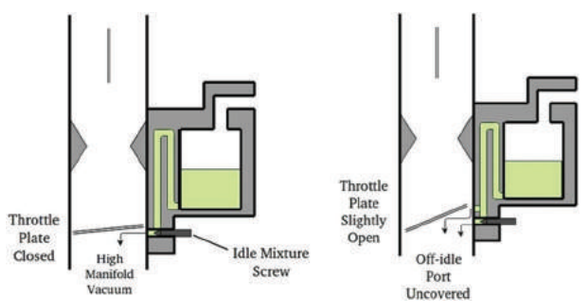


Fig.9.5.5(c) Idling and Low Speed Circuit

When driver accelerates the engine for moving the vehicle, the throttle valve gets opened slightly. Because of the above phenomenon vacuum inside the intake manifold is spreaded in to the idle port and slow speed opening. Hence the fuel coming from the petrol jet and air coming from the air jet are inducted to the engine through slow speed opening and idle port.

4) **Normal running circuit:** For increasing the engine speed driver presses the accelerator, at the time throttle valve gets opened further. Hence the required amount of petrol fuel needed for the engine is comes through the main jet and at the same time maximum amount of air is supplied to the venturi. The air is mixed with the petrol fuel and sent to the engine through the throttle valve.

5) **Acceleration circuit:** If the vehicle is to be accelerated the more fuel must be supplied with rich mixture condition for the engine operation. Acceleration pump in the acceleration circuit is used to perform the above process. Acceleration pump is connected to the accelerator pedal with linkages. The acceleration pump which consists of diaphragm coupled with a spring at one side and linkages on other side which is connected to the accelerator pedal. Petrol fuel is supplied from the float chamber to pump chamber with the help of ordinary pump connected in between the both chambers with pump valve.

By giving sudden acceleration to the accelerator pedal the diaphragm inside the pump will acts against its spring tension.

When the diaphragm is stressed,the more amount of petrol fuel from the tank is injected to the engine through the venturi. When the driver released the accelerator pedal, diaphragm get relived from the stress and comes to its original position. Because of this a vacuum created inside the pump chamber will sucks petrol fuel and sent to the float chamber with help of pump valve. By this way pump get actuated automatically for the next process. Fig 9.5.5(e) shows the Acceleration Circuit

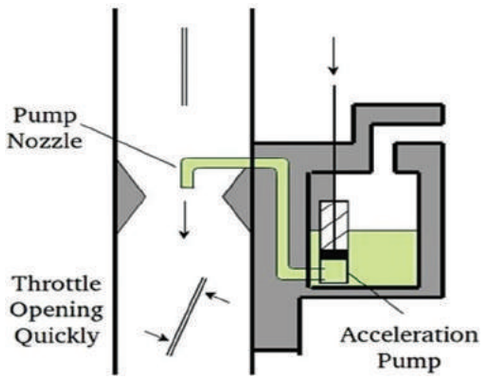


Fig.9.5.5(e) Acceleration Circuit

9.6 PETROL INJECTION

There are some disadvantages faced by sending air fuel mixture with carburation technique in petrol engines. For example, in multi cylinder engines the amount of air fuel mixture was varied from cylinder to cylinder. So at the slow speed engine could not attain steady state condition. Furthermore the energy produced from the each and every cylinder is getting varied. Hence engine vibrates more. So now days in petrol engines also direct injection of petrol is practiced.

Robert Bosch is a German engineer who introduced first time the concept of direct injection of petrol in the Mercedes racing cars. Comparably Petrol injection technique is completely varied from diesel injection. Petrol injection was made near to the intake manifold with minimum pressure in the injector whereas diesel injector operates with high pressure for injection.

9.6.1 Advantages of Petrol Injection technique

1. We can inject uniformly the air-fuel mixture with required amount to the each cylinder in the multi cylinder engine.
2. Increases in volumetric efficiency.
3. It reduces air-fuel mixture escapes from the exhaust during scavenging process.
4. Reduces knocking.
5. For all the speed and torque conditions, uniform amount of air fuel mixture can be supplied.

The following four parts are mainly used in petrol injection technique:

1) Pumping element – used for pumping petrol from tank
2) Metering element – it measures the petrol fuel quantity
3) Mixing element – it atomize the petrol fuel and tend to fine mix with air.
4) Distributing element – supplies petrol fuel to all the cylinders uniformly.

Electronic fuel injection system was established for the proper functioning of the engine. In this technique mechanical injector was replaced with electronic fuel injector with control valve.

The layout of electronic fuel injection system was shown in the fig. 9.6.

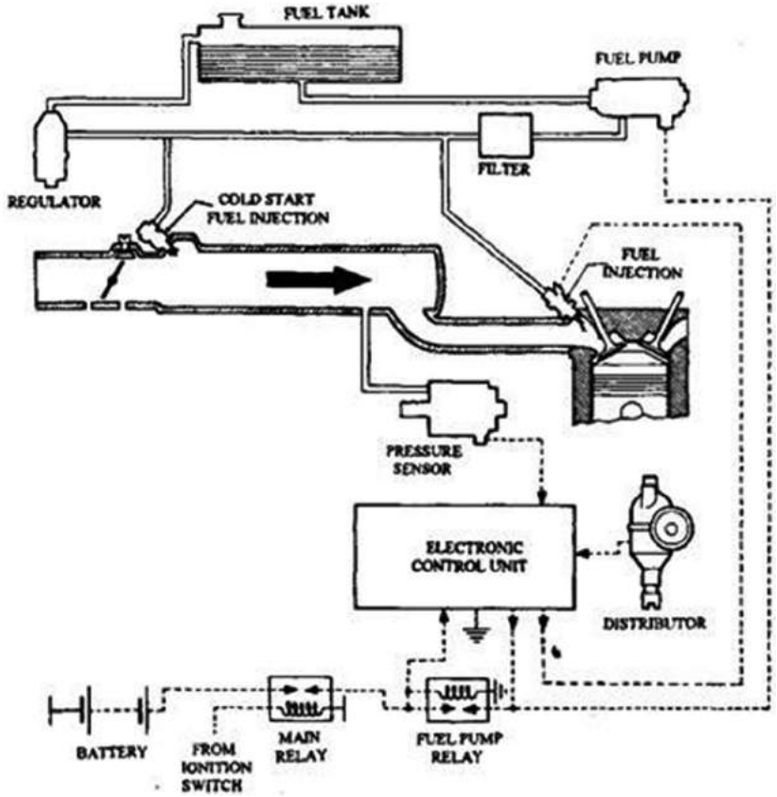


Figure 9.6 Layout of Electronic Fuel Injection System

In this fuel injection system electrically operated control valve with injection pump is introduced. This injection system receives petrol fuel from the fuel tank and injects at high pressure to the engine through metering distributor.

Inside the injector there is a solenoid which is operated under electrical supply with the help of electron control unit. ECU is a preprogrammed control unit with computer.

The injection of petrol fuel timing was given to the injector through the ECU with help of signals from the sensors. Meter valve receives the signal from the sensor and controls the solenoid for injecting petrol fuel in proper ratio in the each cylinder.

The signal quality received from the ECU shows need of some other purpose of the engines behaviour. To determine such behaviours so many sensors are introduced in to the engine. The behaviours are finally converted and send to the ECU. The required sources are air intake temperature, engine load, engine pressure, engine performance, air flow rate, engine coolant temperature, oxygen sensor, etc.,

9.6.2 Types of Petrol Injection

1) Direct injection
2) Single point or throttle body injection
3) Multi point or port injection
4) Timed and continuous fuel injection.

a) Combustion chamber injection (or) direct injection:

It will looks like diesel engine. In this type of injection, it was designed to inject petrol fuel directly to the engine cylinder.

Here petrol fuel air mixture is not sent in to the cylinder through intake manifold and inlet valve. In case of that only air is inducted to cylinder through the intake manifold, whereas petrol fuel was directly injected in to the cylinder. Because of this engine consumes less fuel and produces higher performance. But presently this type of injection system was not in practice, because of some uncontrollable parameters such as exhaust smoke and petrol fuel consumption.

b) Single point or throttle body injection:

In this system injectors are placed at each and every throat in the throttle body. This injector injects and sprays the petrol fuel before the throttle valve in the air. This developed spray of fuel was sent to the intake manifold and mixed with the air. By this way air fuel mixture is sent to the intake port through the inlet manifold. Non-uniform rate of air fuel mixture, vaporization of petrol fuel in the intake manifold, pressure difference inside the manifold are some of the problems involved in this system.

c) Multi –point or port injection:

In this system a separate injector was mounted in to the each and every cylinders intake manifold line. This injector injects and sprays petrol fuel in to the air passage in the intake manifold. This process denotes multi point fuel injection system.

d) Timed and continuous fuel injection:

Injection was depends on timed control it denotes this timed fuel injection. Fuel injection occurs from the injector by fixed timing mode in this system. In continuous injection system fuel injection occurs continuously in to the manifold. The cost and handling in continuous injection system is low and easy compared to timed injection system. In this system more amount of fuel injects in to the intake manifold with low pressure. The injected fuel mixed with the air in the manifold and mixed to form flammable mixture before entering in to the intake port. Now this mixture is ready to inject in to each cylinder. These mixtures get in to the engine by the opening of each and every inlet valve respectively. Inside the cylinder these mixture get mixed more fine for attaining its ignition point. In timed injection system fuel get injected in to the manifold at particular duration given from the timed control unit. In this system by controlling the fuel supply, the consumption of petrol fuel gets controlled. This system looks like diesel injection system used in the diesel engine.

9.7 COMPARISON BETWEEN MPFI AND CARBURETTOR

The working principle of MPFI and Carburettor are mostly same. However, there are several methods are used to identify the amount of air required when sending fuel in to the engine

Carburettor:

When engine is running under idle or slow speed the throttle valve is in closed position, hence the amount of air inducted in to the engine was measured using the pressure difference occurred in the manifold surroundings. During normal running condition the Vacuum created inside the venturi is used to measure the amount of air supplied in to the engine

MPFI:

In this system for injecting fuel we need to measure the amount of air inside the system. Electronic injection system consists of various devices. Air flow meter (sensor) is placed in the system for measuring the amount of air inducted and the signal is sent to the ECU. Then this ECU sends one signal to the injectors. By the method injectors injects fuel in uniform manner with the help of pump in to the each cylinder separately respective to the signal from the ECU.

Types of MPFI System:

Based on the amount of air inducted in to system MPFI classified in to two types

1. D-MPFI (manifold pressure control type)
2. L-MPFI (air flow control type)

D-MPFI

D-MPFI also called as a D-Jetronic. D-Jetronic is a german word comes from a word 'Druck' (pressure). In the type of system air flow rate is measure based on the Vacuum created inside the manifold. D-MPFI is mainly used in the engine which was controlled by the computer control system.

L-MPFI

L-MPPFI also called as L-Jetronics. The word L in the L-Jetronics is comes from the german word called 'Luft'. The meaning for 'Luft' is air. This L-MPFI system is mainly used in the electronic fuel injection (EFI) and Computer controlled system (CCS) adopted engines. In this type of system the air flow rate inside the manifold is measured using sensor called Air flow meter.

Basic parts of MPFI:

The MPFI are consists of three different parts:

1) Electronic Control System
2) Fuel System
3) Air Induction System

(i) MPFI – Electronic Control System

It consists various sensors like Air flow meters, Water temperature sensor, throttle position sensor, Intake Air Temperature sensors etc. The ECU system controls the injection duration of the injectors based on the signals received from the above sensors.

(ii) MPFI – Fuel System

It consists of Fuel Pump, fuel cold start injector, Timing and Injection signal control (ECU). The ECU system controls and defines the amount of fuel to be injected in to the manifold with the help of injector by receiving signals from the sensors.

(iii) MPFI – Air Induction System

It consists of Air cleaner, Air flow meter, Throttle body, Air valve, Air intake chamber, Intake manifold and cylinder. All this devices are used in the system is for supplying exact amount of air required for the complete combustion.

9.8 METHOD OF FUEL SUPPLY (DIESEL ENGINE)

In the present economic condition spending more money for buying fuel for the vehicles becomes a difficult one for the

common people. Hence people prefer low cost fuel for the vehicles. Diesel is a low cost fuel than petrol and it has high thermal energy and pulling power. In this way when diesel is used as fuel the method of supplying the fuel and combusting it becomes different from using petrol in Otto cycle. In the diesel cycle based engines a separate fuel supply system is used for introducing fuel inside the combustion chamber of the engine. The fuel supply system of the diesel engine has the following components.

1. Fuel Tank
2. Primary (course) Fuel Filter
3. Fuel feed pump
4. Secondary (fine) fuel filter
5. Fuel Injection Pump
6. Fuel Injector or Nozzle

In the above components of the fuel supply system the fuel tank, fuel filter, fuel feed pump were already discussed in detail. Hence here the details of types of fuel injection pumps and their arrangements can be seen in detail.

9.9 FUEL INJECTION PUMPS

In any diesel engine for producing required power, specified amount of fuel at the specified pressure and at the specified time must be introduced inside the combustion chamber. The device used for achieving such operation is called as the fuel injection pump. If the fuel is injected in such high pressure inside combustion chamber which has the compressed air at very high temperature then the fuel will get auto ignited and the engine power will increase. The pumps used for such operation are classified into the following types.

1. In line or jerk type Pumps
2. Distributor pumps

9.9.1 Inline (Jerk type) Pump

When the fuel is supplied through the intake manifold by induction like carburetion due to wall wetting effect appropriate fuel will not be supplied to the individual cylinders. Due to this improper distribution of the fuel supply, individual cylinders produce varying power outputs in multi cylinder engines. This distribution of the fuel could be avoided by injecting the fuel by using separate injectors fitted at the individual cylinders of the engine. In multi cylinder engines when the appropriate amount of fuel is injected at the appropriate timings as per the firing order then the power variations can be eliminated. In multi cylinder engines the injectors are mounted at each cylinder of the engine and arranged in line and operated by individual injection pumps which are operated by a common cam shaft. These types of pumps are called as in line pumps. The injection pressure in such pumps can be increased from 7 Mpa (mega pascal) to 30 Mpa. In a diesel engine operating at 6000 rpm with 150 mm^3 quantity of the fuel will be injected 20 times. The In line pumps can be also called as jerk pumps.

Construction:

In an in line diesel pump plunger, barrel and delivery unit are the important components present. The plunger is kept inside the barrel in correct fit and allowed to move inside the plunger barrel up and down. Tooth quadrant provided on the barrel

unit helps to operate the accelerator rod front and back. This arrangement is made in the fuel injection pump by using a spring arrangement. The cam shaft is present at the bottom of the fuel injection pump. When the cam shaft rotates the cam present in the shaft lifts the plunger unit of the pump. There are provisions made in the barrel to admit fuel and deliver the fuel. The helix present in the plunger in connection with the spil port is designed to suck the fuel and pressurise it. The delivery unit present in the pump at the top has the spring loaded delivery valve and the spring as a single unit. The schematic view of the in line pump can be seen in Fig 9.9.1 and the plunger control rack arrangement can be seen in Fig 9.9.1(a).

Operation:

The in line injection pump of the engine is operated by the timing gear. When the engine is started, the crank shaft is rotated and the power is transferred to the engine cam shaft. From the cam shaft the power goes to the fuel injection pump cam shaft through the timing chain. The plunger present in the fuel injection pump moves up and down due to the cam's rotation. When the plunger is moved down the fuel is sucked inside the barrel of the pump through the inlet port. This happens when the vertical slot is in connection with the spill port and the fuel enters into the pump barrel. To control the amount of fuel delivered to the injector the

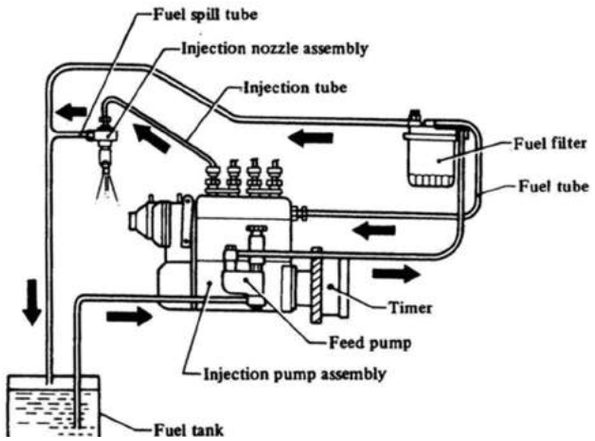


Figure 9.9.1 Schematic View of the In line Pump

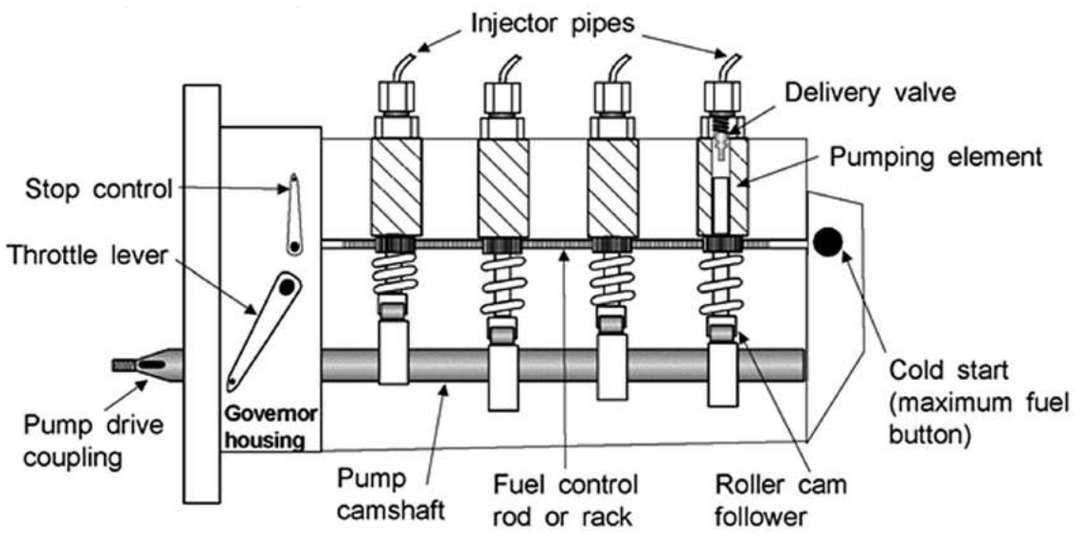


Figure 9.9.1(a) Control Rack and Plunger Arrangement

Control rack in connection with the tooth quadrant present in barrel unit is used. By moving the control rack front or back the helix position in the plunger meeting the spill port is varied. When the plunger is moved up, the inlet and spill port are cut and hence the fuel is compressed inside the barrel and high pressure is developed in the pump. When sufficient pressure is attained the delivery valve opens and the pressurised fuel present in the pump is supplied to the respective injector as per the firing order and injected inside the combustion chamber.

9.9.2 Distributor Pumps

Use of individual pump and injector in individual cylinders of a multi cylinder engines leads to energy loss (due to the operation of the individual plungers in the pump) and more maintenance in diesel engines. Hence instead of the in line pump, a single unit arrangement can be used which could pressurise the fuel and supply it to the appropriate cylinders at the appropriate time. Such pump is called as the distributor pump. The power for the distributor pump is obtained from the gear present in the cam shaft.

Construction: The distributor pump has a sleeve, rotor, plunger and a delivery unit. Rotor is placed inside the sleeve to rotate and move up and down. For the diesel fuel to enter and leave ports are made in the sleeve. The port is called as the metering ports. The plunger unit is placed inside the rotor unit to operate. There is a gear placed at the bottom of the rotor. The delivery unit of the pump is kept at the top of the rotor. The view of the distributor pump can be seen in Fig 9.9.2.

Operation: Unlike the in line pump, the distributor pump is designed as a single unit in such a way to distribute the diesel fuel to all cylinders. In the rotor a long path is present to pass the fuel. This path is provided to supply the fuel to the individual cylinders depending on the rotation of the suction port. When the engine is started due to the rotors rotation and up and down movement the fuel entering inside the pump is compressed and hence the pressure of the fuel is raised. The pressurised fuel then reaches the delivery valve. From the delivery valve through the high pressure line fuel is supplied to the injectors as per the firing order and sprayed at high pressure. The fuel delivered from the pump is controlled by using a metering rod and the governor unit for controlling the engine's speed. To control and meter the fuel the metering rod and the governor unit are used. The governor unit is connected with the accelerator pedal of the vehicle.

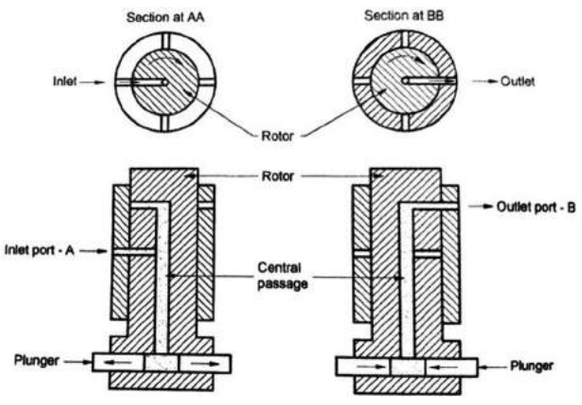


Fig.9.9.2 A view of the Distributor pump

9.10 GOVERNOR

Normally in petrol engines the carburettor unit mixes the air and fuel at correct proportions and supplies to the engine depending upon the engine's requirement. However, in diesel engine air and fuel are

separately introduced inside the engine combustion chamber and then ignited. Hence for supplying the required amount of fuel (in diesel engine) or fuel air mixture (in petrol engines) depending upon the engine's speed and load governor unit is used. At all speeds and loads to operate the engine safely the governor has the following operation stages of operation,

1. Governor cut in speed
2. Governor cut out speed
3. Governor over run

Note:

Governor Cut in Speed: Governor cut in speed represents controlling the speed of the engine by using the control rack by moving the rack out and supplying the required amount of fuel to the engine.

Governor cut out speed: When the control rod is operated beyond the control speed the fuel supply is cut by the governor this is called as cut out speed.

Governor Over run: The difference between the governor cut in and cut out speeds is called as governor over run.

9.10.1 Governor Terminologies

Based on the working principle governors can be classified into three types. They are

1. Mechanical Governors
2. Pneumatic Governors
3. Hydraulic Governors

1. **Mechanical Governor:** To control the engine's speed and load and reduce wastage of fuel governor is used in engines. The mechanical governor is operated mechanically. This governor is generally used in diesel engines. The construction and working principle of the mechanical governor are as follows,

   Construction: In this governor spring loaded weights, control rack, sleeve and bell crank lever are present and linked together properly. The sleeve is placed on the governor shaft and allowed to move freely. The two centrifugal masses are connected with the plunger sleeve through the bell crank lever. The governor shaft gets the power from the engine. The layout of the mechanical governor can be seen in Fig 9.10.

1. ***Height of a governor.*** *It is the vertical* distance from the centre of the ball to a point where the axes of the arms (or arms produced) intersect on the spindle axis. It is usually denoted by *h*.
2. ***Equilibrium speed.*** *It is the speed at* which the governor balls, arms etc., are in complete equilibrium and the sleeve does not tend to move upwards or downwards.
3. ***Mean equilibrium speed.*** *It is the speed* at the mean position of the balls or the sleeve.
4. ***Maximum and minimum equilibrium speeds.*** *The speeds at the maximum and minimum* radius of rotation of the balls, without tending to move either way are known as maximum and minimum equilibrium speeds respectively.
5. ***Sleeve lift.*** *It is the vertical distance which* the sleeve travels due to change in equilibrium speed.

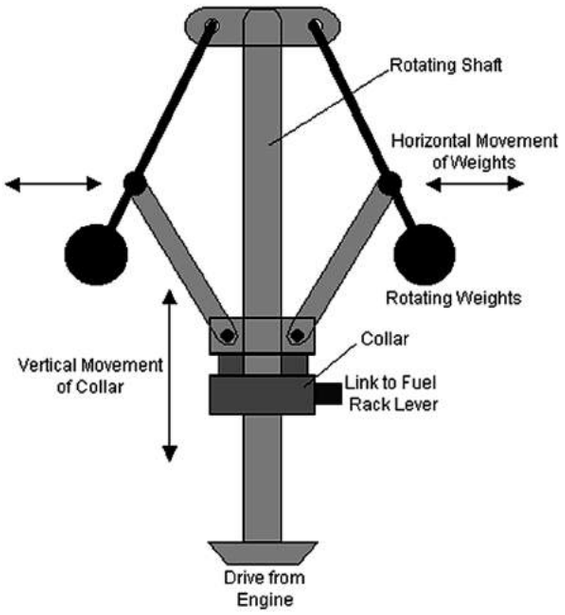


Fig 9.10.1.1 Layout of a Mechanical Gover**nor**

Working Principle: When the engine is started the governor shaft gets the power and rotates. As the governor shaft rotates the masses connected with the spring also rotate and hence the masses are forced to rotate outside due to the centrifugal force. Hence the sleeve placed in the governor shaft is moved upwards. The one end of the lever connected with the control rack is moved up along with the sleeve. This causes the other end of the lever to move down and operates the control rack. Due to this the diesel supplied to the engine is reduced and hence the engine speed is reduced. Similarly when the accelerator pedal of the driver is pressed the control rack is operated and the speed of the engine is varied. In the same way the engine speed can also be increased by moving the centrifugal mass. The governors of this type are of two types. 1. All speed governor and 2. Maximum speed governor. The governor operated by the driver's engine speed control is called as the maximum speed governor and the governor operated by the spring force without the accelerator is called as all speed governor.

2. **Pneumatic Governor :** The governor operated by using only the engine Vacuum without any bolts is called as the pneumatic governor.

Construction: This type of governor has two main parts such as 1. Venturi unit and 2. Diaphragm unit. The venturi unit is connected with the intake manifold and the diaphragm unit is connected with the fuel pump. The venturi unit and diaphragm unit are connected by the Vacuum pipe. The diaphragm is connected to the control rack. The construction of the pneumatic governor is shown in Fig 9.10.1.2.

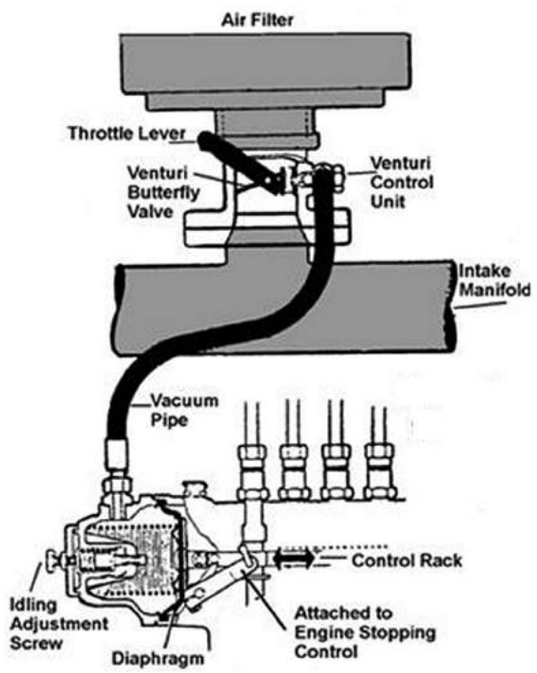


Fig 9.10.1.2 Pneumatic Governor

Working Principle: When the accelerator pedal is pressed the butterfly valve in the venturi opens. Hence the Vacuum in the inlet manifold reaches the diaphragm unit

through the Vacuum pipe. The control rack connected with the diaphragm is operated and the diesel supply is controlled. By this way the engine speed is controlled in the pneumatic governor.

3. **Hydraulic Governor :** This type of governor is operated by the cam shaft of the engine. The control plunger in this governor is connected with the control rack of the fuel injection pump by a spring. This type of governors are operated by the liquid present in the control plunger. When engine is started due to the rotation of the cam shaft the control plunger is operated and the control plunger operates the control rack of the fuel injection pump. The control rack of the fuel injection pump is operated by the hydraulic liquid in the control plunger. The schematic view of the hydraulic governor shown in Fig 9.10.1.3.

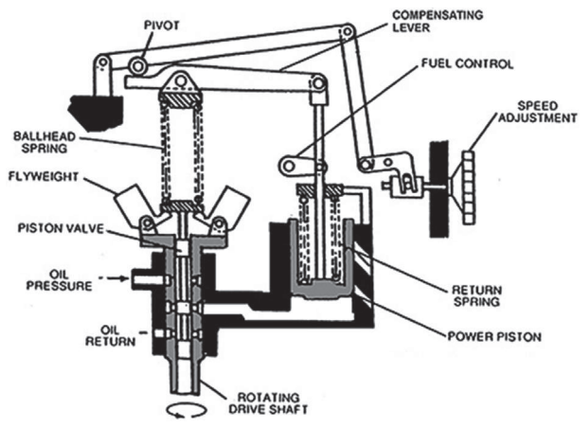


Fig 9.10.1.3 Schematic View of the Hydraulic Governor

9.11 DIESEL KNOCK

Knock in diesel engine is an unwanted effect caused due to the increased ignition delay of the engine. During the ignition delay period fuel is injected continuously. When the accumulation of the fuel is more due to the increased ignition delay, when ignited the accumulated fuel suddenly gets combusted and results in severe fluctuation in cylinder pressure and rate of pressure rise. This cause violent sound called as diesel knock.

9.11.1 *Reasons for Diesel Knock*

1. Lower compression ratio of the engine
2. Lower fuel injection pressure
3. Faulty injector
4. Blockage in the nozzle
5. Earlier injection of the diesel fuel

9.12 COMMON RAIL DIRECT INJECTION

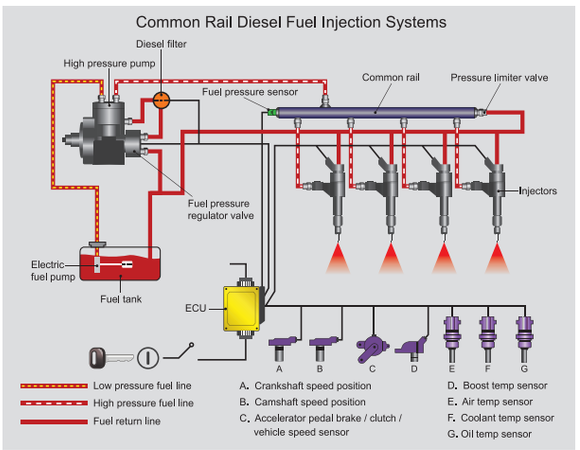


Fig.9.12 Common Rail Direct Injection

Common Rail direct injection of diesel fuel is the recent technology followed in modern diesel engines in introducing diesel fuel inside the engine combustion chamber. To improve the vaporization behaviour of the diesel fuel, the fuel is supplied to a common rail at very high pressure from the fuel pump. This method is called as the common rail direct injection. In this method with a small amount of diesel fuel more power is obtained. In addition the emission levels are reduced

significantly. Hence in modern diesel engines this system is used for good fuel economy and lower emission levels. In this common rail direct injection system the fuel pressure is maintained at 1350 – 2000 bar in the common rail by using a fuel pump. The fuel is supplied to all the injectors from the common rail and injected into the combustion chamber according to the firing order. The pressure maintained in the common rail is not depending on the engine's operation. Hence the CRDI system shows as better method as compared to the conventional engine systems. In the CRDI system the common rail and the high pressure lines connected with the injectors are designed to withstand very high fuel pressures. The electronic control unit (called as ECU) present in the system determines the amount of diesel fuel injected, the fuel pressure, injection timing and the injection duration. The ECU receives the input signals from different sensors, calculates the amount of fuel required, time for injection duration and other details for injection of the fuel and delivers required output signals to the solenoid operated injectors. By this way the fuel injection pressure, time and duration of injection and the amount of fuel injected are controlled.

Construction of CRDI system: The CRDI system consists of a fuel lift pump, a high pressure diesel pump, a common rail for storing diesel at high pressure and solenoid operated diesel injectors. In addition the system has different sensors, actuators and an electronic control unit (ECU). The lift pump is used to pump the diesel fuel through the filter to the high pressure diesel pump. The diesel from the high pressure pump transfers the fuel to the common rail. The injectors mounted on the cylinder head of the engine receive the high pressure fuel from the common rail through the high pressure lines. The solenoid operated injectors open the injector holes according to the signals received from the ECU. 16 bit or 32 bit microprocessor acts as the brain of the ECU used in the CRDI system. The temperature of the engine, temperature of the air and fuel, the rail pressure, engine booster pressure, accelerator pedal position, vehicle speed and intake air amount etc. are monitored continuously by the ECU using different sensors located at different parts of the engine by input signals. Figure 9.12(a) presents the construction of the CRDI system

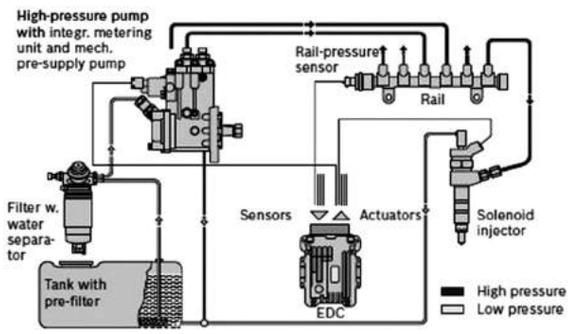


Fig 9.12(a) Construction of the CRDI system

Operation: Diesel fuel from the fuel tank is lifted by the fuel lift pump and supplied to the fuel filter. The fuel lift pump is operated electrically without the support of the engine power. The high pressure pump operated by the engine develops very high pressure and forces the high pressure fuel to the common rail. The fuel from the common rail is supplied to the individual injectors through the high pressure lines and the fuel is sprayed in the cylinder at very high pressure. The electronic control unit receives the

signals from the sensors and calculates the diesel injection pressure, injection timing, amount of fuel injected and the duration of injection etc. and gives output signals to the injectors. The electrical signals from the ECU operates the solenoid switch. Depending on the electrical signals received from the ECU the solenoid will open and close the injector hole and sprays the fuel. The limit switch and the non return valve in the common rail control the diesel pressure and the excess diesel is returned to the fuel tank.

9.12.1 Advantage of CRDI System

1. Improves the engine's performance
2. Reduces the diesel supplied
3. Reduces the emissions
4. Improve the power output
5. Starts the engine quickly
6. Smooth engine operation

Student Activity

1. Students should prepare a report on the rich mixture, lean mixture and normal mixture used in two-wheeler engines.
2. Students should visit the nearby workshops to study the process fuel combustion in an IC engine and should submit a report with the sketch of float chamber, carburettor and AC mechanical pump.

Glossary

Convergent	-	தரமாற்றிக் கொள்ளுதல்
Ventury	-	குறுகிய
Vaporized	-	ஆவியாதல்
Intel Mani Fold	-	உட்செல்லும் வழி
Vacuum	-	வெற்றிடம்
Multi Point Fuel Injection	-	பல துளைகள் கொண்ட எரி பொருள் உமிழ்ப்பான்
Electronic Control Unit	-	மின்னணு கட்டுப்பாட்டுக் கருவி
OTTO Cycle	-	ஆட்டோ சுழற்சி
Centrifugal	-	மைய விலக்கு
Governor	-	செயல் கட்டுப்பாட்டுக் கருவி

References

1. Ganesan V." Internal Combustion Engines, Third Edition, Tata McGraw - Hill ,2007.
2. Mathur, M.L., and Sharma, R.P., A Course in Internal Combustion Engines, Dhanpat Rai Publications Pvt.New Delhi - 2, 1993.
3. Heinz Heisler, Advanced Engine Techology, Butterworth Heinmann Publishers, Second Edition, 2002.

Webliography

1. https://www.youtube.com/watch?v=m6-KZS19HDU
2. http://mechteacher.com/fuel-supply-system-in-diesel-engine/
3. http://enginemechanics.tpub.com/14081/css/Diesel-Fuel-Systems-33.htm
4. https://www.engihub.com/fuel-supply-in-petrol-engine/
5. http://what-when-how.com/automobile/ci-engine-fuel-system-automobile/
6. https://www.howacarworks.com/fuel-systems/servicing-the-fuel-supply-system

SAMPLE QUESTIONS

1. How many types of Fuel Supply System are used in IC Engines?
   a) Two
   b) Three
   c) Four
2. How many Kilogram of air is needed for complete compression of 1 kg of Petrol?
   a) 4 kg
   b) 10 kg
   c) 15 kg
3. Based on air inlet how many types of Carburettor are there?
   a) Two
   b) Three
   c) Four
4. How the Throttle Value in Carburettor is operated?
   a) By Vacuum
   b) By accelerator pedal
   c) By petrol pump
5. Who initially introduced petrol injection system?
   a) Robert Bosch
   b) Nicholas Otto
   c) Rudolph Diesel

TNJL4C

Answer the following questions

1. What are the types of Fuel Supply system?
2. What are the important parts in the fuel supply system?
3. How many types Petrol Pump? Mention the names.
4. What is meant by Air fuel ratio?
5. What is meant by Rich mixture?
6. What is meant by Normal mixture?
7. What is meant by lean mixture?
8. What are the functions of the carburettor?
9. What are the requirements of the carburettor?
10. What are the types of the carburettor?
11. Explain with a neat sketch of a simple carburettor.
12. What are the troubles in the simple carburettor?
13. Draw and explain the starting circuit.
14. What are the advantages in the Petrol Injection system?
15. What is meant by ECU?
16. What is meant by MPFI? And name the types.
17. What are the types MPFI? Explain any one type.
18. What are the important parts of the Fuel supply system in Diesel Engine?
19. What is meant by Governor?
20. What are the types Governor?
21. Name the types of a Governor? Explain any one type with sketch.
22. What is meant by Diesel Knocking?
23. What are the reasons for Diesel Knocking?
24. What is common rail diesel injection system? And explain.
25. What are the advantages of CRDI?

Unit 10

Engine Trouble Shooting & Remedies

Contents

Learning Objectives

- To learn the maintenance procedures to extend the life of vehicles.
- To learn about various maintenance techniques.
- To learn how a vehicle driver maintains the vehicle.
- To learn about the usage vehicle log book, road test form preparation and vehicle servicing.

10.0 INTRODUCTION

All the parts of vehicles are to be maintained periodically by regular inspection. The aim of preventive maintenance is to ensure the safety and to reduce the vehicle down time.

10.1 TYPES OF INSPECTION (MAINTENANCE)

The following three types of sheets are used during inspection

1. Pre Trip Inspection
2. Post Trip Inspection
3. Annual Inspection

10.1.1 Pre Trip Inspection

Daily maintenance are carried out on daily basis. The pre trip inspection has to be carried out by driver and conductor. The main responsibility of driver is to do the pre-trip inspection.

Sometimes if the vehicle is driven by more than one driver, it is important that each driver has to do the inspection during their trip.

The inspection has to be carried out to ensure the safe inspection of the vehicle. If the vehicle is not in a good condition the vehicle has to be removed from use.

10.1.2 Post Trip Inspection

The post inspection is carried out to find the fault in the end of each shift or day. The driver and conductor can do the post trip inspection. So that the fault in the vehicle is verified before it came to the use for the next day and down time also reduced.

The vehicle maintenance form to be attached to the vehicle maintenance file and the copy of the same has to be given to the vehicle inspection person. The provision has to be given to the mechanic for his signature in this form.

All the drivers have to prepare and submit a report about their vehicle at the end of each day.

The vehicle inspection report should have the following content

- It has to identify the vehicle
- All the defects to be listed
- Driver signature is necessary

The following parts of the vehicle have to inspect during pre trip inspection and post trip inspection.

- Light and reflectors
- Brakes and parking brakes
- Mirrors
- Wind shield, wipers, washers
- Tyre, wheel, Rims
- Speedometer
- Doors
- Backup alarm
- Wheel chair lifts
- Visual reviews
- Coupling devices
- Shearing mechanism

The owner of the vehicle has to keep the drive vehicle condition report / daily defect cards in their vehicle. The driver has to give the details about the fault at the end of the day.

10.1.3 Annual Inspection

At the time of fitness Certificate get from the Road Transport Office. We take maintenance of full Vehicle that means under chase and Engine etc, are called Annual Inspection.

10.2 MAINTENANCE OF RECORD

10.2.1 Inspection Form/Road Test Report

1. Road test report shows the condition of vehicle before and after maintenance
2. The road test report will be written by the road test inspector after the vehicle maintenance.
3. This report contains Vehicle registration number, chassis number, TOB number and date of test.
4. The following parameter has to be checked
   - ➢ Front and rear brake caliber
   - ➢ Brake position
   - ➢ Wheel and bearing position
   - ➢ Pickup of the vehicle
   - ➢ Mileage of the vehicle

The sample road test report is given below.

10.3 LOG BOOK

The vehicle log books gives required details about the vehicle to the mechanic for the maintenance and it gives all the detail to the vehicle owner. The log book contains the following details.

- ➢ Distance travel by the vehicle
- ➢ Average fuel cost
- ➢ Best and worst mileage details
- ➢ Overall maintenance expense
- ➢ Cost of vehicle operation
- ➢ The problem of vehicle
- ➢ Previous maintenance dates

The sample log book is shown below.

10.3.1 Trip Sheet

The trip sheet gives all the details from the start to end of the trip. It contains the following information's.

- Trip starting Km and ending Km
- Trips starting time to Ending time

Inspection Forms/Road Test Report

Sl. No.	Parameter to Check	Before Work	After Work
1.	Front Abnormal Sound		
2.	Rear Abnormal Sound		
3.	Front/Rear Suspension Sound		
4.	Steering Sound		
5.	Brake Caliber Sound		
6.	Misfiring/Starting		
7.	Stopping Problems		
8.	Under Body Sound		
9.	Door/Glasses Sound		
10.	Brakes/Door/Wheel Sound		
11.	Wheel Bearing Sound		
12.	Drive shaft Sound		

Vehicle Log Book

Vehicle Reg No : Diesel ☐ Petrol ☐ Kms ☐

Week Beginning : Vehicle Name _____ Driver Name _____

Day	Start Mileage	Finish Mileage	Daily Total	Signature
Monday Tuesday Wednesday Thursday Friday Saturday Sunday				
		Weekly Total :		

Gas/Diesel and Engine Oil

Day	Odo Meter Reading	Fuel in Litres	Product (Gas Diesel or Oil)	Cost of Fund
Monday Tuesday Wednesday Thursday Friday Saturday Sunday				
	Total		Total	

Comments

_____

_____

_____

The sample trip sheet is given below.

Name & Address of the Travels		
Engaged by Mr/Mrs: _____ Vehicle No. _____	Trip No: _____ Driver Name _____	Date: _____
Closing Time : _____ Starting Time : _____ Total Time : _____ Signature of the Customer	 Hire charges per km Driver Batta Excess hours	Rupees _____ _____ _____
	Total	
Advance Rs _____	Driver Signature	For Agency

Vehicle Service Form

Vehicle Name : _____ Vehicle Reg : _____

Date of Service : _____ Mileage : _____

Unit	Yes	No	Comments
Air Filter			
Oil/Oil Filter Change			
Check & adjust the belt			
Check belt			
Check and adjust power steering belt			
Check spark plug gap			
Distributor cap & rotor arm			
Ignition leads			
Check rear brake			
Check front brake			
Check and replace broken light bulb			
Adjust hard brake			
Check and clean battery connection			
Check battery water level			
Renew brake fluid 1 & necessary			
Check type pressure			
Check wiper blades			
Check front and rear suspension			
Charge differential oil			
Grease wheel bearings			
Grease steering			

Vehicle Repair Form

Vehicle Reg : _____ Vehicl Mileage : _____

Driver Name : _____ Date : _____

Discription of Repairs carried out

Reason for repair

_____

_____

_____

Cost of Repairs :

_____

Details of / Company who each carried out Repairs

Name: _____ Phone : _____

Address :

_____

_____

were repairs checked before payments _____

Quality of Repairs

Poor ☐ Satisfactory ☐ Good ☐ Excellent ☐

Signature: _____

Date: _____

Vehicle Accident Report Form

Employer : _____ Age : _____ Sex : _____

Department Supervisor : _____

Date of Accident : _____

Nature of Injuries:

Cause of Accident:

Name & Address of Physician

If Hospitalized, Name & Address at Hospital

Action Taken

Remarks

Supervisor Date :

Driver's Inspection Report

Location/Department : _____

Date : _____

Vehicle Description, year : _____ Male : _____ Model : _____

Serial No. : _____ Mileage : _____

ENGINE CONDITION	INTERIOR	EXTERIOR
☐ Oil Level	☐ Guages/Warmings	☐ Lights
☐ Colour Level	☐ Wind Sheeld	☐ Reflectors
☐ Belts		☐ Suspensions
	☐ Meter/Defrostes	☐ Tyres
	☐ Mirrors	☐ Wheels/Rimers
	☐ Steering	☐ Battery

GENERAL CONDITIONS

☐ Cab/Doors/Windows	☐ Clutch	☐ Exhaust
☐ Body/Doors	☐ Service Brakes	☐ Brake
☐ Oil Leak	☐ Parking Brake	☐ Air Filter
☐ Grease Leak	☐ Caution Triangle	☐ Spare Tyre
☐ Coolant Leak	☐ Emergency Brake	☐ Dents
☐ Sheet Belt	☐ Fire Extinguisher	☐ Other Coupling
	☐ Seat Belt	

Reporting Driver : _____ Date : _____

Receiving Driver : _____ Date : _____

Maintenance Action: ☐ Repair Mode: ☐ No Repair: ☐

Weeked work order / Purchase order No. : _____

Repaired by : _____

Location : _____

Workshop Remarks : _____

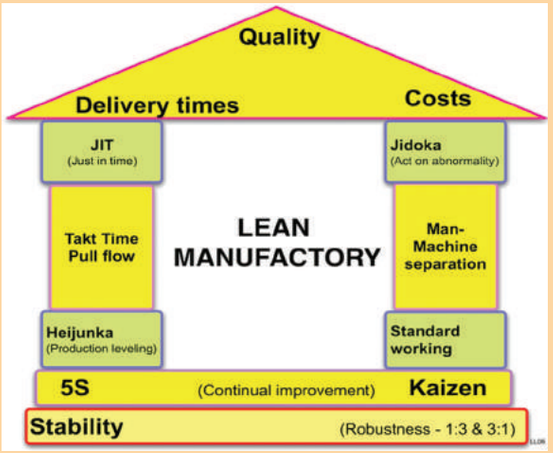
Lean manufacturing

Lean manufacturing or lean production, often simply "lean", is a systematic method for waste minimization within a manufacturing system without sacrificing productivity.

Lean also takes into account waste created through overburden and waste created through unevenness in workloads. Working from the perspective of the client who consumes a product or service, "value" is any action or process that a customer would be willing to pay for.

Lean manufacturing makes obvious what adds value, by reducing everything else (which is not adding value).

This management philosophy is derived mostly from the Toyota Production System (TPS) and identified as "lean" only in the 1990s.



10.4. TROUBLE SHOOTING

10.4.1 Cooling System

Oil Heating	
Causes	**Remedy**
1. Cooling water may be Insufficient	Water to be filled in the radiator
2. Thermostat may not working	To be replaced
3. Water pump may not working	To be repaired or replaced
4. Valve timing may not proper	Set proper timing
5. Blocks may be there in Radiator	To be cleaned
6. Fan belt may cut	To be replaced
7. Excess carbon may deposited	To be removed
8. Blocks in the muffler	To be removed
9. Exhaust pipe may be bend	To be replaced

Over cooling	
a) Thermostat may be damaged	To be replaced
b) Not working of temperature gauge	To be replaced

10.4.2 Lubrication System

Sl. No.	Complaint	Causes	Remedy
1.	Oil Leakage	a) Gasket damaged b) Spraying excess	To be replaced Excess oil to be removed through drainage plug
2.	Low Oil	a) Oil level may be low b) Blocks in the oil filter c) Relief valve springs tension may be low d) Oil diluted oil may be thinned e) Oil gauge may be damaged	Fill correct level Replace the filter element Change the defective spring Change correct grade oil To be replaced
3.	Excessive oil con-sumption	a) Damaging of Piston, piston rings, cylinder liner b) Valve seat defective c) Damaging of Valve stem d) Oil leakage e) Excess Oil level f) Using low viscosity oil	To be replaced To be replaced To be replaced To be change the gasket Maintain the oil level Use correct viscosity oil
4.	High oil pressure	a) Blocks in oil pipe b) Damaged the pressure parts c) High viscosity oil	To be removed the blocks pipe to be reload or clear To be change / rectify Use correct viscosity oil

10.4.3 PETROL ENGINE

Indicating and warning of rectification of engine parts

1. Speedo meter needle always shows zero

Causes	Remedies
1. Speedo meter spindle shafts does not connected	To be repaired
2. Driving key may be wear or broken	To be changed
3. Driver gear may be wear	To be changed
4. Speedo meter may be repaired	To be changed
5. Speedo meter cable may be broken	To be changed

2. Fuel gauge pointer always shows E

Causes	Remedies
1. The wire of ignition switch to gauge or gauge to tank unit may be disconnected	To be checked and rectified
2. Does not earthing of tank unit	To be earthed
3. The float may be punchered	To be changed
4. Gauge may be damaged	To be changed

3. Fuel gauge pointer always shows F

Causes	Remedies
1. Does not earthing of gauge casing	To be proper earthed
2. The tank unit terminal may be earthed	To be insulated
3. Float arm may be checked	To be checked and rectified
4. Gauge may be damaged	To be changed

4. Starter motor rotates but engine not functioning

Causes	Remedies
1. Ignition system may be a problem	System to be checked and repaired
2. Un availability of petrol	Petrol to be filled
3. Pipe line may be blocked	The blocks to be rectified
4. Pump may be a problem	To be repaired
5. Carburettor system may be a problem	To be repaired
6. Engine may be a problem	To be checked and rectified
7. Exhaust system may be blocked	To be checked and rectified

5. Engine does not start

Causes	Remedies
1. Battery may be discharged	Battery to be charged
2. Ignition timing may be changed	To be changed
3. Ignition coil may be problem	To be changed new one
4. Ignition switch may be problem	To be changed new one
5. Disconnection of L .T / H.T wires	Connection to be proper
6. Broken of spark plug	Fixing of new spark plug
7. Excess deposit of carbon	To be cleaned
8. Fuel pump problem	To be checked and rectified
9. Blocking of carburetor parts	Removing the blocks
10. Wearing of piston rings and cylinders	To be changed new one
11. Blocking of exhaust system	Removing the blocks

6. Engine does not run properly

Causes	Remedies
1. Fuel pump may be problem	To be repaired
2. Excess heat of engine	To analysis the reason and rectified
3. The floating level of carburetor may be high	To be rectify the mechanism

7. The Engine Acceleration increases the engine may be stopped

Causes	Remedies
1. Ignition system may be problem	To be check all the system parts and rectified
2. Compression may be improper	To be check and rectified
3. Carburettor throat may be wear	To be check and rectified
4. Clutch and transmission problems	To identify and rectify the problem

8. The good condition of the engine speed is how affect the loss of vehicle

Causes	Remedies
1. The slippage of clutch	To be check the reason and rectified
2. Gear box gears and shafts may be wear or damaged	Damaged parts to be changed
3. Propeller shaft may be wear	To be check and rectified
4. Difference's system may be problem	To be check and rectified

9. Accruing of misfire

Causes	Remedies
1. Spark plug not working in any cylinder	Cleaning / replacing of spark plug
2. Valve clearance not properly set	Set proper clearance
3. Damaging of valves	To be changed new one
4. Wearing of cam in cam shaft	To be changed new one
5. Damaging of cylinder head gasket	To be changed new one

10. Excess noise of engine

Causes	Remedies
1. Valve and parts of valve mechanism may be damaged / wear	Damaged parts to be replaced
2 Connecting rod damaged	To be changed new one
3. Crank shaft damaged	To be rectified
4. Piston pin may be loose	To be check and tight
5. Loosening of engine parts	To be check and tight
6. Valve clearance not properly set	Set proper clearance
7. Engine transfer machine system may be not aligned	Set proper alignment

11. Back firing of engine

Causes	Remedies
1. Ignition timing problem	Ignition timing adjusted
2. Air fuel ratio not proper	Air fuel ratio adjusted
3. Excess heat of engine	To analyses the reason and rectify
4. Valves may not sit in valve seat	Properly set the valve
5. Broken of distributor cup	To be changed new one

12. Excess white smoke of engine

Causes	Remedies
1. Cylinder head gasket damaged	To be changed new one
2. Cylinder head may be loose	To be check and tight

13. Excess blue smoke of engine

Causes	Remedies
1. Mixing of lubricant oil with petrol is high	To be mix proper ratio
2. Damaging of piston rings	To be changed To be re-bored
3. Wearing of cylinder bore	

14. Excess black smoke of engine

Causes	Remedies
1. Excess petrol in fuel mixer	To control the petrol level
2. Ignition system problem	To be checked and rectified
3. Ignition timing problem	Ignition timing adjusted
4. Wearing of jets in the carburettor	To be rectified
5. Wearing of piston rings	To be changed
6. Excess weight on the vehicle	To remove the excess weight

10.4.4 DIESEL ENGINE

1. Engine starting problem

Causes	Remedies
1. Problem in the starting system	To be check and rectified
2. Starter motor may be damaged	To be check and replaced
3. Level of diesel may be low	Maintaining the level of diesel
4. Blocking in air cleaner	To be cleaned
5. Blocking in diesel filter	To be cleaned
6. Diesel pump may be repaired	To be check and rectified
7. F.I.P may be damaged	To be check and rectified
8. Mixing of lubricating oil water in diesel	Lubricating oil water to be separated

2. High consumption of fuel

Causes	Remedies
1. Leakage may be in the fuel system	Leakage to be arrested
2. Blocking in the air cleaner	To be cleaned
3. Valve clearance is not proper	Set proper alignment
4. Compression may be low in the engine	Engine to be over hauled

10.4.5 FUEL SYSTEMS

1. High consumption of fuel

Causes	Remedies
1. Blocks in the air cleaner	To be cleaned
2. Leakage in the fuel system	Leakage to be arrested
3. Driver unnecessarily pressing of accelerator pedal	To avoid pressing of accelerator pedal
4. Excess fuel supply of carburettor	To cut the excess fuel supply
5. Excess size of jets	To be changed
6. Wearing of needle works	To be changed

2. Engine starting of difficulties

Causes	Remedies
1. Blocks in the carburettor jets	To be cleaned by pressurized air
2. Chock valve not closed properly	To be properly closed
3. Blocks in the fuel filter	To be cleaned
4. Fuel pump pressure may be low	To check the pressure and rectify

3. Idling is very low

Causes	Remedies
1. Idling adjustment is very low	Properly adjusted
2. Float adjustment is not proper	Properly adjusted
3. Carburettor is not fixing proper	Properly fixed
4. Loosing of carburettor jets	To be tight
5. Blocks in the air cleaner	To be cleaned

4. Low engine break power

Causes	Remedies
1. Developing lean mixture in carburettor	To be tune up
2. Blocks in the jets	To be cleaned by pressurized air
3. Gasket damaged	To be changed
4. Blocks in the fuel filter	To be cleaned
5. Pumps problem	To be check and rectify

5. Problems during engine operation

Causes	Remedies
1. Blocks in the fuel filter	To be cleaned
2. Pumps problem	To be check and rectify
3. Accelerator's pump is not properly adjusted	Adjusted properly
4. Puncher of pump diaphragm	To be change the diaphragm

10.5 ENGINE TUNE UP

It is a process of inspecting, servicing and replacing the important components of engines like carburettor, spark plug, timing gears, fan belt etc. based on their condition. This will help to improve the performance and reduce the maintenance cost.

10.5.1 ENGINE TUNING PROCEDURE

1. Start the engine with loose condition of spark plug and remove the carbon powder and moisture. Then switch of the engine and remove the spark plug.
2. Checking of engine compression ratio
3. If engine's compression ratio is low then engine is over hauled and rectify the problems. After rectification of compression ratio, spark plug to be fixed.
4. To remove and cleaning of distributor cap. Then check the wearing of cap and wire. If wearing is more then change the new one.
5. To check the distributor's rotor condition. If damaged, change the new one.
6. To check the H.T. wires of distributor. If any damage in that wire, should be replaced.
7. To check the main mechanism of distributor.
8. To check the vacuum mechanism.
9. To check and cleaned the C.B. points, then set the proper gap. If C.B. point damaged then it should be replaced.
10. Again fix the distributor gap and connect the wires properly.
11. To check the battery and maintain the distilled water level.
12. To check the battery wires and rectify the problems.
13. To check the dynamo / alternator when battery is low power.
14. To check the engine belt conditions. If damaged change the fan belt.
15. To check the engine valve clearance and set properly.
16. To tight the inlet manifold's bolts when leakages occurs.
17. To check the leakages, tightness and straightness of fuel pipe lines.
18. To check the leakages in the cooling system and hose pipes. If coolant level is low then maintain the level
19. To check the accelerator connection of and adjust the connection.
20. To check the crankcase ventilation system.
21. To check the quality of engine lubrication oil and if required, change the lubrication oil.
22. To remove and cleaned the carburetor and air cleaner. If required change the air cleaner and to check the chock valves.
23. To check the ignition timings and if required set properly.
24. To check the carburettor's idle speed adjusting screw and if required adjust the same.
25. To check the light and horn. Head light to be adjusted properly.
26. To check the steering system's smoothness and freeness. If required rectify the system.
27. To check the wear, excess movement and tightness of suspension system and shock absorber system.

28. To check the wear and tightness of front wheel, ball joints and bearings.
29. To check the lubricated parts and lubricate the same.
30. The same way the starting motor, ignition coil, condenser, tyre pressure and condition of break and etc., to be check.

Student Activity

1. Students should visit the transport office to learn the procedure involved in getting a vehicle license and getting a Fitness Certificate (FC) for a vehicle.
2. Students should learn the vehicle maintenance and inspection procedure.

Glossary

Parameter	-	வரையறைக்குட்பட்ட வினியோகம்
Distribution	-	வினியோகம்
Ignition	-	எரிதல்
Physician	-	மருத்துவர்
Fire Extinguisher	-	தீ அணைப்பான்
Emergency	-	அவசரம்
Philosophy	-	தத்துவம்
Production	-	உற்பத்தி
Viscosity	-	பிசுபிசுப்பு
Gasket	-	கசிவு நீக்கி

References

1. Rajput R.K. Internal Combustion Engines, Laxmi Publications (P) Ltd, 2006.
2. Ganesan V. Internal Combustion Engines, Third Edition, Tata McGraw - Hill , 2007.

Webliography

1. http://www.austin7.org/Technical%20Advice/Minor%20Engine%20Faults/
2. https://www.johnhughes.com.au/2012/03/12/common-car-troubles-their-causes-and-solutions/
3. http://www.karacare.co.uk/starting.html
4. http://www.old-engine.com/enginetroubles.htm
5. https://auto.howstuffworks.com/engine3.htm
6. https://www.micksgarage.com/blog/common-fuel-systemfuel-related-problems-fix/

SAMPLE QUESTIONS

Choose the correct answer:

1) What is the name of the book? Which consists of all vehicle types of vehicle management?

   a) Vehicle
   b) R.C. Book
   c) Trip sheet Book

2) Which sheet is give all details of the vehicle from the start to end of the trip?

   a) Maintenance sheet
   b) Trip sheet
   c) Record sheet

3) How many types of vehicle maintenance system followed?
   a) 2
   b) 3
   c) 4

4) What is the reason for engine over heating?

   a) low level water in the radiator
   b) low level of fuel
   c) carburetor not functioning in well

5) What is the procedure for engine running in good condition? While change the worn parts of the engine?

   a) engine tune-up
   b) engine checkup
   c) vehicle inspection

TNYQIQ

Answer the following questions:

1) What are the types of inspection methods followed in vehicle maintenance?

2) What are the types of inspection maintenance? Explain any one type.

3) Explain how the vehicle maintenance record are maintained?

4) Show with neat tabular column how the vehicle road test report prepared.

5) What is meant by trip sheet?

6) Explain vehicle log book.

7) Give short notes above vehicle service form.

8) Write short note above vehicle report form.

9) Write short notes about vehicle accident.

10) Give short notes ab.

Case Studies - Sankar

Name	:	**Sankar S/o Anbazhagan 2-15-7 Osechou, Hitachi, Japan-3170076**
Father Name	:	**A. Anbazhagan**
Mother Name	:	**A. Alamelu**
Education Qualification	:	**Bachelor of Mechanical Engineer**
Occupation	:	**CAD/CAM Engineer**
Name of Company	:	**Mitsubishi Hitachi Power System, Deputation by R-Tchno Japan.**
Address	:	**1-1 Saiwai-cho, 3-Chome, Hitachi, Ibaraki, Japan - 3178585**
E-mail	:	**anbazhagansankar@mhps.com**
Monthly salary	:	**Rs 2,00,000**

Dear Friends,

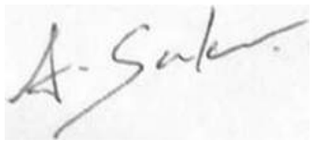
I would like to share my life's changeover by selecting auto mechanic group in my higher secondary school. I was an average student in my primary and secondary school, as I could not decide my higher secondary education course. At that time I met my Teacher, Mr. Sathiamoorthi, sir He advised me to select auto mechanic group. Auto mechanic lessons which have taught by Mr. Sathiamoorthi sir impressed me to learn more and depth and got excellent marks in public examinations.

Again I was guided by Mr. Sathiamoorthy sir, to select the mechanical engineering in my bachelor degree and graduated with first class as a mechanical engineer. After completed my B.E., I worked and developed as an Engineer at a private Auto mobile manufacturing company for three years

Japanese people respect Indians for their individuality especially they recognize Tamil people's intelligence. It is great opportunity to work with Japanese people, where we can learn their dedication on work and advanced technology. At the same time they accept our individual talents and opinions.

The Auto mechanic course guided me to select Mechanical engineering, which changed economic level in my life. That helped me to review my social vision and knowledge even to contribute for social welfare activities. I will seed that Education can make all the changes and improvements in life.

I am eternally grateful from the bottom of my heart to Mr. Sathiamoorthi Sir, for his guidance and support to select Auto mechanic group.



A.Sankar

Case Studies - Barathan

Name	:	**T. Barathan** B.E., M.Tech,
Father's Name	:	**Mr. S. Thirunavukkarasu**
DOB	:	**03 May 1989**
Address	:	**No: 7/3, Durairaj Street, Devaraj Nagar, Saligramam, Chennai-93.**
Working Place	:	**Agni college of Technology (3.36 L/Annum)**
Annual Salary	:	**Rs 3,36,000**

Dear Friends,

I feel greatly elated to write about my fortune **"The General Cariappa Higher Secondary School"**, Saligramam Chennai.

Cariappa School is not just one among the best schools in Chennai, but this School is much more. Trust me! This school will turn your life completely around. I did my vocational course in Automobile Engg. during the year 2004-2006. I was totally surprised to see the professionalism and the enthusiasm of the teachers in molding the students and shaping their future in the better possible way.

Every day during the school anthem I was strongly driven to succeed in life. I still remember the anthem and would love to quote it again.

"This is my school
I am proud of my school
My school is proud of me
I will bring laurels to my school"

One day the drive to make my school proud burst out as tears, when I was declared state rank in my 12th standard public examination. Thanks is always a thanks even if it is belatedly-said.

I take this opportunity to thank my teachers, headmaster, School management, Friends and Family for helping me to reach the heights

After completing my schooling I joined Thanthai Periyar Govt. institute of technology, Vellore for my bachelor's degree in Mechanical Engineering in the year 2006. A special thanks to **MPL FORD CARS PRIVATE LTD**, Chennai for sponsoring my higher studies.

After completion I worked with top MNC'S in different Fields of engineering. The blazing spirit of learning which I acquired from my school made me to pursue my post graduation in Central institute of Plastics Engineering and Technology, Chennai. I was lucky to get a placement on campus drive at CIPET at a manufacturing company.

Even though I worked with Different companies at various positions I felt something was empty in my life. To truly salute my teachers I took the teaching profession leaving all my other opportunities.

(**Barathan.T**)

Case Studies - Sivasubramanian

Dr. M.Sivasubramanian, M.E., Ph.D,
Associate Professor and Head
Department of Automobile Engineering
Kalasalingam Academy of Research and Education

I, Dr. M. Sivasubramanian, pursued my higher secondary vocational course "Auto Mechanic" during the year 1993 to 1995 at T.V.S. Higher Secondary School in Madurai.

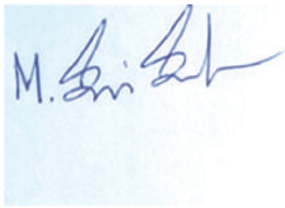
I have been fortunate to have Mr. R.S.Muralidharan as my Auto Mechanic teacher at TVS Hr. Sec. School, Madurai. He encouraged the hidden talent and delivered the quality education in the Automobile domain with the mission of spreading knowledge to the students with the learning disabilities was commendable .

This domain knowledge gained in the automobile field through this course enabled me to get an opportunity to pursue my Bachelor's degree in Mechanical Engineering in 1999. Further I have completed Master's degree in Production Engineering in 2005. My interest in automobile fields induced me to carryover my research work in Experimental heat transfer enhancement and Computational Fluid Dynamics and I was awarded with Ph.D degree in Faculty of Mechanical Engineering in the year 2015.

During my research career, published 11 international journals and attended many International Conferences. With the interest and knowledge in automobile field helped me for inventing many things related to automobile and mechanical engineering and as an outcome of this I have registered 19 patents in India. One of the inventions is '**Eco friendly hybrid electric car with self electrical charging'** received a fund of 1lakh rupees from Innovation and Entrepreneurship Development Centre, National Science & Technology Entrepreneurship Development Board (NSTEDB) Department of Science & Technology, Govt. of India.

This Vocational education program "Auto Mechanic" made a real difference in my life. This course created a spark for research, build self-confidence and leadership skills by allowing me to expose my intra personal unique qualities and talents. I believe this course revealed a proper tactic in my life and I hope this will help me in my future endowers also. I take this as a

golden opportunity to motivate the young budding innovators, technocrats and many more who elects this vocational education course I can say as their career tool to shape their future. I wish that, youth prerequisites to be endowed and it can be done through virtuous vocational education and training.



Dr. M. SIVASUBRAMANIAN
Associate Professor and Head,
Department of Automobile Engineering,
Kalasalingam University,
Anand Nagar, Krishnankoil - 626 126.

Case Studies - Jayappriyan

Mr. R.M. Jayappriyan, M.E.,
Junior Research Fellow
Department of Printing Technology,
College of Engineering Guindy, Anna University.

I, R.M. Jayappriyan, aspired to become an Engineer following the footsteps of my father. I enrolled myself in Vocational stream after my secondary education to fulfil my Engineering dream. To narrow down my Engineering dream I made myself in "Auto Mechanic" course during the year 2007 to 2009 at Neelambal Subramaniam Higher Secondary School, Salem. I had great exposure to theoretically and practical in this course. I was able to perform well in my studies with guidance of my teachers and I made a good score in the Public Examination which helped me in getting into a reputed Engineering college. I got State First in Auto Mechanic Subject during the year 2009. I completed my Bachelor's Degree in the discipline Production Engineering from Government College of Technology, Coimbatore during the year 2009 - 2013. After my Graduation, I did my Post-Graduation in Packaging Technology at Anna University, Chennai. I excelled as a Topper of the batch and awarded 1st rank holder and Gold Medallist for the period 2013 - 2015.

I started my Career as Production and Maintenance Engineer in a Label Manufacturing Company, where I used all my knowledge that I got from my Plus Two to Post Graduation. I loved playing the role of Maintenance Engineer in which I had more challenging and great learning environment. Then I found myself to be more interested in learning new things day by day which made to join as Junior Research Fellow at Anna University. I became a Researcher in the department where I studied my Post-Graduation.

I was appointed as Junior Research Fellow for a Project that is supported by the Ministry of Science, Government of India. As a part of the research work,I have presented three national conference and published a paper in a National Journal.

I still remember that I stood Unique in my under Graduate because of my skills in Automobile. At request of my classmates, I took them a class on "Transmission System" of an Automobile Vehicle for an hour. The knowledge with I acquired from the vocational course makes me Technically Sound. The course really impacting knowledge to the Students to the level of Diploma Education. I take the privilege to say that vocational Education system provides a right guidance and a right route to become Engineers, Entrepreneurs, Scientist and many other Professionals. I wish all the Vocational Students to attain great height of Success in their lives.

Jayappriyan R M

Model Question Paper

Marks -Allocation
Auto Mechanic 1st Year – Vocational Theory

Total Marks - 90

Internal Assessment Mark - 10

Total Mark - 100

Part – A	Choose the Best Answer	1 × 15 = 15 marks
Part – B	Answers the Following Ten Question	3 × 10 = 30 marks
Part – C	Answer the Following 5 Question	5 × 5 = 25 marks
Part – D	Answer the following 2 Questions	2 × 10 = 20 marks

Total	90 marks
Internal Assessment	10 marks
Total	100 marks

Auto Mechanic 1st Year – Vocational Theory
Model Question Paper
Total Marks: 90

Part – A

Choose the correct Answer

Answer all the Questions ***15 × 1 = 15***

1. What is the abbreviation of ABS ?
   a) Anti Log braking system
   b) Anti Brake System
   c) Air Brake System
2. Which principle is used in the hydraulic Jack?
   a) Pascal Law
   b) Newton Law
   c) Lever Principle
3. Honing Machine is used to
   a) To drill the cylinder
   b) To enlarge the hole in cylinder
   c) To finish the cylinder bore accurately
4. What type of liquid fuel used in Automobile Engine
   a) Mineral Oil
   b) Vegetable Oil
   c) Animal Oil
5. Crank throw is
   a) The distance between TDC & BDC
   b) Half of the stroke length
   c) Double time of the Stroke Length
6. Which material is used for manufacturing cylinder block?
   a) Gray cast iron or aluminum alloy
   b) Cast iron or steel
   c) Brass or steel
7. Connecting Rod is used to
   a) To connect Crank shaft and cylinder head
   b) To connect crank shaft and piston
   c) To connect crank shaft and cylinder block
8. Which is used to prevent leakage between cylindet and cylinder head
   a) Gasket
   b) Oil seal
   c) Dust cover

9. Which liner is directly contact with cooling water
   a) Dry linner
   b) Wet liner
   c) None
10. Which is used to open the value in Engine?
   a) Crank shaft
   b) Cam shaft
   c) Fly Wheel
11. Which Chemical is used to prevent freezing of cooling water?
   a) Ethyl glyed
   b) Acetone
   c) Methane
12. Which Value is located in Radiator Pressure cap?
   a) Pressure valve
   b) Thermostat valve
   c) Pressure and vacuum valve
13. In Internal combustion Engines how many types of fuel supply system.
   a) Two
   b) Three
   c) Four
14. How many types of Air entering system in a carburetor
   a) Two
   b) Three
   c) Four
15. what is the Reason for engine overheating
   a) Low level water in the radiator
   b) Low level of fuel
   c) Carburetor not function well

Part – B

Answer any ten questions ***3 × 10 = 30***
Note : Question No 25 is Compelsury

16. Define Safety Precaution
17. Define First–Aid?
18. What are the Simple hand tools?
19. What are the types of hammers?
20. What is meant by volt meter?
21. Define fuels.

22. Who is invented petrol Engine?
23. What is meant by muffler?
24. What is meant by Thermostat valve?
25. What is meant by S.A.E?
26. What is meant by volatility?
27. What is meant by Trip – Sheet?

Part – C

Answer the Any Five questions ***5 × 5 = 25***

Note : Question No 30 is Compulsory

28. Explain any five safety precautions on the tools.
29. Mention any Five Sizes of Box spanner.
30. Write any five properties of petrol.
31. Mention any five types of Ring Spanners.
32. State any five method to control the expansion of piston due to overheat.
33. Name the types of Radiator.
34. What is meant by M.P.F.I and name the types?

Part – D

Answer all Questions ***2 × 2 = 20***

35. Explain about R.P.M Gauge?

    (or)

    Describe History of Automobile.

36. Draw a neat sketch of overhead puppet valve mechanism and Explain the same.

    (or)

    What is common Rail Diesel injection System and Explain.

References

Unit – 1 Industrial Safety

1. Accident Prevention Manual for Industrial Operations", N.S.C.Chicago, 1982.
2. Blake R.B., "Industrial Safety" Prentice Hall, Inc., New Jersey, 1973.
3. Dan Petersen, "Techniques of Safety Management", McGraw - Hill Company, Tokyo, 1981.
4. Heinrich H.W. "Industrial Accident Prevention" McGraw-Hill Company, New York, 1980.
5. John Ridley, "Safety at Work", Butterworth and Co., London, 1983.
6. Lees, F.P., "Loss Prevention in Process Industries" Butterworth publications, London, 2nd edition, 1990.
7. Relevant Indian Standards and Specifications, BIS, New Delhi.
8. "Safety and Good House Keeping", N.P.C., New Delhi, 1985.

Unit – 2 Tools and Measuring Instruments

1. Jain R.K., "Engineering Metrology", Khanna Publishers, 2005.
2. Alan S. Morris, "The Essence of Measurement", Prentice Hall of India, 1997.
3. Gupta S.C, "Engineering Metrology", Dhanpat rai Publications, 2005.
4. Jayal A.K, "Instrumentation and Mechanical Measurements", Galgotia Publications 2000.
5. Beckwith, Marangoni, Lienhard, "Mechanical Measurements", Pearson Education, 2006.
6. Donald Deckman,"Industrial Instrumentation", Wiley Eastern, 1985.

Unit – 3 Fuels and its Types

1. Rajput R.K. Internal Combustion Engines, Laxmi Publications (P) Ltd, 2002.
2. Rai G.D., "Non-conventional energy sources", Khanna publishes, 1993.
3. Khandelwal K.C., Mahdi S.S., "Biogas Technology - A Practical Handbook", Tata McGraw Hill, 1986.
4. David Boyles, "Bio Energy Technology Thermodynamics and costs", Ellis Hoknood Chichester, 1984.
5. Mahaeswari R.C., "Bio Energy for Rural Energisation", Concepts Publication,1997.

Unit – 4 Automobile History

1. Kirpal Singh, "Automobile Engineering Vol 1 & 2", Standard Publishers, Seventh Edition, 1997, New Delhi.
2. Jain, K.K., and Asthana. R.B, "Automobile Engineering" Tata McGraw Hill Publishers, New Delhi, 2002.
3. Joseph Heitner, "Automotive Mechanics", Second Edition, East-West Press, 1999.
4. Newton,Steedand Garet, "Motor Vehicles", Butterworth Publishers,1989.

Unit – 5 Engine

1. Kirpal Singh, "Automobile Engineering Vol 1 & 2", Standard Publishers, Seventh Edition, 1997, New Delhi.
2. Jain, K.K., and Asthana. R.B, "Automobile Engineering" Tata McGraw Hill Publishers, New Delhi, 2002.
3. Ganesan V. Internal Combustion Engines, Third Edition, Tata McGraw - Hill, 2007.
4. B.P. Pundir, I.C. engine combustion and emissions. Narosa Publishing House, July 2010.
5. Rajput R.K. Internal Combustion Engines, Laxmi Publications (P) Ltd, 2006.
6. Ramalingam, K.K., Internal Combustion Engines, SciTech Publications (India) Pvt. Ltd., 2004.

Unit – 6 Intake, Exhaust System and Combustion Chambers)

1. Rajput R.K. Internal Combustion Engines, Laxmi Publications (P) Ltd, 2006.
2. Ganesan V. Internal Combustion Engines, Third Edition, Tata McGraw - Hill, 2007.
3. B. P. Pundir, "IC Engines Combustion and Emission" Narosa publishing house, 2010.
4. Crouse William, Automotive Emission Control, Gregg Division /McGraw - Hill, 1980.
5. Mathur, M.L., and Sharma, R.P., A Course in Internal Combustion Engines, Dhanpat Rai Publications Pvt. New Delhi-2, 1993.

Unit – 7 Cooling System

1. Rajput R.K. Internal Combustion Engines, Laxmi Publications (P) Ltd, 2006.
2. Ganesan V. Internal Combustion Engines, Third Edition, Tata McGraw - Hill, 2007.
3. Duffy Smith, Auto Fuel Systems, Good Heart Wilcox Company Inc., Publishers, 1987.
4. Eric Chowanietz, Automobile Electronics, SAE International, 1995.
5. Internal Combustion Engine Handbook: Basics, Components, Systems and Perpectives, Richard Van Basshuysen and Fred Schafer (Editors) SAE International USA and Siemes VDO Automotive, Germany, 2002.

Unit – 8 Lubrication System

1. Rajput R.K. Internal Combustion Engines, Laxmi Publications (P) Ltd, 2006.
2. Ganesan V. Internal Combustion Engines, Third Edition, Tata McGraw - Hill, 2007.
3. Duffy Smith, Auto Fuel Systems, Good Heart Wilcox Company Inc., Publishers, 1987.
4. Eric Chowanietz, Automobile Electronics, SAE International, 1995.
5. Internal Combustion Engine Handbook: Basics, Components, Systems and Perpectives, Richard Van Basshuysen and Fred Schafer (Editors) SAE International USA and Siemes VDO Automotive, Germany, 2002.

Unit – 9 Fuel Supply System

1. Ganesan V. Internal Combustion Engines, Third Edition, Tata McGraw - Hill, 2007.
2. Mathur, M.L., and Sharma, R.P., A Course in Internal Combustion Engines, Dhanpat Rai Publications Pvt. New Delhi - 2, 1993.
3. Heinz Heisler, Advanced Engine Techology, Butterworth Heinmann Publishers, Second Edition, 2002.

Unit – 10 Engine Faults and Remedies

1. Rajput R.K. Internal Combustion Engines, Laxmi Publications (P) Ltd, 2006.
2. Ganesan V. Internal Combustion Engines, Third Edition, Tata McGraw - Hill, 2007.

Common Glossary

கலைச் சொற்கள்

வ. எண்	ஆங்கிலம்	தமிழ்
1	Engine	விசைப்பொறி
2	Cylinder	உருளை
3	Cylinder Block	கலன் கூறு
4	Cylinder Head	கலன் தலை
5	Crank Shaft	மாற்று அச்சுத் தண்டு/வளைவச்சுத் தண்டு
6	Cam Shaft	நெம்புருள் தண்டு
7	Fly Wheel	விசையாள் சில்லு
8	Vibration Damper	அதிர்வு தாங்கி
9	Dash Board	முகப்புப் பெட்டி
10	Delivery Pipe	விடு குழாய்
11	Exhaust Manifold	வெளியேற்று பன் மடிமம்
12	Inlet Manifold	உள்ளிழு பன் மடிமம்
13	Governor	செயல் கட்டுப்பாட்டுக் கருவி
14	Indicator	சுட்டிக்காட்டி
15	Idle Speed	நிலையியக்க வேகம்
16	Ignition Circuit	தீ மூட்டுச் சுற்று
17	Ignition Switch	தீ மூட்டு திறப்பான்
18	In Line Engine	கலன்கள் நேர்வரிசையாக உள்ள விசைப் பொறி
19	Catalytic Converter	வினையூக்கி மாற்றி
20	Ignition	பற்றி எரிதல்
21	Nozzle	தெளி மூக்கு/நுனிக்குழாய்
22	Piston	ஆடுதண்டு
23	Pressure Valve	அழுத்த திறப்பான்
24	Radiator	வெப்ப குறைப்பான்
25	Spark Plug	தீப்பொறிச் செருகி (or) தீப்பொறி கட்டை
26	ABS	விட்டு பிடிக்கும் நிறுத்தி
27	EFI	மின்னணு எரிபொருள் உட்செலுத்தமைப்பு
28	MPFI	பன்முனை எரிபொருள் உட்செலுத்தமைப்பு
29	Throttle Body	நெரிப்பகம்
30	Throttle Body Fuel Injector	நெரிப்பக எரி பொருள் தெளிப்பான்
31	Throttle Position Sensor	நெரிநிலை உணரி
32	Throttle Plate	நெரி தகடு
33	Turbo Charger	சுழல் ஊட்டி
34	Belt Drive	வார் இயக்கி
35	Carburetor	கலவை கருவி
36	Connecting Rod	இணைப்புத்தண்டு

BASIC AUTOMOBILE ENGINEERING

Practical

CONTENTS

EXERCISE

1

VERNIER CALIPER

EXERCISE 1

Aim

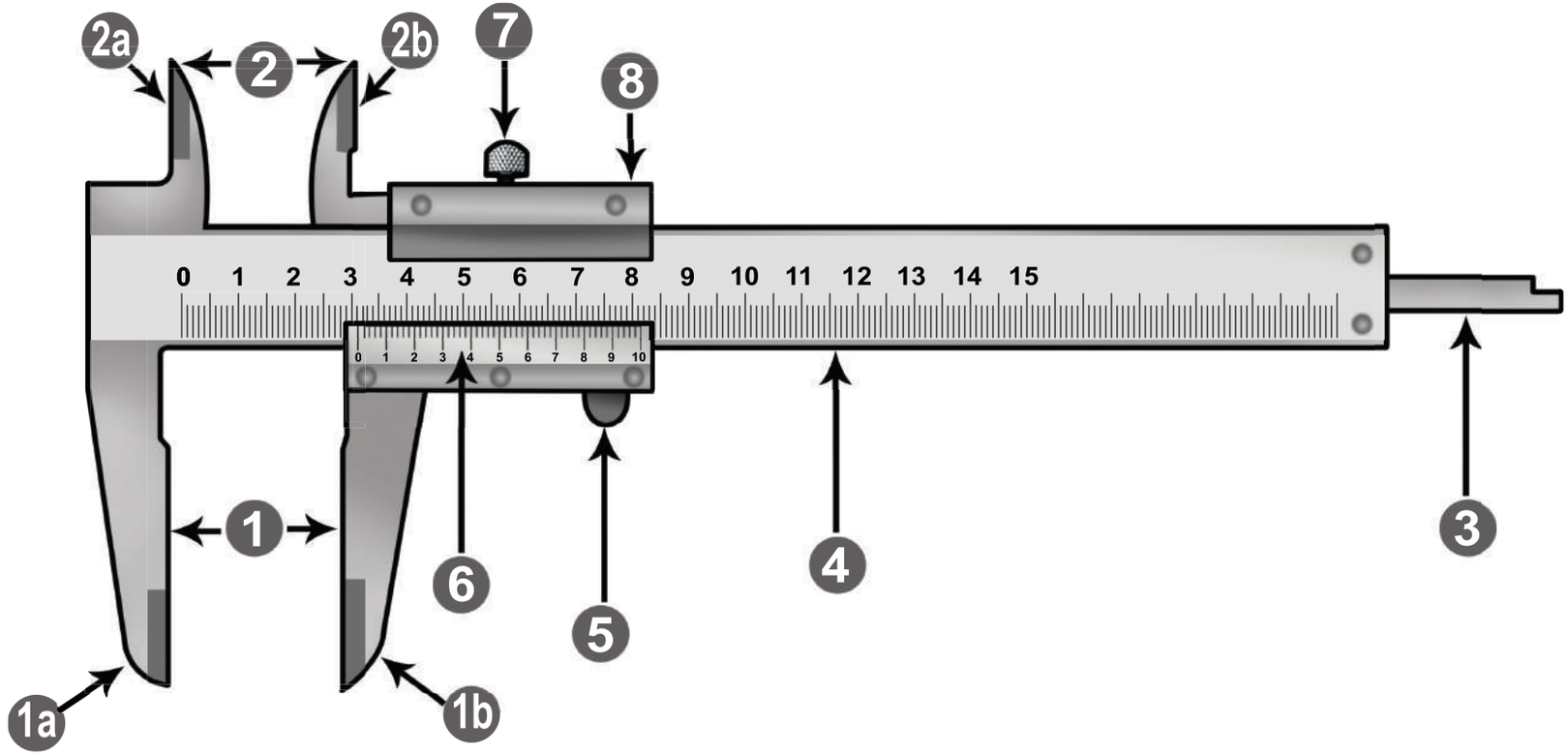
To find the outside diameter, inside diameter and depth of a given object accurately by using vernier caliper.

Equipments Required

Vernier caliper

Parts

- Beam
- Fixed jaw for External Measurement
- Fixed jaw for Internal Measurement
- Movable jaw for External Measurement
- Movable jaw for Internal Measurement
- Main Scale
- Blade for depth measurement
- Adjusting finger grip
- Locking screw



1.Lower Jaws
2.Upper Jaws
3.Depth Probe
6.Vernier
1a.Lower Fixed Jaw
2a.Upper Fixed Jaw
4.Main Scale
7.Friction Nut
1b.Lower Movable Jaw
2b.Upper Movable Jaw
5.Retainer
8.Slider

Fig 1.Vernier caliper

Beam

Beam is the basic part of the verniercaliper. Main scale is graduated on beam. Each graduation in main scale equals to 1mm. Every tenth graduation line is marked as bold and big.

Fixed jaw for External or Internal measurement

Fixed jaw is located left side top and bottom of the beam. These two jaws are attached with beam. Vernier unit is moving on the backside of the beam.

Movable jaw for External or Internal measurement

Both movable jaws are moving together during measurement. Main scale is graduated in between the movable and fixed jaw.

Vernier scale moves along with movable jaw in right side. By this movement we can able to measure as required. Vernier unit is locked by locking screw after measuring. To give more accurate measurement a fine adjusting screw is also provided.

Least Count

The least measurement that can be measured with an instrument is called least count. The least count is the difference between main scale division and vernier scale division.

Least count = Main scale division – Vernier scale division

Note

Let	Main scale division	= 1mm
	Vernier scale division	= 9 / 10 = 0.9mm
	Then Least count	= 1-0.9
		= 0.1 mm

Material

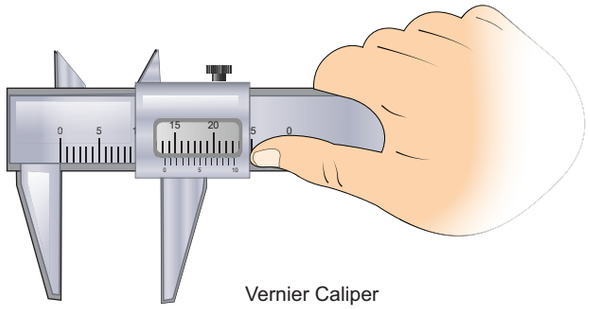
Verniercaliper is manufactured with nickel chromium steel.

Depth bar

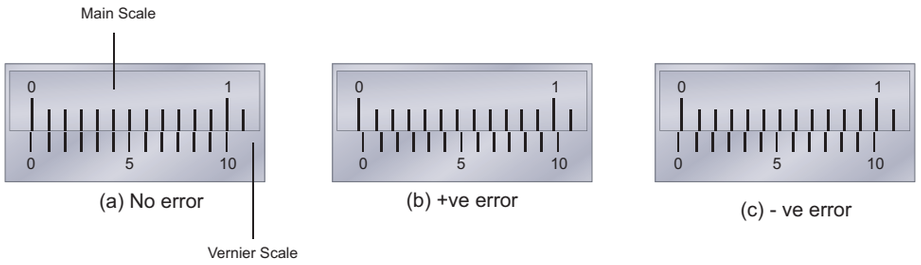
It is located on the backside bottom of the main scale. It is used to measure the depth of an object.

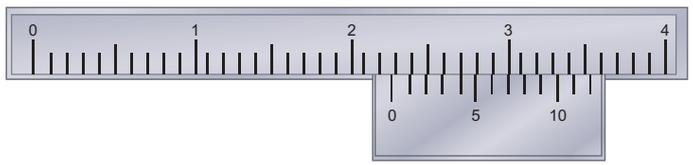
Procedure for Measurement

- Take the measurement in the main scale
- In vernier scale, note down the line which coincides with main scale.
- Now multiply least count with vernier scale measurement. This gives the vernier scale reading.
- Add main scale reading and vernier scale reading. This is the required measurement.



Vernier Caliper





(d) Vernier reading

A model reading
MSR = 2.3 cm ; VSC = 4 divisions;
Reading = [2.3 cm+(4x0.01cm)] = 2.34 cm

Zero error

When both jaws closed together, Zero error occurs when zero on the main scale coincides with the zero on the veriner scale.

Positive error

When both jaws closed together, the vernier scale zero is more than the zero on the main scale.

Negative error

When both jaws closed together, the vernier scale zero is less than the zero on the main scale.

If the error occurs, add or subtract from the measurement appropriately.

a) Outside Diameter

- Fix the given object in between the fixed jaw and movable jaw for external measurements.
- Using the adjusting screw, adjust and lock the locking screw.
- Now take the external measurement of the object.

S.No	Description	Measurement
1	Main Scale Reading (MSR)	––––– mm
2	Vernier scale Reading (VSR)	––––– mm
3	Error (Positive/Negative)	––––– mm
	Final measurement	––––– mm

b) Inside Diameter

- Fix the given object in between the fixed jaw and movable jaw for internal measurement.
- Using fine adjusting screw, adjust and lock the locking screw.
- Now take the internal measurement of the object.

S.No	Description	Measurement
1	Main Scale Reading (MSR)	––––– mm
2	Vernier scale Reading (VSR)	––––– mm
3	Error (Positive/Negative)	––––– mm
	Final measurement	––––– mm

c) Depth

- Take the depth measurement using bar given backside of the main scale in the verniercaliper.
- Adjust the length of bar by moving the movable jaw of a verniercaliper. Adjust and lock the locking screw.
- Now take the depth measurement of the object.

S.No	Description	Measurement
1	Main Scale Reading (MSR)	––––– mm
2	Vernier scale Reading (VSR)	––––– mm
3	Error (Positive/Negative)	––––– mm
	Final measurement	––––– mm

Conclusion

Measurements are taken accurately and tabulated.

EXERCISE 2

MICROMETER

EXERCISE 2

Aim

To find the external diameter of the object accurately by using outside micrometer.

Required Instrument

Micrometer

Parts

- 'U' frame
- Anvil
- Spindle
- Lock nut
- Barrel (or) sleeve
- Major scale
- Minor scale
- Thimble
- Ratchet (or) Ratchet screw
- Knurled grip

Various Sizes of Micrometer

Outside micrometers are available in the following sizes.

1. 0 to 25 mm
2. 25 to50 mm
3. 50 to 75 mm
4. 75 to 100 mm & above

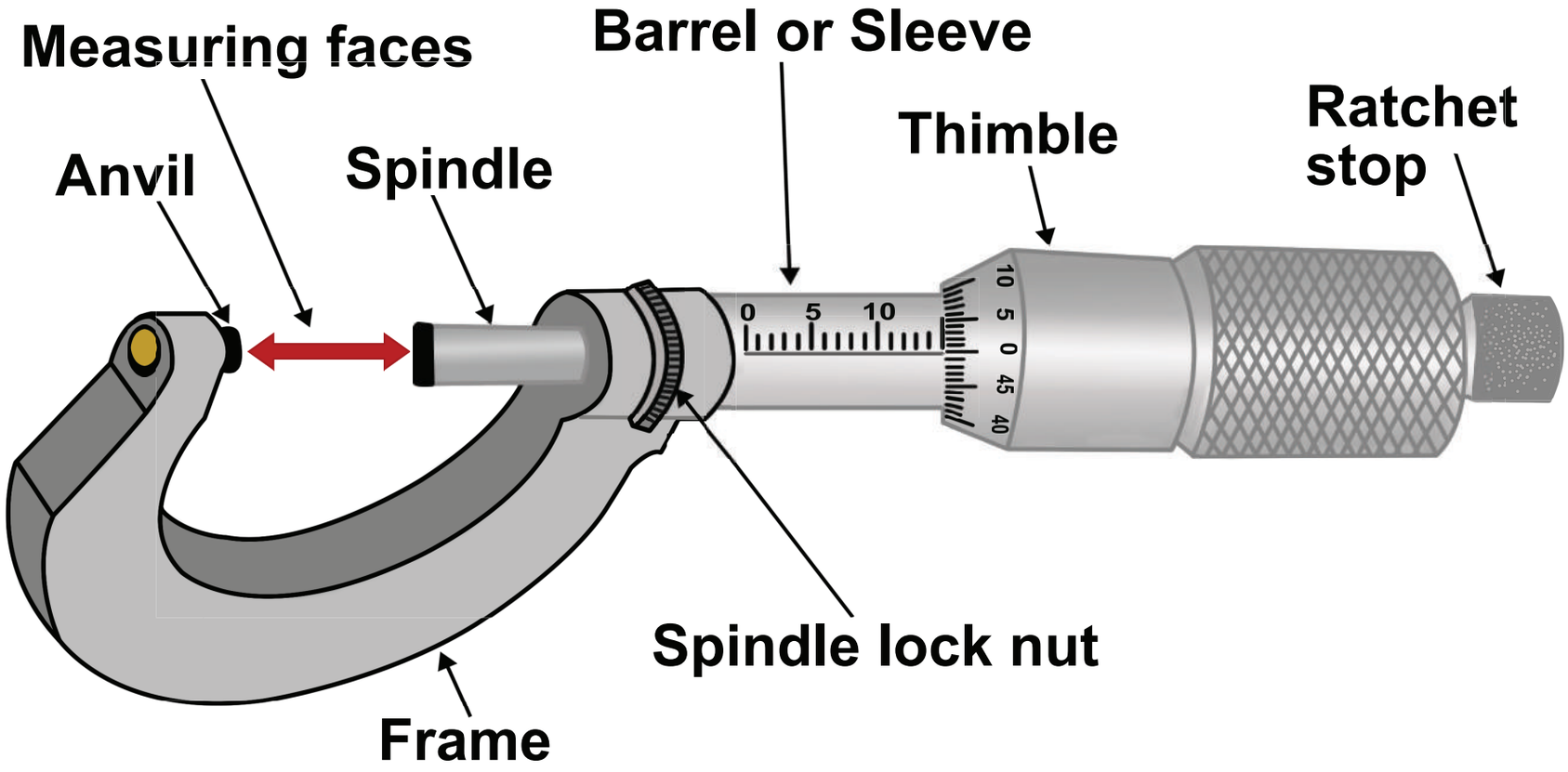


Fig 1. MICROMETER

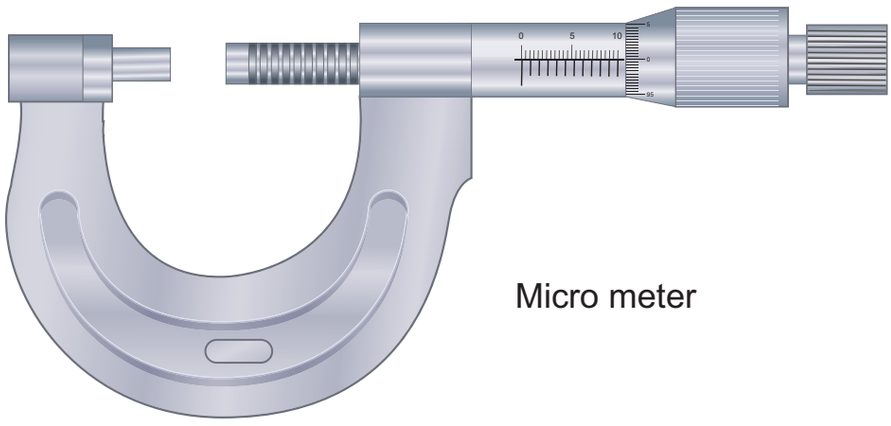
Description

Bolt and Nut principle is used in micrometer. Both the major scale reading and minor scale reading are on the barrel. One division in major scale equals to 1mm and 0.5 mm in minor scale. Major scale is marked above the datum line and minor scale is marked below the datum line. Thimble is divided into 50 equal parts and graduated on circumference. One division of thimble is 0.01 mm.

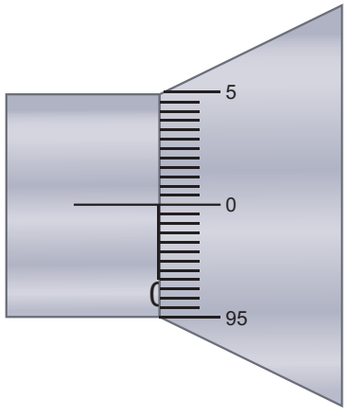
One division on major scale = 1 mm
One division on minor scale = 0.5 mm
One division on Thimble $= \frac{0.5}{50} = 0.01$ mm

Anvil and Spindle ends are fitted with Carbidge tips.

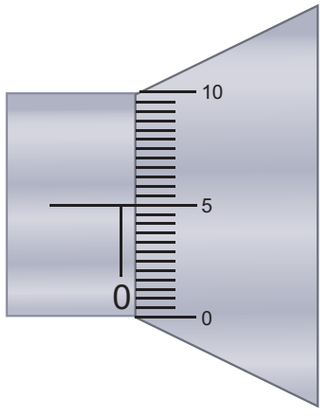
If anvil and spindle are closed together, then thimble and the indexed line should coincide with '0'. When there is no error, this is called as zero error. Before taking the measurements, ensure that there is any error in the micrometer. Positive and Negative errors are adjusted by adding and subtracting with the measurements taken.



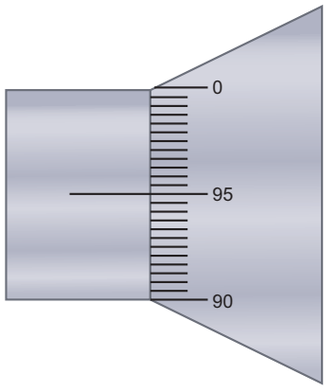
Micro meter



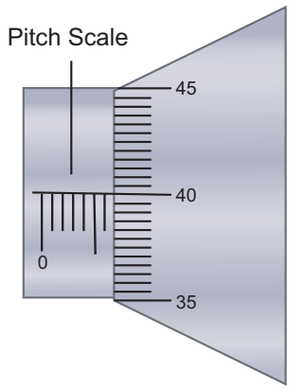
(a) No error



(b) +ve error



(c) - ve error



(d) Micro meter reading ★

★A model reading
PSR = 6 mm ; HSC=40 divsions;
Reading = [6mm+(40x0.01mm)]=6.40mm

Large Micrometer

- We can measure up to 25mm using 0-25 mm micrometer. Suitable size of extended anvil can be attached for measuring larger size.

Measuring Methods

1. Select correct size micrometer
2. Place the measuring object in between anvil and spindle.
3. Tight the thimble using ratchet stop.
4. Note down the main scale division reading.
5. Note down the sub scale division reading.
6. Note down the thimble reading. It is multiplied by least count.
7. Finally add all the measurement.

S.No	Explanation	Reading
1.	Major scale division	––––– mm
2.	Minor scale division	––––– mm
3.	Thimble reading	––––– mm
4.	Error	––––– mm
	Measurement	––––– mm

Conclusion

Outside diameter is measured accurately using micrometer and the measurements are tabulated.

DECARBONISING

EXERCISE 3

EXERCISE 3

Aim

To remove the carbon settled on cylinder block, cylinder head and piston head in the engine block.

Equipment Required

An engine.

Tools Required

1. Double End Spanner set,
2. Wooden Mallet,
3. Screw driver,
4. Scrapper,
5. Drilling machine,
6. Wire brush.

Materials Required

1. Cotton waste,
2. Kerosene,
3. Emery sheet,
4. Fine cloth,
5. Compressed air.

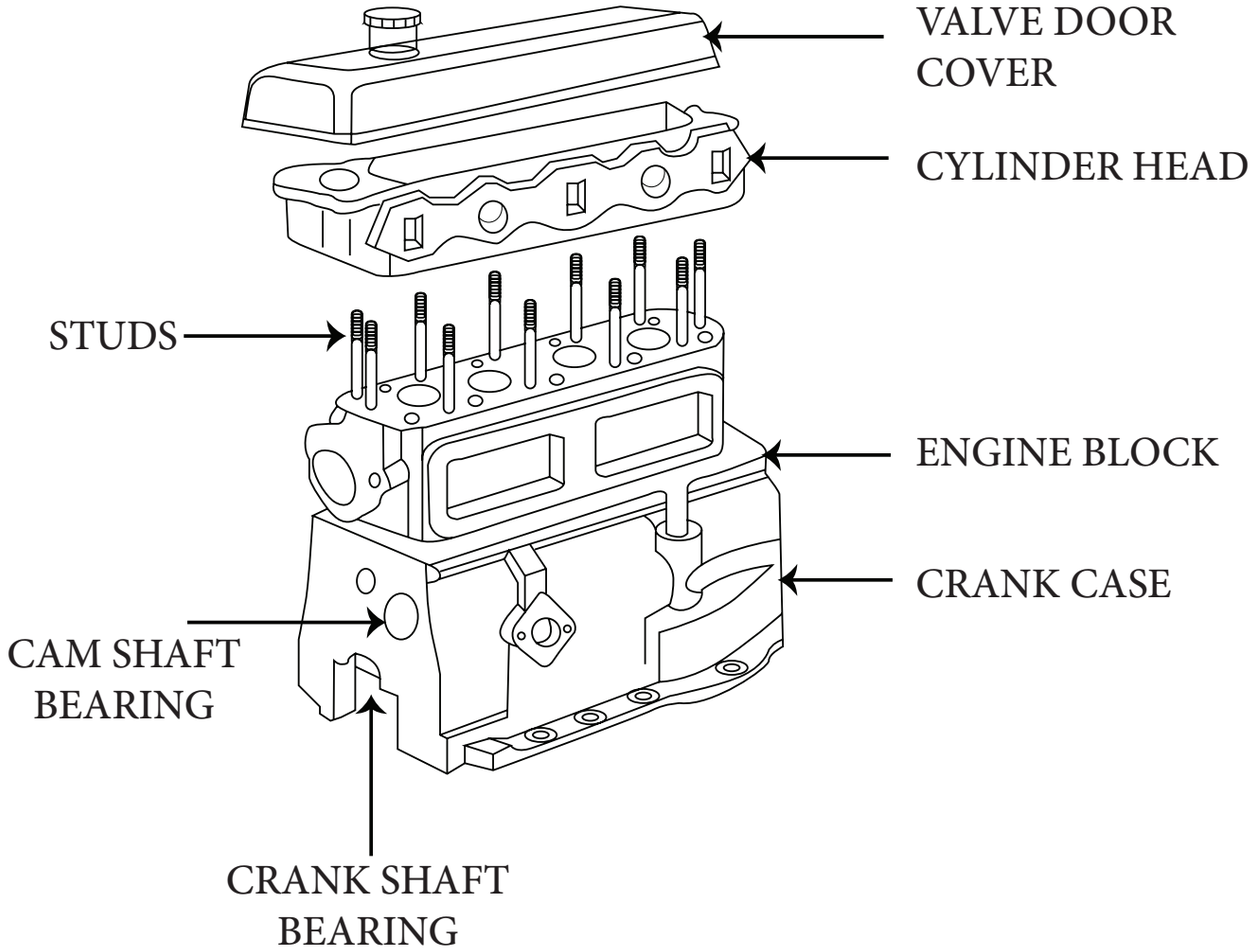


Fig 1. Cylinder block - Line Diagram

Reasons for Decarbonising

1. Black smoke exits through silencer.
2. Pre Ignition
3. More exhaust noise
4. Back firing
5. Due to depreciated piston ring the lubrication oil get burned and settled on the combustion chamber

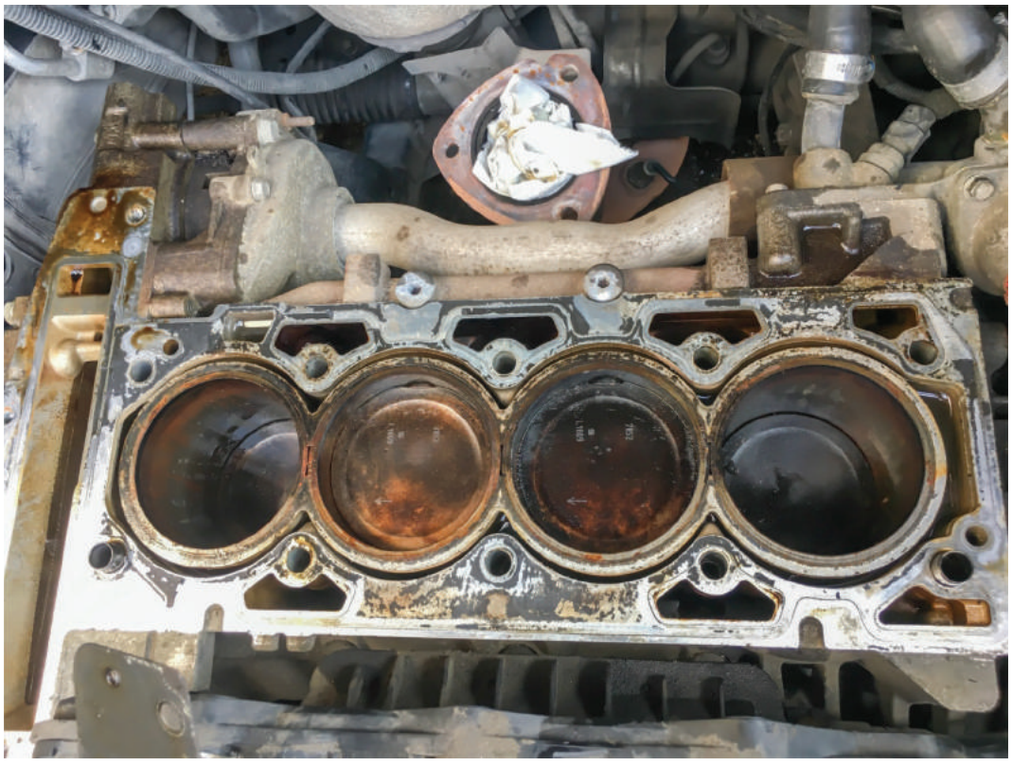


Fig 2. Cylinder block - Before Decorbonising

Procedure for Dismantling

1. The following parts to be removed in order:
   - Fan belt
   - Dynamo
   - Fan
   - Water pump
   - Exhaust manifold
   - Air cleaner
   - Carburettor
   - Inlet manifold
2. Lubrication oil needs to be drained completely, the oil pump and oil gallery tube to be removed.
3. Ignition coil, distributor, petrol pump and oil pump to be removed.
4. After removing the valve door, Tappet Push rod, Rocker arm, Valve spring, Spark plug or diesel injector will also be removed.
5. After all the parts are separated, cylinder head to be removed by wooden mallet and to be kept in a clean place.
6. The Crank Shaft need to be moved to TDC and the carbon particles on the piston head and to be removed by scrapper using clean cloth.

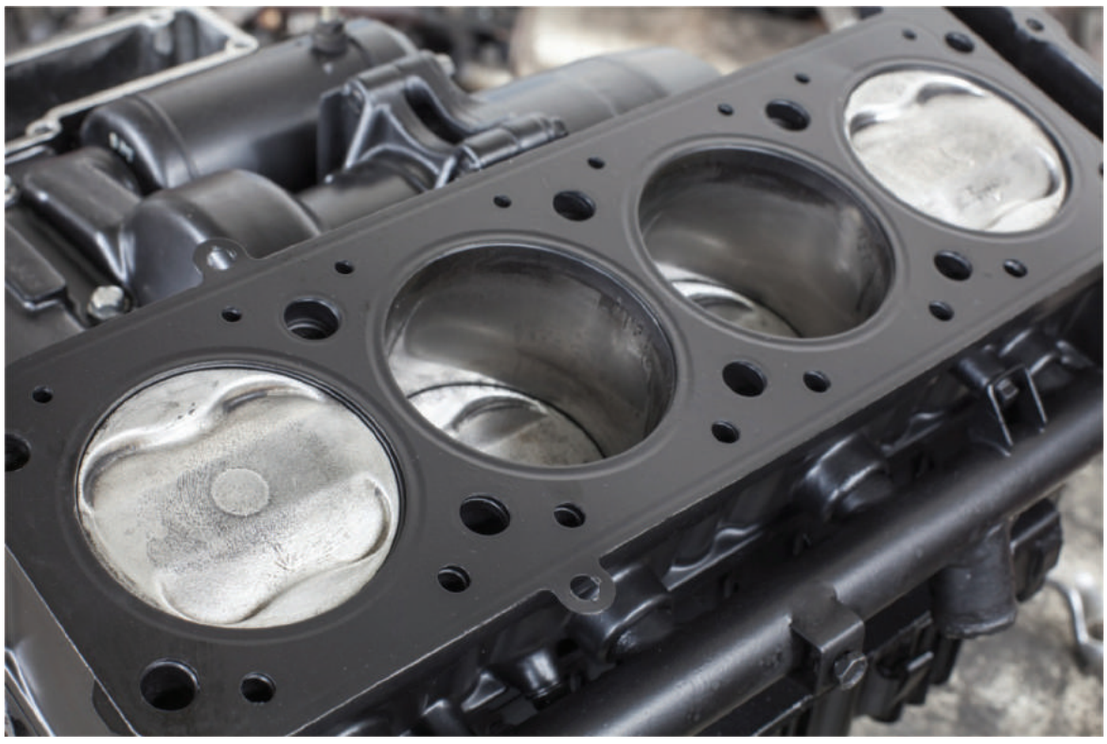


Fig 3. Cylinder block - After Decorbonising

Precaution

When Cleaning one Cylinder piston close all other Cylinder by Cloth, otherwise the carbon particles damage the other cylinder and Piston by the Carbon Particles.

Re – Assembling

After decarbonising process is finished, all the parts are assembled in the reverse manner of the dismantling inorder

Note

During Assembly process use new Gasket for all Joints.

Conclusion

After Completing the decorbornising process all the parts are re – assembled

EXERCISE

4 CARBURETTOR

EXERCISE 3

Aim

To remove the carburettor from a given engine repair service and refix.

Equipment Required

Engine

Tools Required

1. Double ended spanner
2. Screw driver
3. GO- NOGO Gauge
4. Magnifying glass-10x

Materials Requred

1. Soft cloth
2. Sufficient petrol
3. Low pressure air
4. Sprit senor paper
5. Fine brush

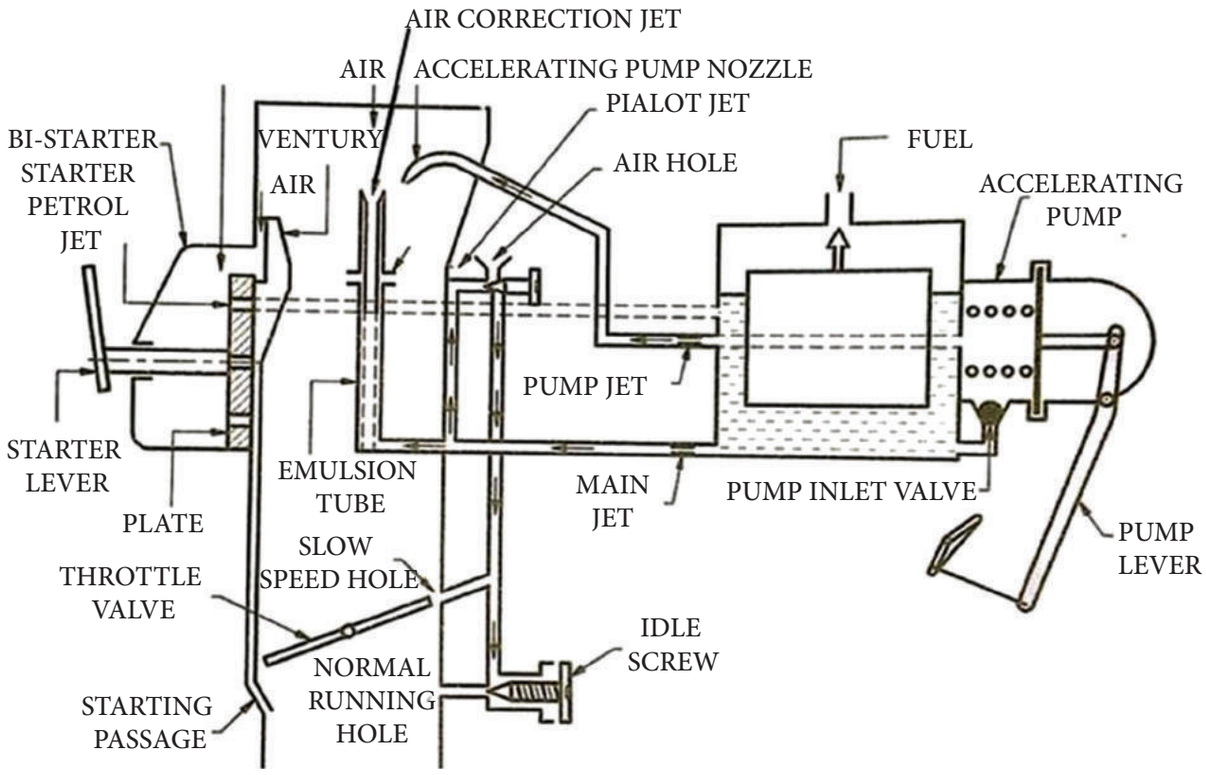


Fig 1. Carburettor - Line Diagram

Fig 2. Carburettor

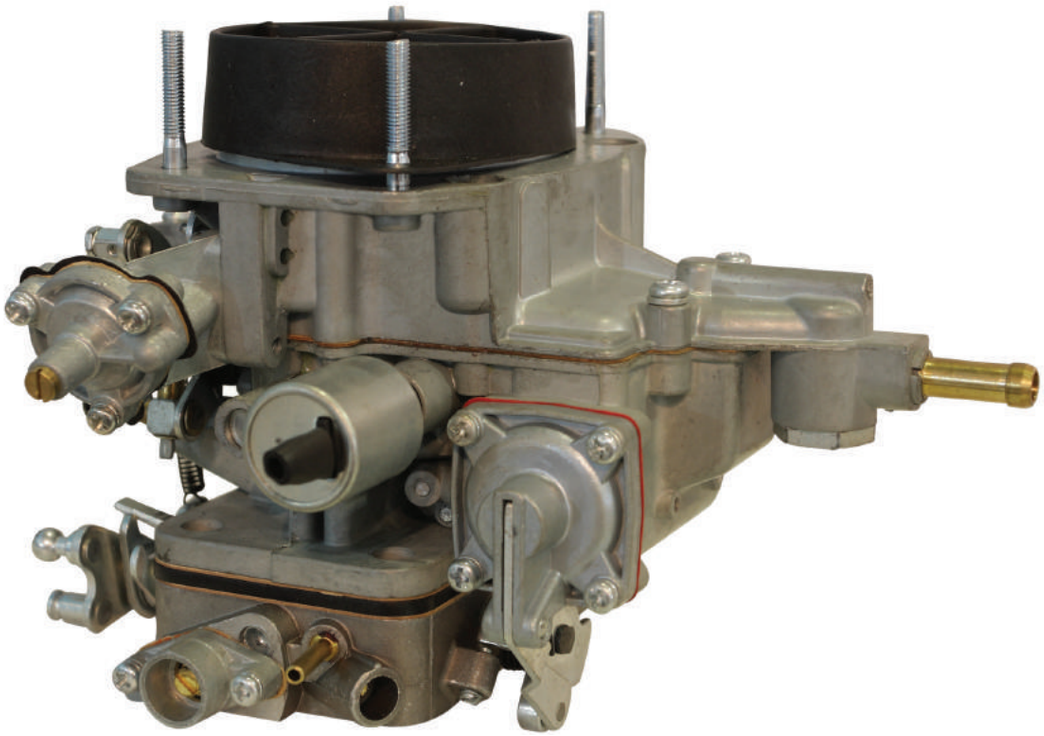


Fig 3. Carburettor

Reasons For Dismantling

1. Air fuel mixture does not come to the engine from the carburettor.
2. Efficiency of the engine is less.
3. KMPL of the engine decreases.
4. Starting trouble due to repair in the Accelerator Pump Circuit.
5. Starting trouble of the engine
6. Sudden halt of the engine while running
7. Time lapse as recommended periodical inspection by the company.

Removal

1. After completing all precautionary steps the carburetor to be removed from the engine.
2. First drain plug need to be removed from the carburetor and the fuel need to becollected in a vessel and to be kept in a safe place
3. Inlet connection need to be removed. Inlet joints to be kept closed using a clip if it is flexible.
4. Air cleaner connection need to be disconnected.
5. Carburettor need to be removed from the Engine Inlet Manifold and to be kept in a highly ventilated room.

Dismantling

1. Remove the Carburettor top lid with a proper tool.
2. Remove the hinge plate pin in the float chamber and place in a tray.
3. Float need to be taken out and cleaned and to be kept in a jar with weight over it and immersed with spirit to see if there is any damage in the float.
4. Float need to be kept in the same position for some time. Place the sprit sensor paper on the circumference of the float for checking the crack.
5. Check and replace the float with new one if there is any damage.
6. Starting circuit need to be removed with proper tools and lever, starting valve, washer to be kept in a tray after removing separately.
7. Distributor passage to be removed with proper tools and its gasket to be removed and to be kept in a tray separately.
8. Take the Main jet out.
9. Remove the valve in the outlet separately.
10. Idling speed adjusting Screw spring to be kept in a tray without damage to its tip.
11. Remove the Pilot jet adjusting screw using proper tools and keep in the tray. Check for any damages without opening the throttle valve.

Servicing

1. Clean all the dismantled parts with petrol.
2. Wipe all the parts with fine cloth.
3. Clean the Small passages with fine brush.
4. Clean all the parts using low pressure air.

Inspection

1. Check the Carburettor for damages with magnifying glass
2. Replace with the new one if there is any crack or damage found
3. Check the Throttle valve for any damage.
4. Check the Main Jet with Go No Go gauge.
5. Check the Idling adjusting Screw with needle. Reject and replace with a new spare if not in good condition.

Re-Assembling

1. Assemble in the reverse process of dismantling in order.
2. While assembling gasket, replace the washer with new spares.

Conclusion

The given carburetor is examined, serviced and fixed in the engine.

EXERCISE

5

OIL PUMP

EXERCISE 5

Aim

To remove the oil pump from the given engine and reassemble the same after checking and servicing.

Equipments Required

An Engine (any type)

Tools Required

1. Double End spanner set
2. Feeler gauge
3. Screw driver
4. Ring spanner set

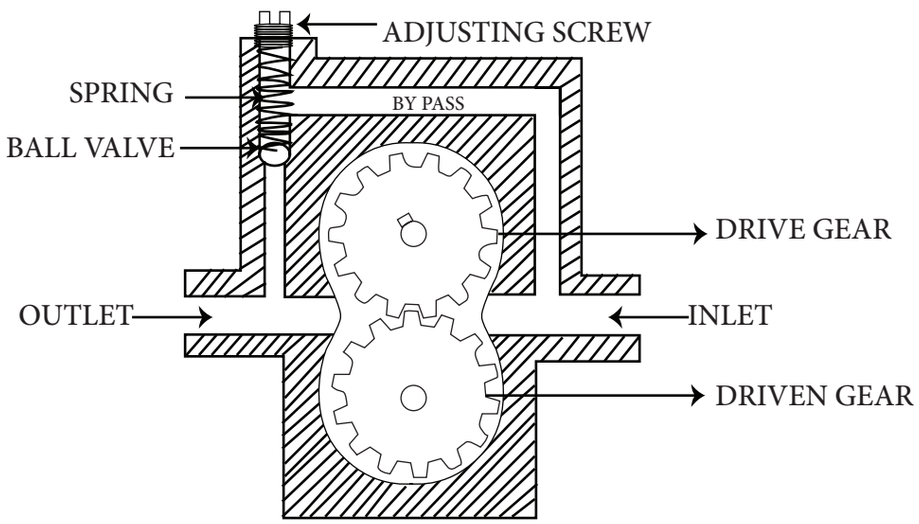


Fig 1. Gear type Oil Pump

Materials Required

1. Waste Cotton
2. Kerosence
3. Degreaser
4. Lubricating Oil SAE 30
5. Emery sheet

Reasons for Dismantling

1. Low oil pressure
2. Block in oil filter
3. Loose connection in suction of oil filter
4. Hole in Oil filter
5. Company recommended period of inspection and servicing lapses

Dismantling

1. Start and run the engine up to the working temperature reaches 70^0 C.
2. Stop the engine and drain the oil from the sump after some time.
3. Remove the connections of inlet and outlet of the oil pump.
4. After removing the distributor remove the oil pump from the crankcase.
5. Dismantle Driving gear, Driven gear and all other parts and clean them by degreaser and kerosene.

Inspection

a) Gear Type Oil Pump

1. To check the damages of the gears and clean the surface by using emery sheet.
2. Check the gap between pump shafts and pump body. (Pump shaft to body clearance).
3. Check the gap between drive Gear and Pump Shaft. (Drive gear to spindle clearance).
4. Check the gap between Gear and Pump body (gear to body clearance).
5. Measure the gap between pump shaft guide to guide push clearances.

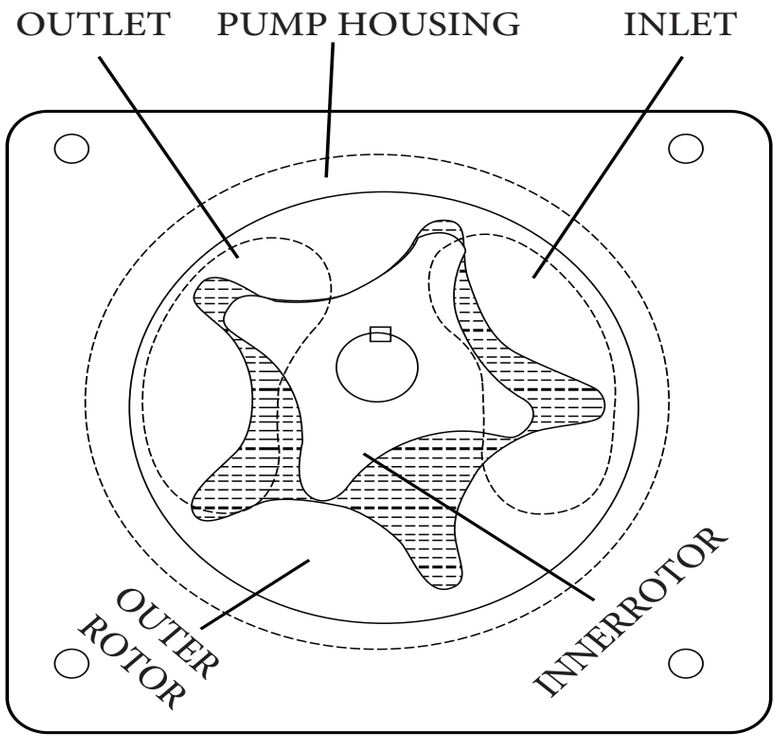


Fig 2. ROTOR type Oil Pump

b) Rotor Type Oil Pump

1. Check the gap between outer rotor body clearances.
2. Check the gap between pump shaft and rotor clearance.

Reassembling

- Reassemble the oil pump in the crankcase at the same time slowly rotate the camshaft and tight the fixing bolt.
- If pressure relief value is located in the oil pump then clean and refit the cover, spring and adjusting screw.
- After filling the oil sump with sufficient oil and start the engine. Check the oil pressure by increasing the speed of engine slowly and compare the pressure with the recommendation of the manufacturer.
- While fixing the oil pump in the crank case the camshaft is slowly rotated and fixing bolt is screwed.

- If pressure relief valve is joined with the pump cover, then spring, adjusting screws need to be removed and cleaned and refitted in the correct manner.
- Start the engine after the oil sump is filled with lubricating oil. The pressure of the lubricating oil is measured by pressure gauge by increasing the engine speed and compared with recommended quantity by the company.

Precaution

- Compare the actual clearances with the recommended clearances by the manufacturer. If it exceeds the limit, pumps will not be allowed to use.
- If the gear or rotor has any breakage or crack, the pump will be rejected and new one should be replaced.

Conclusion

Fuel pump from the given engine is dismantled,examined and reassembledafter servicing.

EXERCISE

6

Ac Mechanical Fuel Pump

EXERCISE 6

Aim

To dismantle the AC Mechanical fuel pump, examine and assemble it after servicing

Equipment Required

Petrol Engine.

Tools Required

1. Screw driver
2. Double end spanner set
3. Copper wire
4. Scrapper

Fig 1. Mechanical Petrol Pump

Materials Required

1. Fine brush
2. Petrol
3. Cloth
4. Compressed air

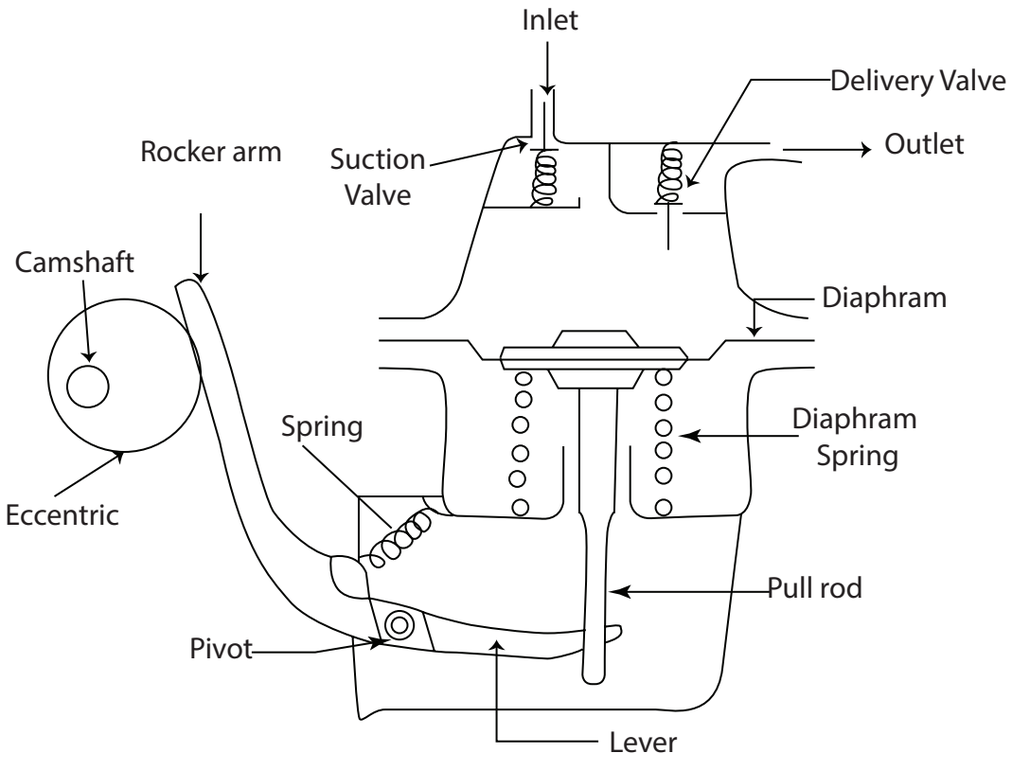


Fig 2. Mechanical Petrol Pump - Line Diagram

Reasons for Dismantling

1. No fuel supply during starting
2. Petrol leakage in the lower chamber
3. Petrol leakage in the passage hole
4. Starting trouble in the engine
5. Company recommended period of inspection and servicing lapses

Dismantling

1. All the precautions must be followed before dismantling the pump filter, valveretainer, rubber gasket, filter element which are located on the top of the pump will bekept in a tray.
2. Mark the top chamber and bottom chamber to avoid wrong fitment before dismantling the screws.

3. While removing, the diaphragm may stick to the upper chamber. So required caution to be taken.
4. Remove the Grub screw joining the Rocker arm and keep separately.

Inspection and Servicing

1. Check if the filter element is damaged
2. Check if the diaphragm is damaged and if so replace it with new one.
3. Check if the inlet valve and outlet valve in the valve retainer are working well.
4. All the removed particles are cleaned with petrol using brush.
5. Check if the spring and Valve seats are damaged and if so they are replaced by new ones.

Reassembling

1. Fix the valve retainer in the right place and screw with bolt and nut.
2. By pressing the Diaphragm assemble rocker arm in the lower chamber
3. Tightly screw Rocker arm with bolt to avoid disconnection
4. Bring the holes on the Lower chamber, diaphragm and upper chamber in a straight manner. Then, join them with screws.

Conclusion

The serviced petrol pump is tested for correct measurement and pressure of pumping petrol and fixed in the engine.

EXERCISE 7

SILENCER

EXERCISE 7

Aim
To dismantle, examine and refix the silencer after servicing.

Equipments Required
Any Vehicle

Tools Required
1. Double end spanner set
2. Screw driver
3. Hammer
4. Wooden Mallet
5. Hack saw frame with blade

Materials required
1. Cotton waste
2. Kerosene long rod
3. Wire brush.

Reasons for Dismantling
1. Pulling power of the engine is reduced.
2. Starting trouble in the engine.
3. Exit of black smoke from the silencer
4. Back firing & Oil leakage
5. Noisy Engine

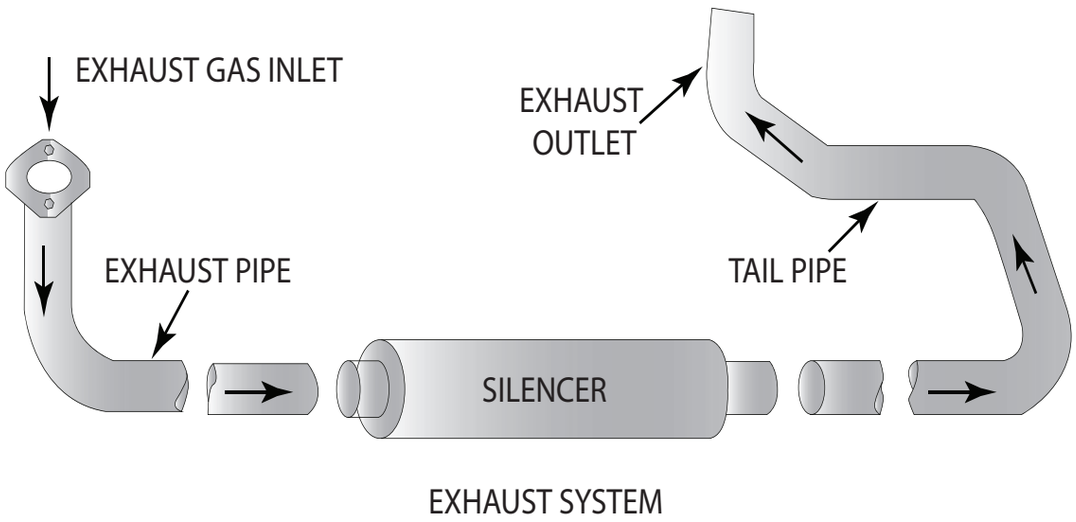


Fig 1. Silencer

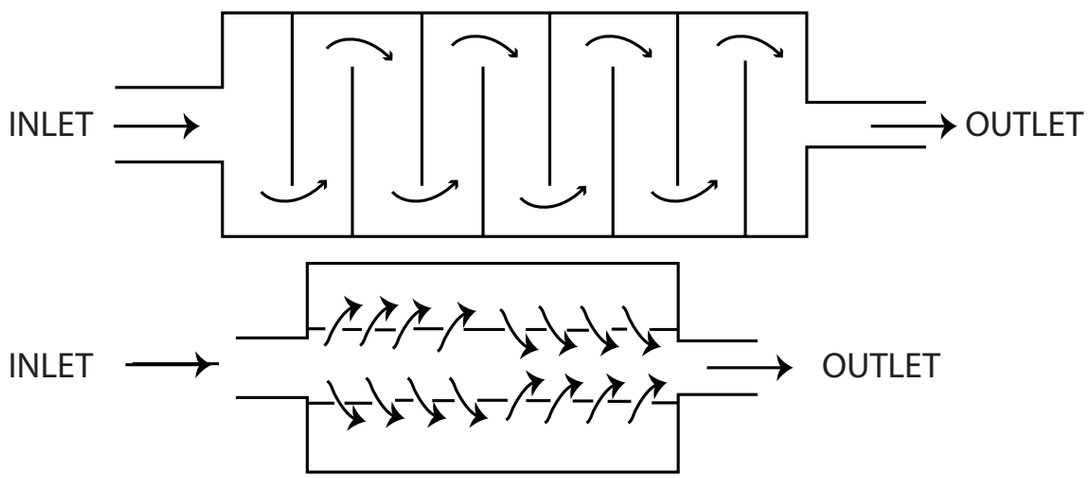


Fig 2. Silencer

Dismantling

1. Remove the Mounting bolts and clamps of the silencer.
2. Remove the Bolts from Exhaust manifold and keep separately.
3. Remove the Exhaust pipe and silencer and keep separately.
4. Using wooden mallet, hammer the sides and up and down of the silencer to remove the carbon particles which disturbs the flow.
5. Heat the Silencer well and allow it to cool for some time. Then, hammer it by mallet, move the iron rod inside the silencer to remove carbon particles.
6. Use Rod or wire brush to remove carbon particles

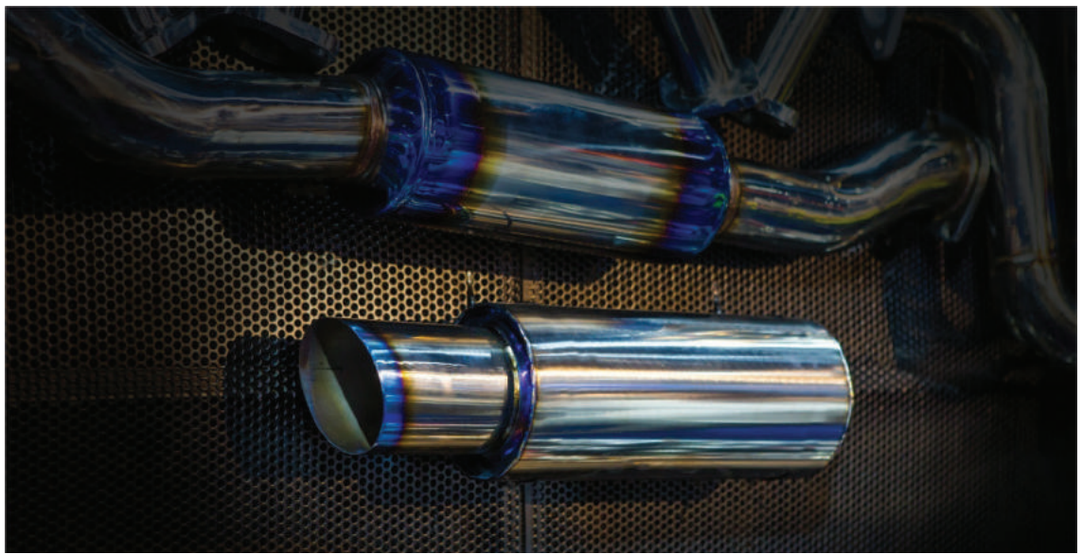


Fig 3. Silencer - Corediagram

Note

If the silencer is attached with the catalytic convertor, then service the same after knowing the type of convertor and its properties.

If the settling of carbon particles are high, then cut the silencer by Hack saw blade and welded again after servicing.

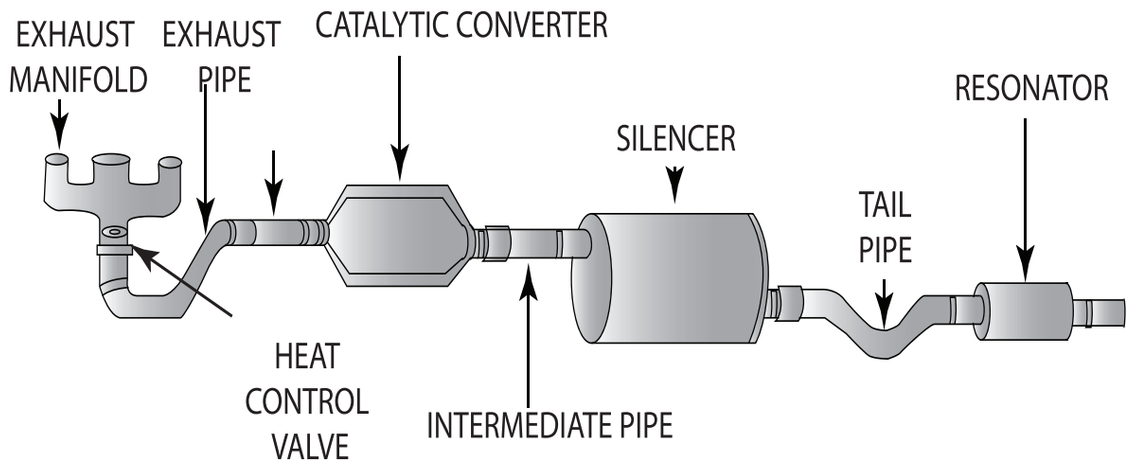


Fig 4. Catalytic Convertor type Exhaust System

Re-assembling

1. Silencer is assembled in the reverse process of dismantling the parts.
2. Silencer is fixed with new or serviced washer.

Conclusion

Silencer from the given Vehicle is serviced in the correct method and fixed.

EXERCISE

8

PISTON ASSEMBLY

EXERCISE 8

Aim

To dismantle, Inspect, Service and Reassemble the Piston assembly of the engine.

Equipment Required

Any Engine

Tools Required

1. Double end Spanner
2. Ring Spanner Set
3. Outside Caliper
4. Feeler Gauge
5. Iron Hammer
6. Steel drift
7. Vernier Caliper
8. Ring Compressor and
9. Ring Expander

Materials Required

1. Cotton Waste
2. Emery Sheet

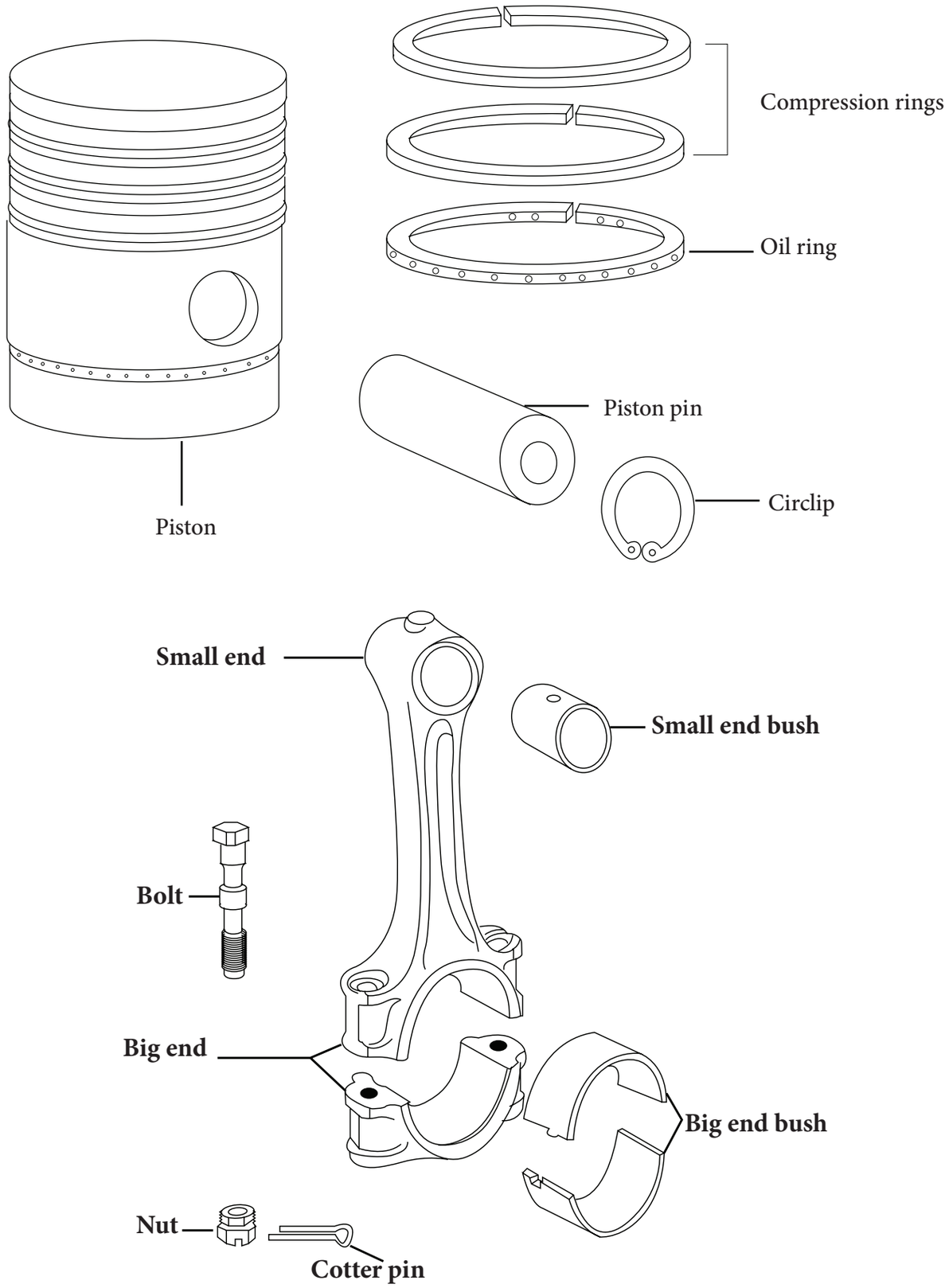


Fig 1. Piston and Connecting Rod Assembly - Line Diagram

Reasons for Dismantling

1. RPM of the engine is decreased
2. BHP of the engine is decreased
3. Over Fuel Consumption
4. Reduced Compression Level in the3 cylinder
5. Outlet of Black Smoke through the Silencer
6. Consumption of Excess Lubrication Oil
7. Noisy Operation of the Engine
8. Company recommended period of inspection and servicing lapses

Fig 2. Piston and Connecting Rod Assembly

Dismantling

1. With all precautions dismantle the cylinder, Head, Crank case and keep the engine stand.
2. Mark the number on the connecting rod big end by using number punch
3. With the help of spanner ,remove the nuts of connecting big end bearing with the connecting rod and take the piston assembly through cylinder head.
4. Check if the bearing is depreciated and if so reconditionor replace the new bearing
5. Remove other piston assembly and keep it on a tray.

6. Change the Piston Circlip if it is loose
7. Change Piston ring if it is depreciated
8. Use wooden mallet to fix piston assembly into the cylinder block

Fig 3. Piston and Connecting Rod Assembly

Assembling

Assemble in the reverse process of dismantling. Apply lubrication oil on the cylinder walls before fixing piston assembly to cylinder block.

Conclusion

Assemble the piston assembly in the Engine after servicing.

Note

Can do the piston assembly in the class room and practical exam with the aviability of different piston spares.

EXERCISE

9

WATER PUMP

EXERCISE 9

Aim

To Dismantle, Inspect, Service and reassemble the water pump from an engine

Equipments Required

An engine

Tools Required

1. Double End spanner set
2. Puller
3. Drift punch
4. Hammer

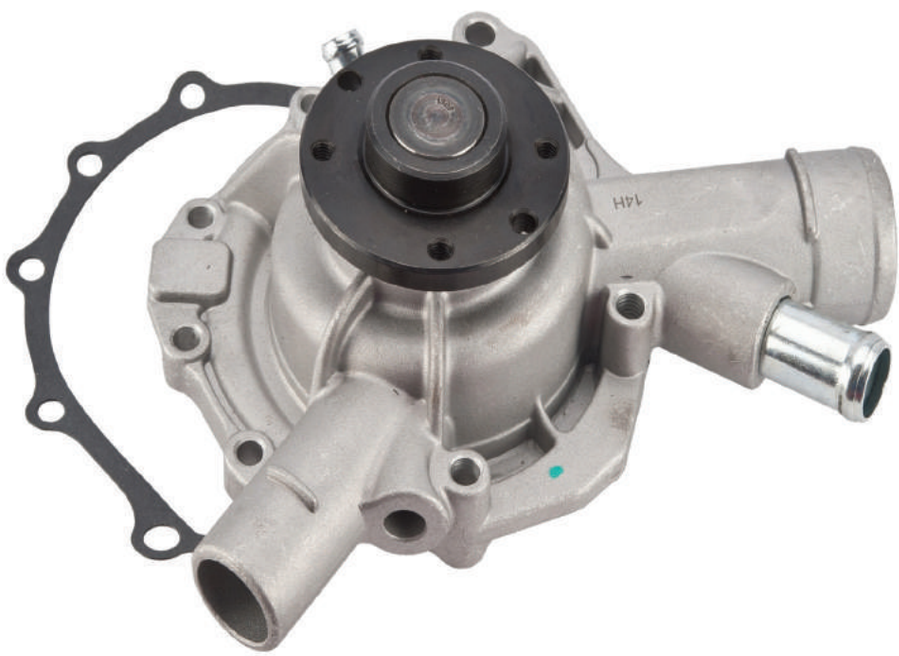


Fig 1. Water Pump

Materials Required

1. Kerosene
2. Cloth

Reasons for Dismantling

1. Noise in the bearing
2. Over heat in the engine
3. Leakage of water in between Engine and water pump
4. Too loose or too tight fan belt affects water rotation
5. Time lapse as recommended by the company

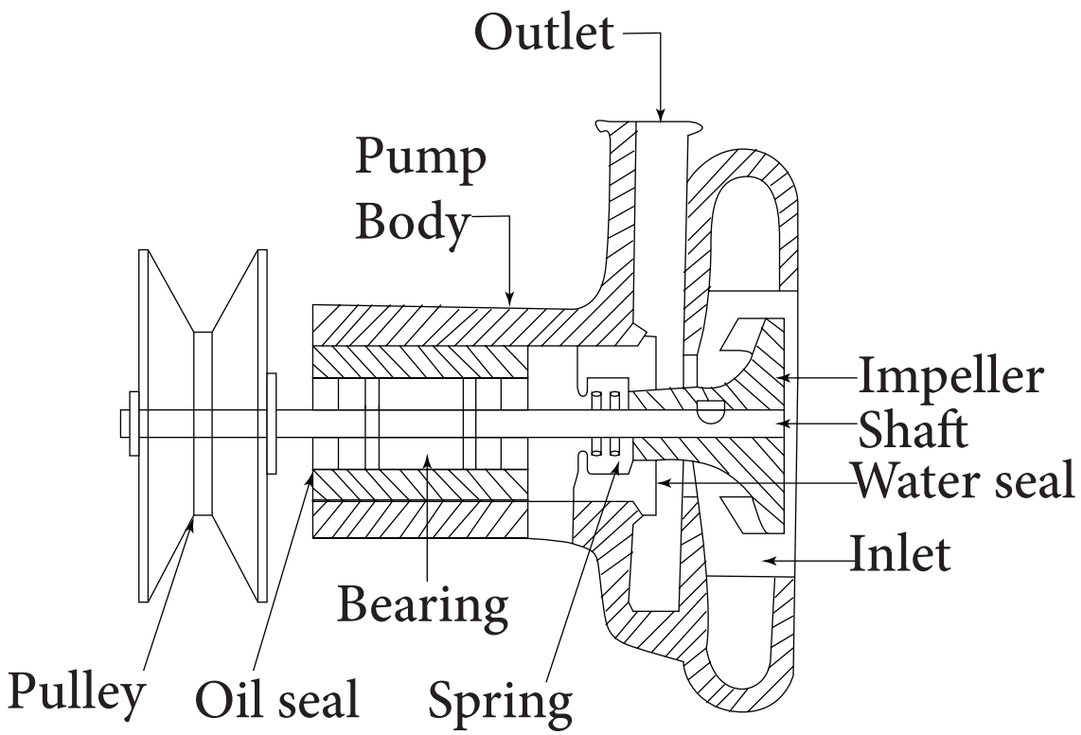


Fig 2. Water Pump - Line Diagram

Dismantling

1. Remove the rubber hose from radiator lower tank before removing the water pump
2. Remove the fan belt.
3. Remove the water in the upper part of water jacket after removing the fan.
4. Remove the dynamo.
5. Remove the water cooling pump assembly from the engine.
6. Remove the Fan belt pulley using correct tools from the water pump
7. Remove the thermostat valve.

Cleaning and Inspection

1. Clean the water pump parts by using degreaser after taking out of the engine
2. Remove the pump shaft slowly by using drift pin, copper hammer and wooden mallet.
3. Check the impeller is broken
4. Check if the pump shaft shake and replace it if the shake is more.
5. Change the bearing if it is too loose.

Precaution

Before fixing the water pump replace new water seal, oil seal and gasket.

Re-assembling

Assembling is the reverse process of dismantling in the correct order.

Conclusion

After dismantling, Inspecting and servicing the water pump is fixed in the given engine.

EXERCISE

10

DIESEL INJECTOR

EXERCISE 10

Aim

To Dismantle, Inspect and reassemble the diesel injector from a given diesel engine.

Fig 1. Diesel Injector

Equipments Required

Diesel Engine

Tools Required

1. Double end spanner set
2. Ring spanner set
3. Screw driver
4. Hammer

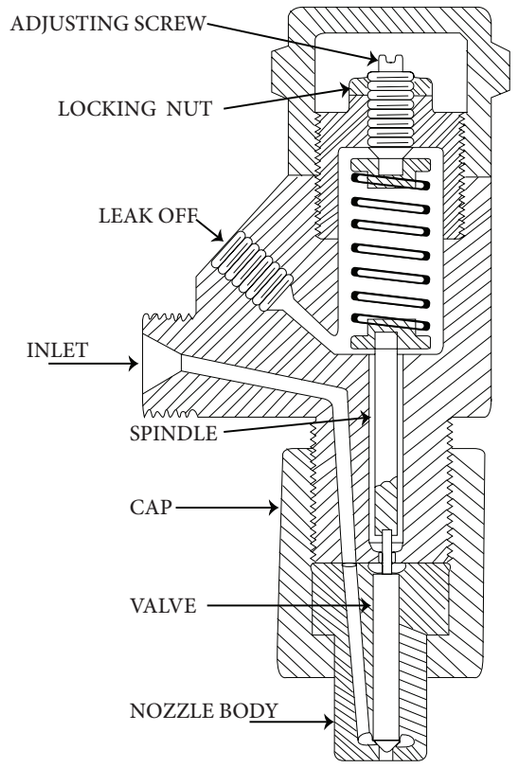


Fig 2. Diesel Injector - Line Diagram

Reasons for Dismantling

1. Low engine speed.
2. Low pulling power of engine .
3. Diesel was not injected from injector
4. Uneven speed of the engine
5. Company recommended period of inspection and servicing lapses

Removal

1. Remove the diesel tube from injection pump
2. Remove leak off pipe from the injector
3. Remove injector from cylinder head using proper spanner.
4. Put the injector on the tray and keep it in a clean and air ventilated room.

Dismantling and Cleaning

1. Remove the diesel injector spindle, spring, washer, adjusting screw from injector and put on the tray.
2. Clean all the parts of injector using kerosene.
3. Again clean all the parts of injector using cloth.
4. Check any crack in the injector body and the nozzle.
5. If any crack is found change new injector.
6. Check any block in the inlet passage and leak off passage.
7. Check the bottom of the injector hole and also clean the carbon deposit.

Fig 3. Diesel Injector

Reassembling

Assemble is the reverse process of dismantling in the correct order.

Note

- After cleaning the diesel injector, again sent to the final inspection.
- The diesel injector is used after pressure test, spray test and leak off test are done.

Conclusion

After dismantling, inspecting and servicing fix the diesel injector in the engine.

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Theory & Practical
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