USN 1CR14ME074

Eighth Semester B.E. Degree Examination, June/July 2018
Automotive Engineering

Time: 3 hrs. Max. Marks:100

Note: *Answer any FIVE full questions, selecting at least TWO questions from each part.*

PART – A

1 a. Mention the different cylinder arrangements of a IC engine and discuss their merits and demerits. (08 Marks)
b. Sketch and Explain,
(i) Thermosyphon system of engine cooling.
(ii) Pump circulation system of engine cooling. (12 Marks)

2 a. Discuss normal and abnormal combustion in SI engine. (06 Marks)
b. What are OCTANE and CETANE rating of IC engines? (06 Marks)
c. With neat sketch, explain S.U. carburetor. (08 Marks)

3 a. Discuss various methods of super charging of IC engines. (08 Marks)
b. Discuss with sketches of various types of superchargers. (12 Marks)

4 a. Sketch and explain battery coil ignition system. What are its advantages and disadvantages? (10 Marks)
b. Explain following types of automatic ignition advance mechanisms:
(i) Centrifugal advance.
(ii) Vacuum advance. (10 Marks)

PART – B

5 a. What are the requirements of clutch? Sketch and explain cone clutch. (08 Marks)
b. With neat sketch, explain the working of three speed synchromesh gear box. (12 Marks)

6 a. Sketch and explain the working of a Differential. (08 Marks)
b. A motor vehicle has a wheel base of 2.75 m and pivot centers are at a distance of 1.05 m apart. The front and rear wheel track is 1.25 m. Determine the correct angle of outside lock and turning circle radius of the outer front and inner rear wheels when the angle of inside lock is 40°. (05 Marks)
c. Sketch and explain power steering arrangement. (07 Marks)

7 a. Sketch and explain following suspension systems:
(i) Torsion bar
(ii) Leaf spring. (10 Marks)
b. Sketch and explain hydraulic braking system. (10 Marks)

8 a. Sketch and explain positive crank case ventilation system. (08 Marks)
b. Sketch and explain EGR system of NOx reduction. (06 Marks)
c. Write short notes on emission standards. (06 Marks)

* * * * *

1A) CYLINDER ARRANGEMENTS

Multicylinder engines are preferred over single cylinder due to reasons like

* giving smooth torque output
* Lighter flywheel
* engine compactness
* Easy balancing

In multicylinder engines, the arrangement of cylinders is very important.

Types of cylinder arrangements:

1. In line arrangement → placed side by side / → 180° out of phase
2. Opposed cylinder type
3. V- engine
4. Radial engines.

(a) In-line type cylinders placed side by side ⇒ this type has two single cylinders placed side by side vertically so that their pistons are in phase. Such an engine will have a power impulse every 360 degrees of crank shaft rotation.

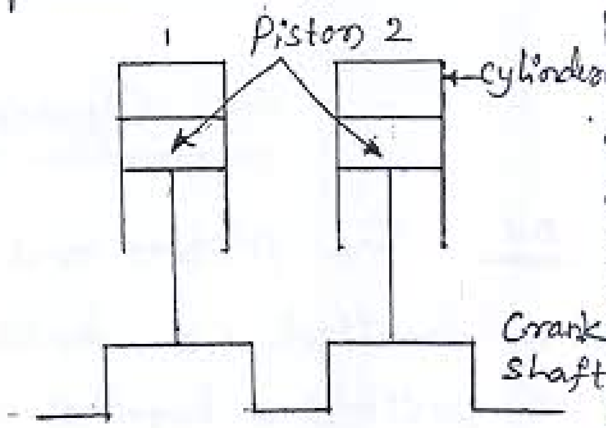


fig. Inline side by side arrangement (2 cylinder

ADV

* Easier maintenance.
* Simple construction.

In this the two single cylinders are in effect placed side by side vertically, so that their cranks are 180° out of phase. This type provides good balancing.

DISADV ⇒ Unequal firing intervals: the spark takes place at 0°, 180°, 720°, 900° and so on.

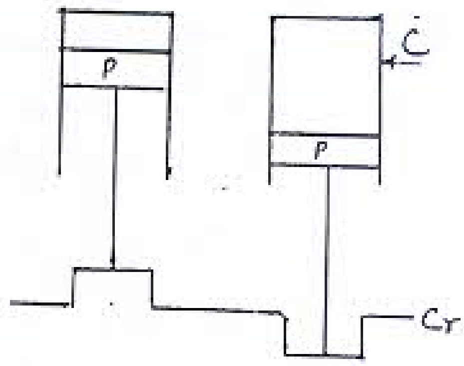


fig. Inline cylinders 180° out of phase

Opposed cylinders

Horizontally opposed type: The two cylinders are arranged horizontally opposite each other. as shown below. In this type power impulses occur at even intervals of 360° of crankshaft rotation.

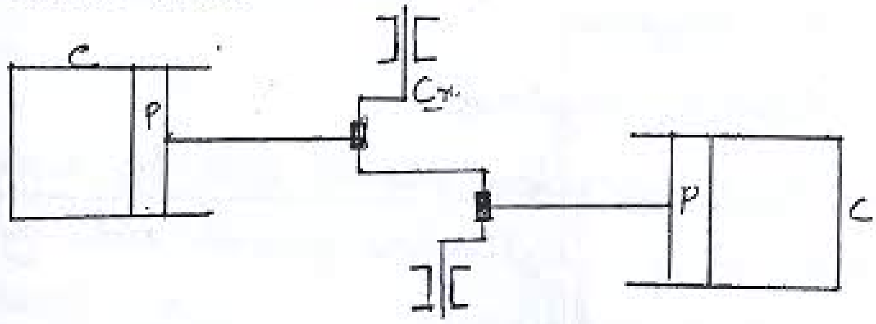


fig. Opposed type cylinders

ADV: The piston and the connecting rod movements are identical i.e. both the pistons approach TDC and BDC positions together. This causes the engine to be perfectly balanced. as regards the reciprocating force
* engine can run smoothly because of perfect balancing
* Vehicle stability is more, because centre of gravity is low.

DISADV

* Two cylinders are not in line, the forces in the rods produce a rocking couple, which acts alternately in the clockwise & counter clockwise directions, depending upon the movement of the pistons.

* Length of the engine increases to much.

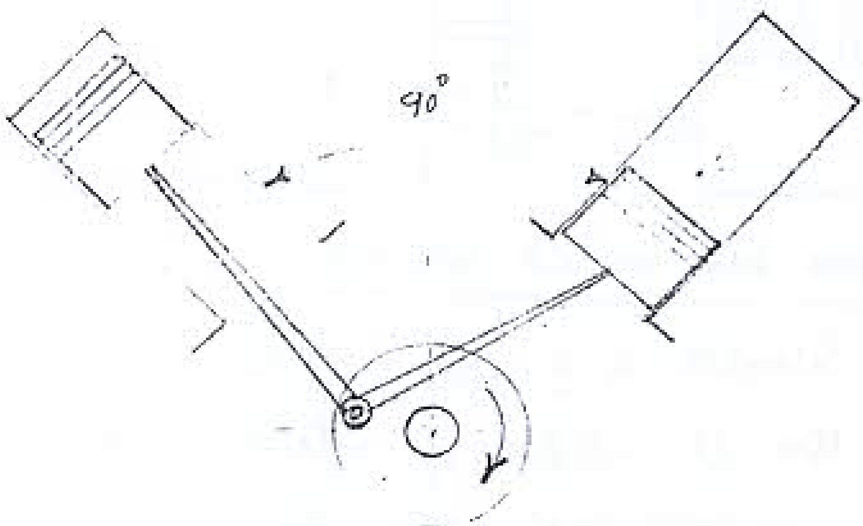
V-type CYLINDERS:

In this two cylinders are placed with their centre lines at some angle to each other. Generally this angle is kept 60°, but in some instances angles from 40° to 90° have also been used.

ADV

* More compact because of short crankshaft
* More rigidity due to short crankshaft
* Engine runs more smoothly at higher speeds due to more rigidity.
* Overall length & height of the engine are decreased.

DISA.



V-type-engine

2A) Thermosyphon System of Cooling.

thereby cooling the same. the same heat in the water is then dissipated into the atmosphere. through the radiator, by mainly conduction and convection. Therefore the circulating water becomes cold by the time it reaches the collector tank of the radiator. The same water is then circulated through the engine to collect heat from the cylinders. The rate at which water circulates in this system is proportional to the heat output or the load on the engine and not to the engine speed. Some of the thermosyphon systems also had fans mounted behind the radiator and driven by belt and pulleys from the crank shaft, to assist the flow of cooling air.

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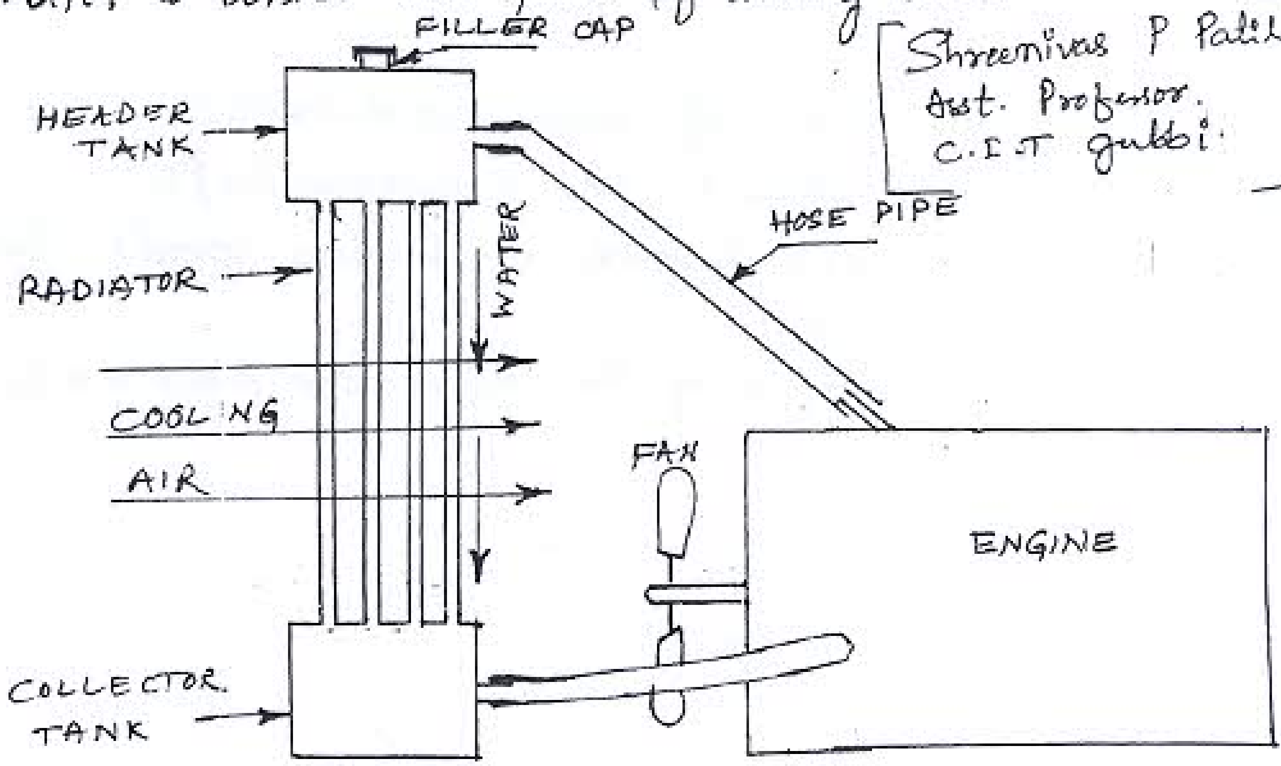


FIG. THERMOSYPHON SYSTEM OF COOLING

ADV ⟹ (1) Simplicity & low initial cost.

DISADV (1) As the circulation of coolant is maintained by natural conventional only, the cooling is rather slow. Therefore, to have adequate cooling the capacity of the system has to be large.

(2) Due to the quantity of coolant being large, it takes more time for the engine to reach the operating temperature.

(3) Radiator header tank must be located higher than the top of the cylinder coolant jackets, which is no more possible with the modern body styles.

(4) If the coolant falls below the level, continuity of flow would break and the system would consequently fail.

PUMP CIRCULATION SYSTEM :

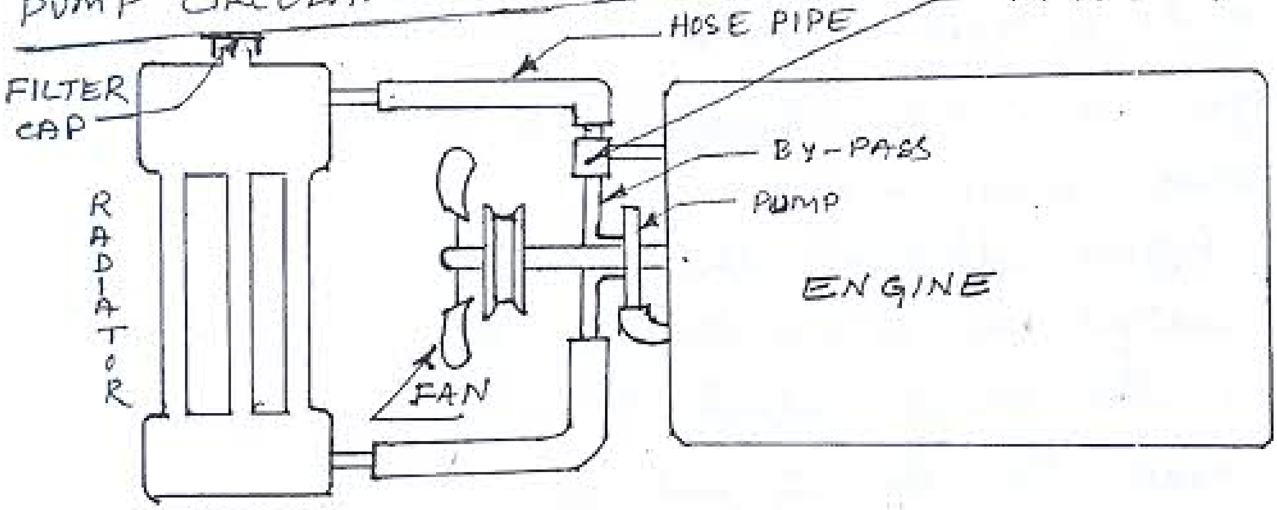


FIG. PUMP CIRCULATION SYSTEM.

This system is similar to thermosyphon system described above with the only differences that a pump is used for the circulation of coolant and thermostat is employed to control the flow of coolant. The pump is driven by means of a belt from the engine crank shaft. The drive for the fan is also obtained from the same belt that drives the pump and the generator.

(3)

SUPERCHARGING: Supercharging is the process of supplying to the engine, air-fuel mixture at a pressure above the atmospheric. On an ordinary engine without a supercharger, the downward piston movement during the intake stroke creates a vacuum in the inlet manifold, which is used to draw in the air-fuel mixture through the carburettor into the cylinders. With supercharging however due to higher pressure, the density of charge increases and, therefore, its weight per stroke is increased for the same swept volume. The power output of an engine is almost directly proportional to the weight of charge per minute, therefore, the supercharged engine gives more output.

At higher altitude, the air gets thin thus reducing the weight rate of air flow in the engine leading to fall in the power output. In this case, superchargers increase the density and hence the weight rate of air flow in the engine, thus offsetting any fall in power output due to altitude.

The power output of an IC engine depends on the following.

(1) Quantity of air sucked in by the engine per cycle.
(2) Quantity of fuel admitted and burnt
(3) Extent of completion of combustion of fuel.
(4) Extent of utilization of the sucked air.
(5) Thermal efficiency of the engine.

An engine may not produce the same power output when it operates at different locations (particularly at different altitudes) and at the same location at different times due to the variation in ambient conditions. Supercharging is used to overcome this problem and mainly to increase the power output of the engine. Supercharging is also called boosting.

Influence of Supercharging on engine performance.

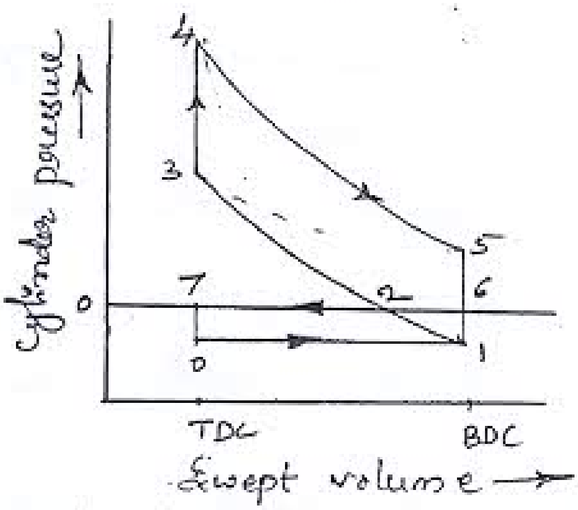
1) Power output of the engine is higher than the naturally aspirated engines.
2) Torque is improved over the whole speed range, better torque especially at low speeds.
3) Faster acceleration of the engine becomes possible
4) In a compression ignition engine, ignition delay is reduced and combustion becomes smoother and quiter.
5) Mechanical efficiency of the engine is slightly better than that of the naturally aspirated engine
6) Specific fuel consumption of a supercharged engine in most cases, though not in all, is lowered slightly compared to that of the naturally aspirated engine.

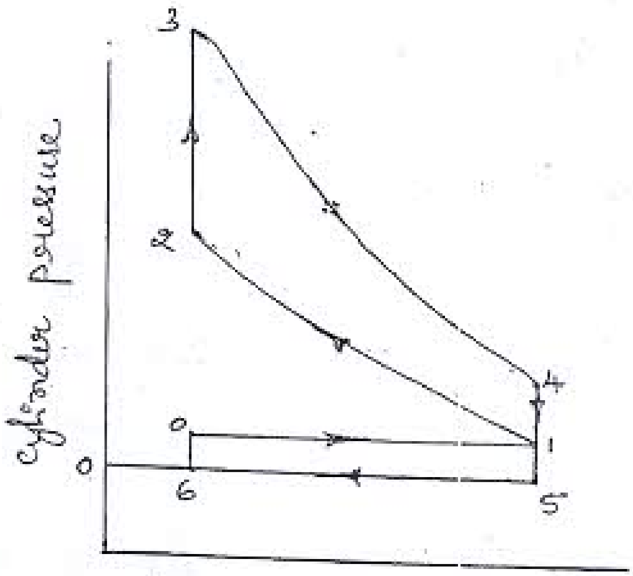
Advantages of supercharging or Turbocharging

1) Improve the power output of a given displacement engine
2) Improve torque characteristics.
3) Reduce the fuel consumption
4) Reduce the exhaust gas emissions.
5) Increased B.P/weight ratio compare to normal engines

Effect of supercharging on power output.

Theoretical operating cycles of a naturally aspirated and a supercharged petrol engine have in fig (A) and (B).





Theoretical P-V diagram of a naturally aspirated engine.

Theoretical - P-V diagram of a supercharged engine

In fig (A) loop 2-3-4-5-6 represents the useful power developed, whereas loop 0127 represents the negative power i.e., the power required to induct the fresh charge in the cylinder. In the same way, in fig (B) the useful work is represented by the loop 1-2-3-4, while the lower loop 0-1-5-6 corresponds to the work done in pumping the fresh charge into the cylinder.

three types of superchargers :-

1. Centrifugal type.
2. Vane type.
3. Roots air-blower type.

1) Centrifugal type supercharger: This is the most common type of supercharging on the automotive engines. It is run from the engine pulley by means of a V-belt. The air/fuel mixture enters the impeller at the centre and after passing through the impeller and the diffuser vanes, it enters the volute casing, where a part of its kinetic energy is recovered and the mixture at supercharged pressure goes out of the casing to the engine. Generally due to the high pressure, about 30 per cent more air-fuel mixture is forced into the combustion chamber.

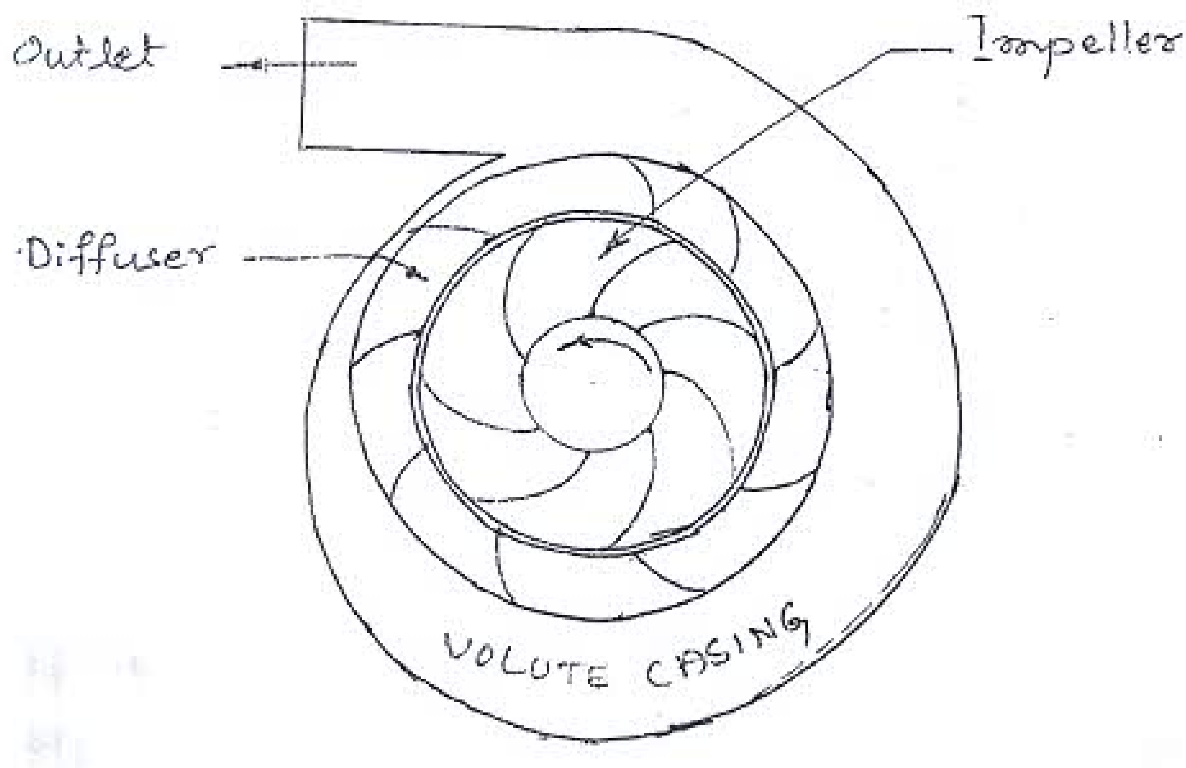
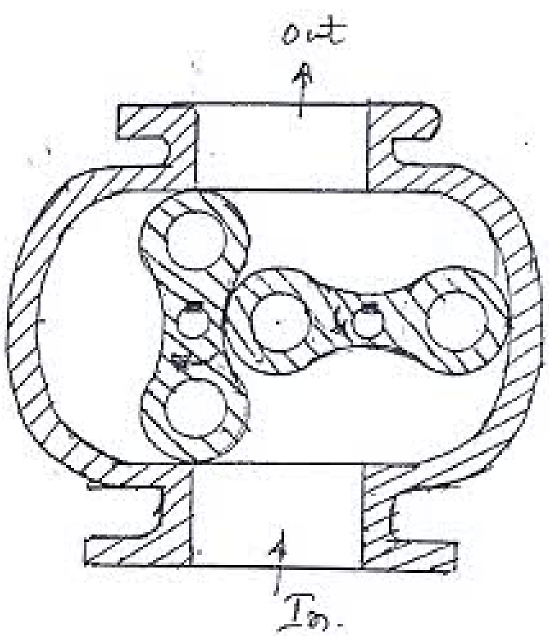


Fig:- Centrifugal type of supercharger.

The propeller of this supercharger is required to run at very high speeds, say upto 80,000 r.p.m. which dictate that it should be able to take the accompanying stresses at such high speeds. Generally, impellers are made of duralumin or alloy steels.

2) ROOTS SUPERCHARGER

It consists of two rotors of epicycloid shape. An epicycloid is the locus of a point on the circumference of a circle which rolls on another circle. Each rotor is keyed to its shaft, which are connected together by means of gears of equal size, so that the two rotors revolve at the same speed. The working action of this supercharger is just like a gear pump, so that we get the mixture at the outlet at a high pressure.



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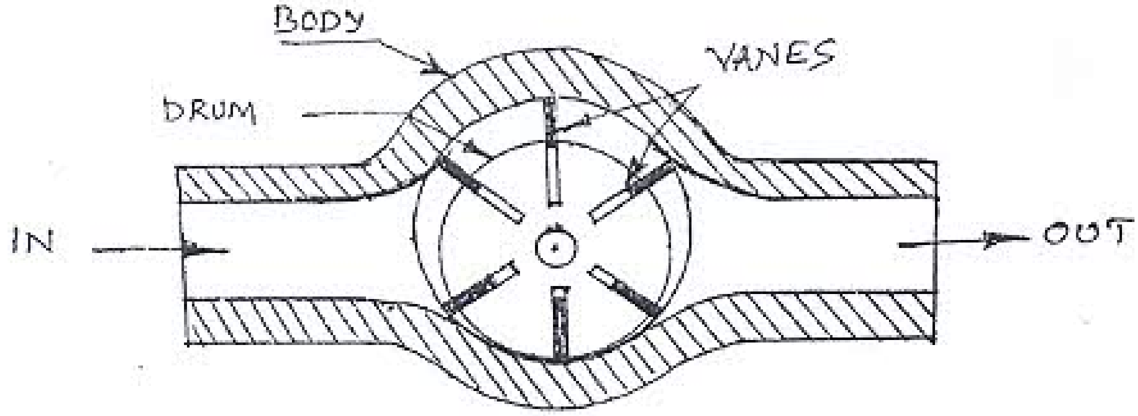
ROOTS SUPERCHARGER

Commonly used roots superchargers are
(1) Eatons Roots-type positive displacement pump
(2) Eatons Twin Vortices Series (TVS).

The fig shows the construction of a vane type super charger. In a simplified manner. A number of vanes are mounted on the drum is such a manner that they can slide in or out against some spring force, so that all the time they are in contact with the inner surface of the supercharger body.

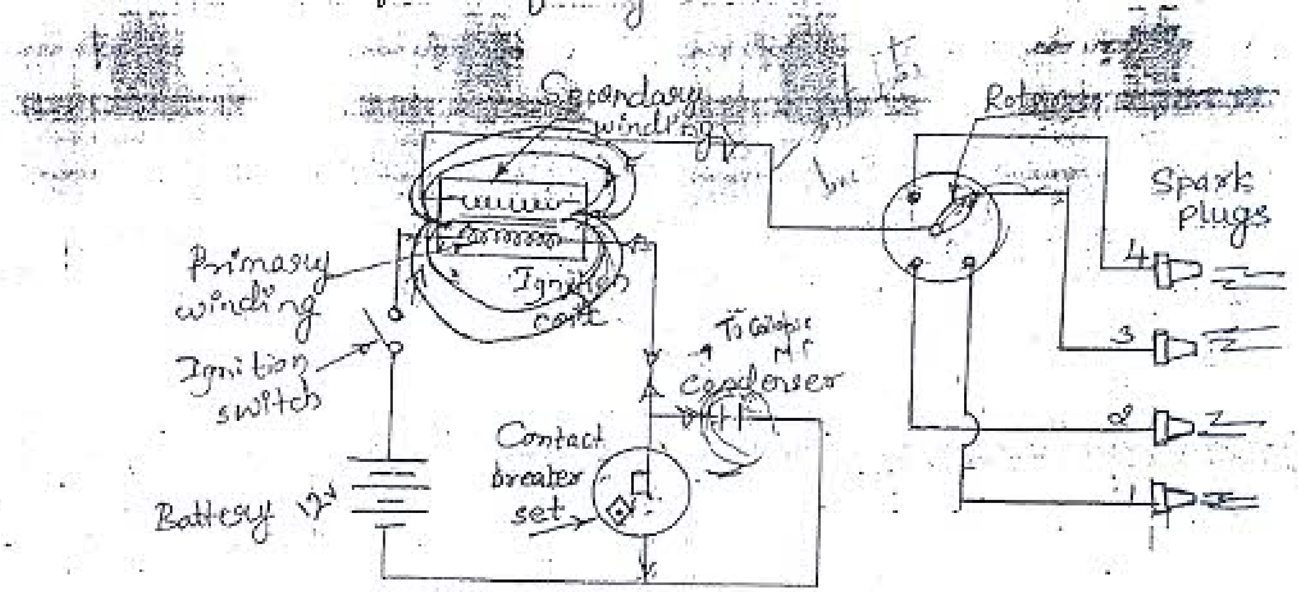


VANE TYPE SUPERCHARGER

The vanes are usually made from lami-nates of linen impregnated with phenolic resin. However, Tufnol, because of its similar qualities, has also been used. The properties required for a vane material are, quite running, low friction, low co-efficient of thermal expansion and resistance to continuous exposure to oil and petrol. It is seen that space between the body and the drum goes on decreasing from the inlet to the outlet side as the drum rotates. Thus the mixture entrapped b/n any two vanes at the inlet will experience decrease of volume & hence increase of pressure as it reaches the outlet.

begins to collapse. This induces an EMF in the secondary which is directly proportional to the rate at which magnetic field collapses which in turn depends on the rate of decrease of the primary current.

A condenser placed across the contact breaker helps to collapse the magnetic field very rapidly by absorbing part of energy of the magnetic field. i.e., it acts as a reservoir for a flowing current.



Battery Coil Ignition system (Firing order 1-3-4-2)

→ Due to a rapidly collapsing magnetic field, high voltage is induced in the primary (250 volts) and even higher in the secondary (10,000 to 20,000 volts). This high voltage in the secondary passes to the distributor rotor or arm through (high tension lead). The distributor arm connects high voltage to different spark plugs depending on the firing order of the engine. As high voltage passes across spark plug gap, produces an arc (spark) and ignition

250 - 20,000

→ Complex
- battery
Coil
distributor

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of the combustible charge in the cylinder take place. The presence of condenser avoids burning of contacts points due to over heating. The burning of contact point is called "Pitting".

ADV

1. It produces better sparks at low speeds of the engine i.e., during starting and idling
2. The maintenance cost is negligible except for the battery.
3. The intensity of spark is not affected by advance and retard positions of timing control mechanism.
4. Simple distributor set.
5. The initial cost is low.

DISADV

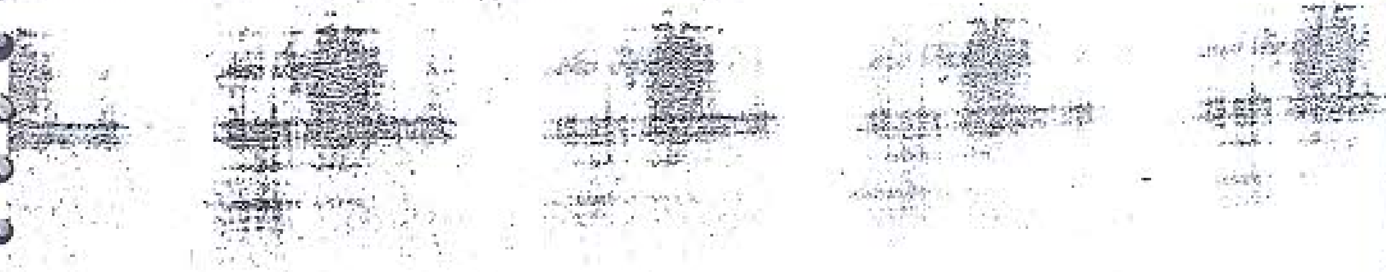
1. If battery runs down, the engine will not start.
2. The system weight is greater than magneto type.
3. The system wiring is much more complicated than magneto type.
4. The sparking voltage drops with increasing speed of the engine.

Magneto Ignition System

For many applications of the S.I engine a lighter and more compact source of electrical energy than the battery is desirable. The magneto is a special type of electric generator which produce and supplies the current to the primary winding. The basic component

Automatic Advance Methods

4(b) [(a) Centrifugal Advance: In this method ignition timing is controlled depending on engine speed. The system consists of an advance cam integral with the ignition cam, a pair of centrifugal weights A and B as shown in figure.



The weights A and B are connected to the breaker plate 'C' by using springs. when the engine speed increases, the centrifugal weights swing out due to the centrifugal force. As the weights swing out, they turn the breaker plate and cam in the anticlock wise direction, thus advance the spark. As the engine speed decreases, the springs attached to the weights overcome the decreased centrifugal force which tends to keep them in the outer position, thus retarding the spark.] 1(i)

Q 6m 4(i) [(b) Vacuum Advance: In this method, control of ignition advance can be done according to engine load. The system consists of a rubber diaphragm which is connected the base plate of the distributor. Atmospheric pressure acting on one side of diaphragm while on the other side vacuum from the carburetor acts. The springs keeps the system at zero advance if no vacuum is applied. As the engine is loaded, throttle opens and thus vacuum from the carburetor acts on one side of diaphragm through the port provided just above throttle. Due to this pressure difference, diaphragm moves against spring pressure thus causes rotation of distributor baseplate in the opposite direction to the usual distributor rotation. This causes ignition to advance. As vacuum decreases, the diaphragm and link breaker plate move back to original position due to spring pressure.] Q(i)

— 0 —

possible with the help of the two pinions rotating on their own axles in the differential unit.

6(a) CONSTRUCTION:

It consists of a drive piniown or bevel pinion, attached to the shaft which is coupled to the propeller shaft. A crown wheel or ring gear which is bolted to the differential cage, is in mesh with the bevel pinion. The cage carries a cross pin or spider (cross pin is used when two pinion gears are employed and spider is used when four pinions gears are used) to support two differential pinion gears which are in mesh with the two differential side gears (sun gears) which are splined to the axle half shafts. The ring gear is free to rotate on the half shaft.

operation ⇒ The operation of differential is as follows. The drive pinion, (driven by the propeller shaft, rotates the crown wheel.) Since the differential case is attached to the crown wheel it also rotates. when the case rotates, the bevel pinions and the cross which carries them above around in a circle. with the differential case.

Let us consider the following two cases of vehicle operation and the way in which the differential works:

1. When the vehicle is driven on a straight level road:

In this case, both the driving wheels meet the same rolling resistance. Hence the loads on the planetory gear teeth which are in mesh with the teeth on one half axle shaft side gear will be the same as those on the teeth that mesh with the other side gear. As such, the two bevel pinions do not rotate on the arms of the cross.

In the above operating condition, the crown wheel, differential case, bevel pinion and the two side gears all will tend to turn as a single unit without any relative motion between them. The whole unit rotates at the same speed as the crown wheel.

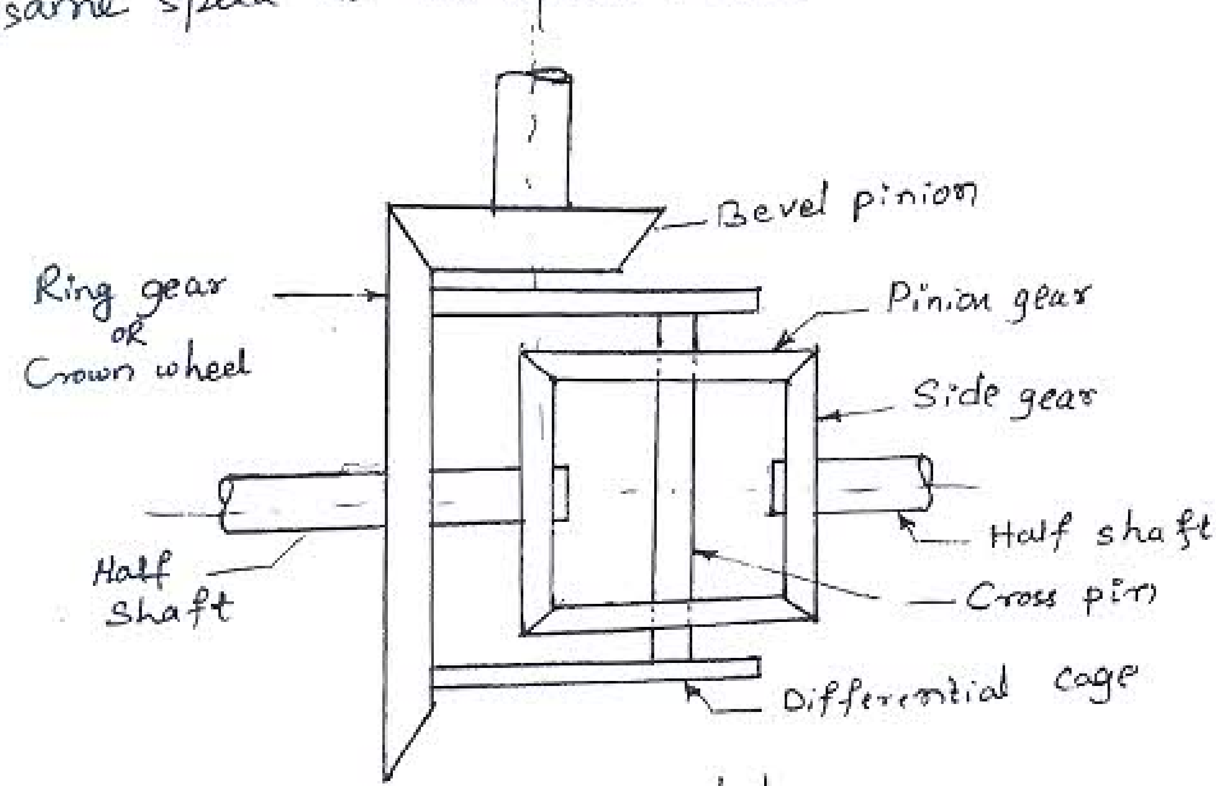


fig. Differential

The crown wheel, being operated by the propeller shaft crown pinion, rotates the differential case with the cross & the bevel pinions. The bevel pinions being in mesh with the right and left side gears, exert pressure on them, and rotate them. This in turn rotates the two half axle shafts at equal and same speed as that of the crown wheel. The vehicle, therefore, moves on a straight path.

In fact, if a vehicle will be driven in a straight path only without having to make turns, then there is no necessity to have the differential in the drive train.

POWER STEERING

6(b) In heavy duty trucks and tractors, driver has to apply inadequate effort to turn the wheels. The use of booster arrangement in steering system over comes this draw back. The booster is put into operation when the steering wheel is turned. It does most of the works for steering. The power steering system uses compressed air, electrical mechanisms, and hydraulic pressure.

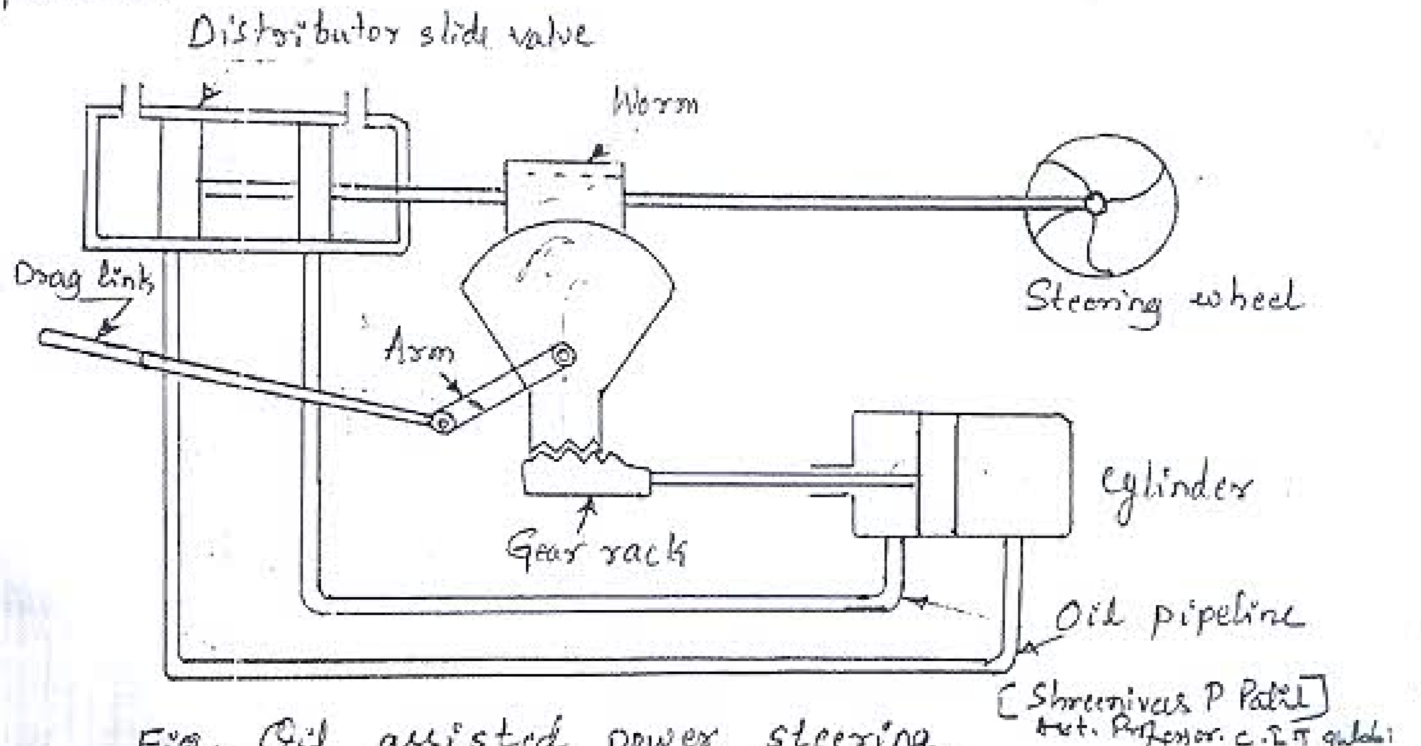


Fig. Oil assisted power steering

The fig shows a simplified diagram of hydraulic booster. The arrangement consists of a worm and worm-wheel, distributor slide valve, booster cylinder etc. When the steering wheel is turned the worm turns the sector of worm wheel and hence actuates the arm. The arm inturn actuates the road wheels through drag link. If the resistance offered to turn the wheel is too high and drivers effort to the steering wheel is too weak, then the worm, like a screw in a nut will be displaced axially together with the distributor slide valve. This axial movement will admit compressed air or oil into booster cylinder through the pipeline. The piston in the booster cylinder will turn the road wheels via the gear rack, the toothed worm sector, arm and drag Link. In the mean time, the worm sector will actuate the worm and will shift it along with distribution slide valve to its initial position. This movement of slide valve will stop the piston travel in the booster cylinder. Here the system uses power assistance in proportion to the effort needed to turn the wheels.

6(c)

SOLVED EXAMPLES

(1) A motor vehicle has a wheel base of 2.75 m and pivot centres are at a distance of 1.05 m apart. The front and rear wheel track is 1.25m. Determine the correct angle of outside lock and turning circle radius of the outer front and inner rear wheels when the angle of inside lock is 40°.

Given Data:

Wheel base $= b = 2.75\,m$

Pivot centre distance $= c = 1.05\,m$

Wheel track $= a = 1.25\,m$

Angle of inside lock $= \theta = 40°$

To find ⇒

Angle of outside lock $= \phi = ?$

$R_{OF} = ?$

$R_{IR} = ?$

Solution:

(i) To find correct angle of outside lock

wkt, $\cot\phi - \cot\theta = \frac{c}{b}$

$\cot\phi - \cot 40 = \frac{1.05}{2.75}$

$\cot\phi = 1.573$

$\frac{1}{\tan\phi} = 1.573$

$\tan\phi = \frac{1}{1.573}$

$\boxed{\phi = 32.44°}$

(ii) To find, turning circle radius of outer front wheel R_{of}

wkt,
$$R_{OF} = \frac{b}{\sin\phi} + \left[\frac{a-c}{2}\right] = \frac{2.75}{\sin 32.44} + \left[\frac{1.25-1.05}{2}\right]$$

$$\boxed{R_{OF} = 5.226\ m}$$

(iii) To find, turning circle radius of inner rear wheel. R_{IR}

wkt,
$$R_{IR} = \frac{b}{\tan\theta} - \left[\frac{a-c}{2}\right]$$

$$= \frac{2.75}{\tan 40^\circ} - \left[\frac{1.25-1.05}{2}\right]$$

$$\boxed{R_{IR} = 3.17\ m}$$

3) A vehicle has a track with pivot pins at a distance of 1.35m. The length of each steering arm (track arm) is 170 mm and length of the track rod is 1.25m. Calculate the wheel base which will give true rolling for all wheels when the vehicle turns, so that the inner wheel stub axle is 55° to the centre line of the vehicle.

Given Data:

Referring $\theta = 90 - 55 = 35^\circ$ [Ackerman mechanism]

distance b/w pivot pins = $C = 1.35m$

length trackarm = $r = 0.17m$

length of track rod = $l = 1.25m$

To find: wheel base 'b' for exact steering condition

3) Plastic spring
4) Air spring
5) Hydraulic spring.

TORSION BARS 7(a)

Torsion bar is simply a rod acting in torsion and taking shear stresses only. These are made of heat treated alloy spring steel. The amount of energy stored per unit weight of material is nearly the same as for coil springs. Torsion bar is often used with the independent suspension. A torsion bar suspension system is as shown below.

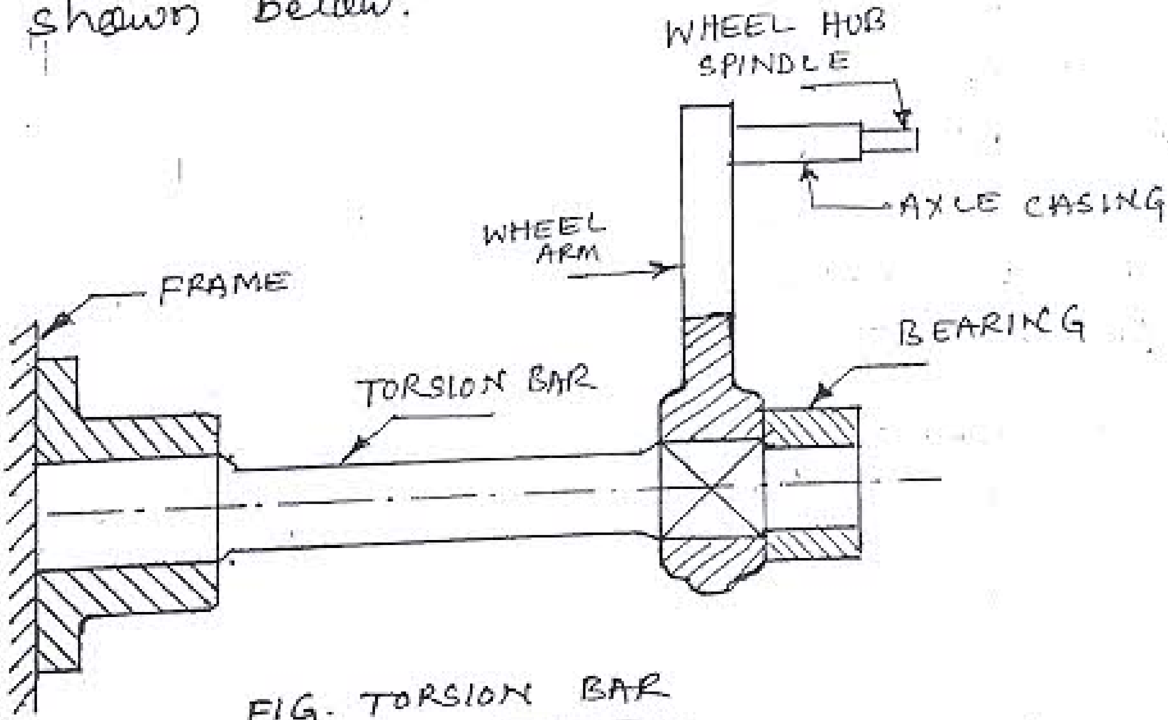


FIG. TORSION BAR

The bar is fixed at one end to the frame, while the other end is fixed to the end of the wheel arm and supported in the bearing. The other end of the wheel arm is connected to the wheel hub. When the wheel arm is connected to the wheel hub. when the wheel strikes a bump. it start vibrating up and down, thus exerting torque on the torsion bar. which acts spring. In this arrangement, the weight of the car ... ed on the three points.

Semi-Elliptic Leaf springs.

These almost universally used for suspension in light and heavy commercial vehicles. For car also, these are widely used for rear suspension, but now replaced completely by coil springs.

Construction: The spring consists of a number of leaves called blades. The blades vary in length as shown. The composite spring is based upon the theory of a beam of uniform strength. The lengthiest blade has eyes on its ends. This blade is called master leaf. All the blades are bound together by means of steel straps as shown below.

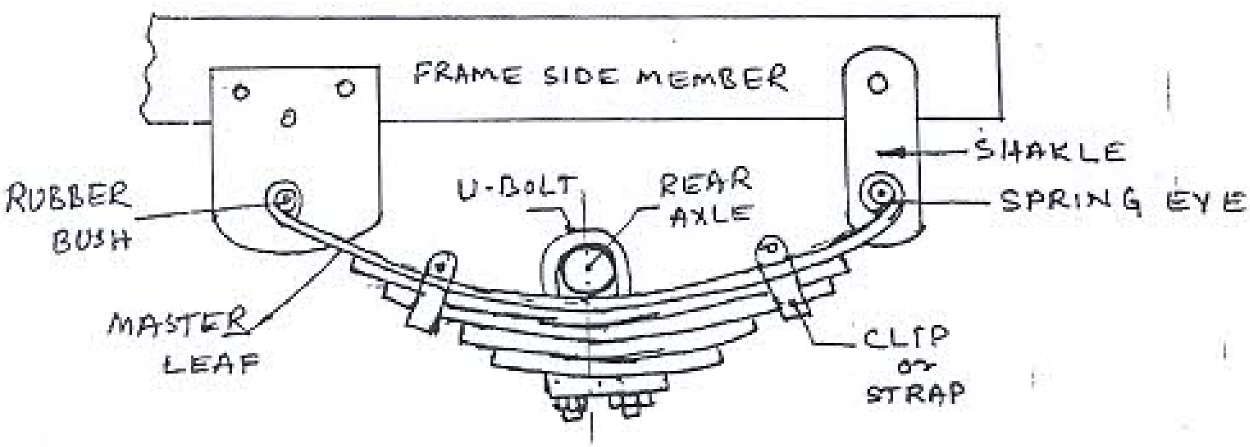


FIG. REAR LEAF SPRING

The spring is supported on the axle, front or Rear by means of U-bolt. One end of the spring is mounted on the frame with a simple pin, while on the other end, connection is made with a shackle. When the vehicle comes across a projection on the road surface, the wheel moves up, deflecting the spring

(7b)

This changes the length b/w the spring eyes. If both the ends are fixed, the spring will not be able to accommodate this change of length. This is provided by means of a shackle at one end which gives a flexible connection.

<u>Helper Springs</u>

Helper springs are provided on many commercial vehicles in addition to the main leaf springs. They allow for a wide range of loading. When the vehicle is only lightly loaded, these helper springs do not come into operation. But as the load is increased, they take their share of load. Generally helper springs are used on rear suspension only. The fig shows the helper spring.

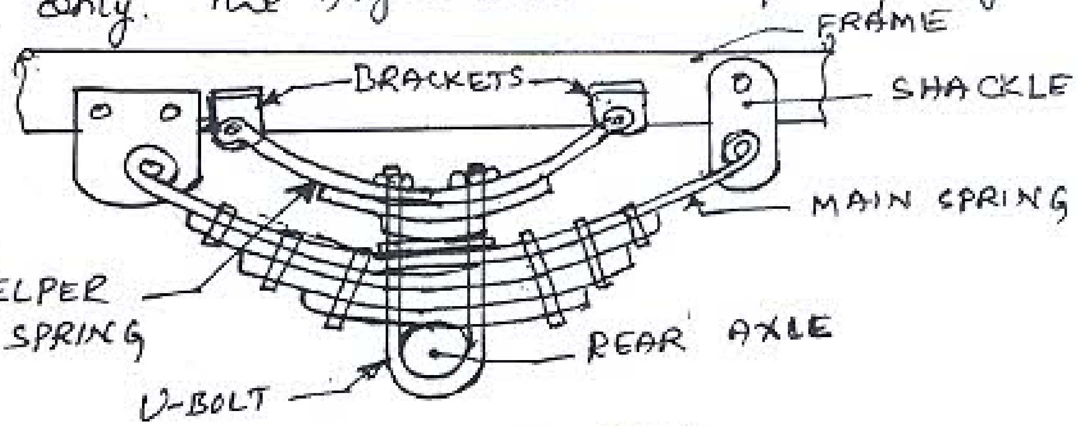


FIG. HELPER SPRING

When the load on the road wheel increases so much as to deflect the main spring to such an amount that the ends of the helper spring touch the special bracket fixed to the side member, the helper spring comes into operation.

Materials for Leaf Spring ⇒ 1. Chrome Vanadium steel (1.4%)

2. Silico-Manganese steel (Si = 1.95 & Mn = 1.05)

3. Carbon steel

... Si = 0.2

transmit pressure without loss equally in all directions".

Hydraulic Brake system [Construction & Operation]

Construction ⇒ 7(c)

It essentially consists of two main components Master cylinder and wheel cylinder The master cylinder is connected by tubing to the wheel cylinders at each of the four wheels. The system is filled with the liquid under light pressure when the brakes are not in operation. [The liquid is known as brake fluid; and is usually a mixture of glycerine and alcohol or caster oil de-natured alcohol and some additives.]

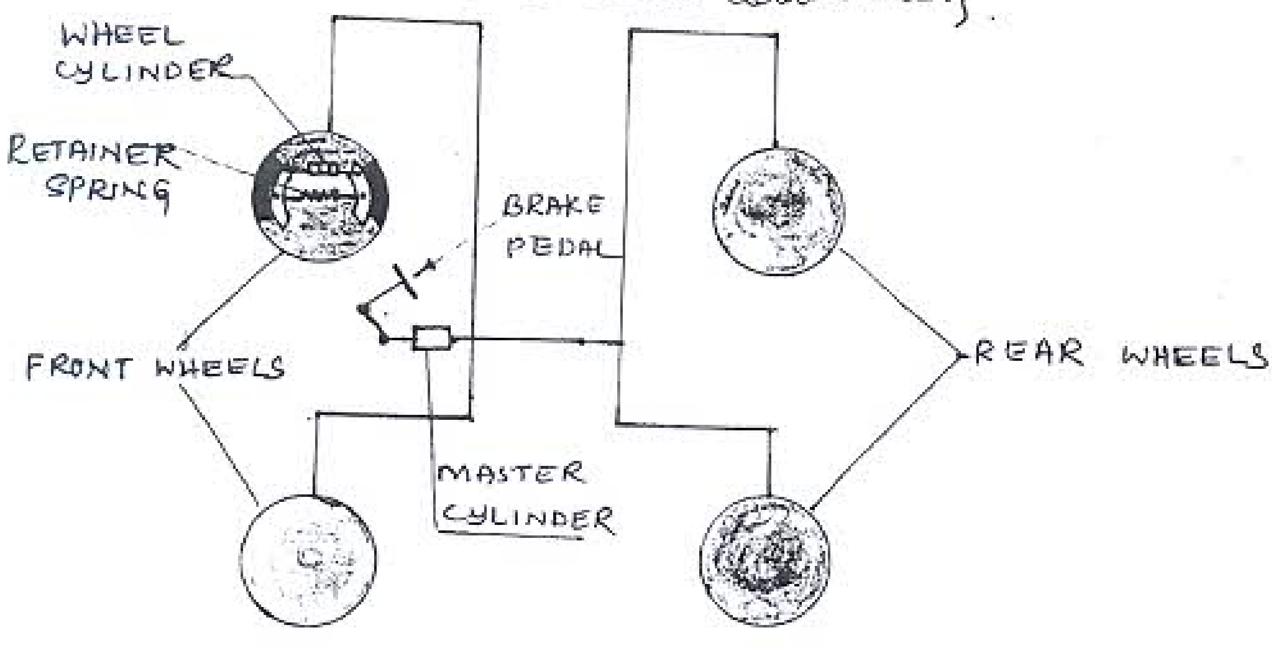


FIG. HYDRAULIC BRAKE SYSTEM

Each wheel brake consists of a cylinder brake drum which is mounted on the inner side of the wheel and revolves with it; and two brake shoes which are mounted inside the brake drums and do not rotate. The shoes are fitted with a heat and wear resisting brake lining on their surfaces. The brake pedal is connected to the master cylinder piston by means of piston rod.

Operation →

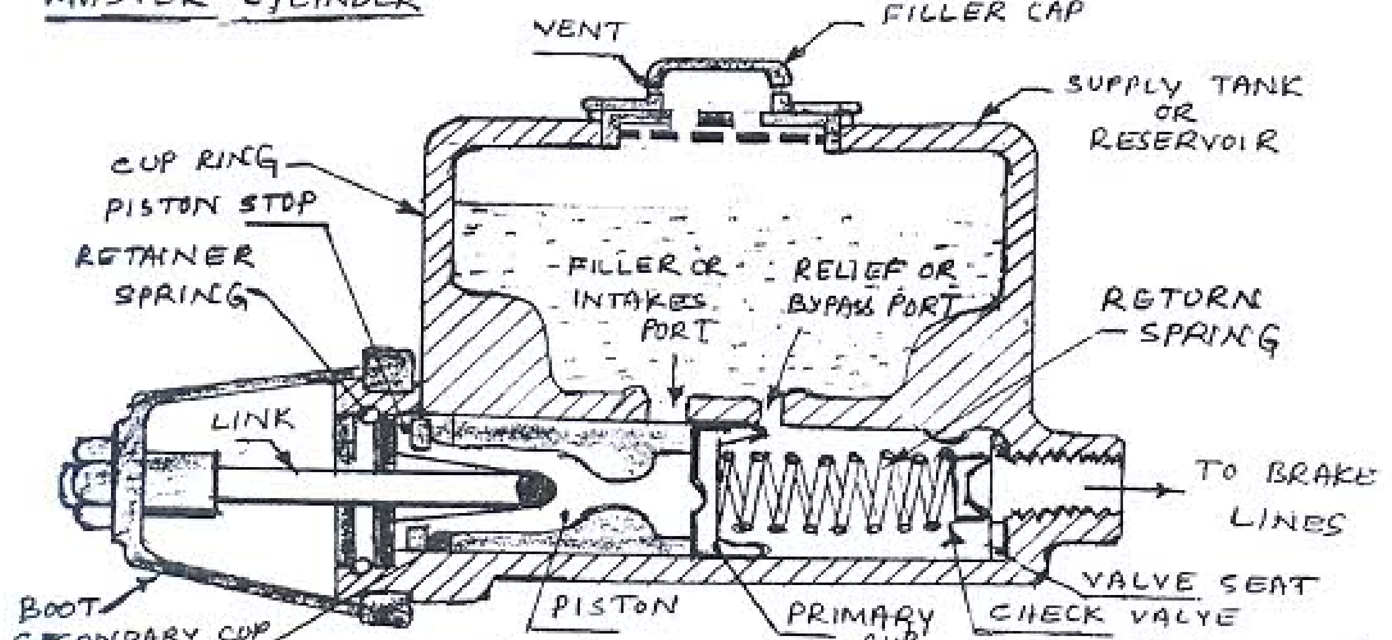
When the brakes are to be applied, the driver depresses the pedal, the piston is forced into the master cylinder, this increasing the pressure of the fluid in the master cylinder and in the entire hydraulic system. This pressure is conducted instantaneously to the wheel cylinders on each of the four brakes, where it forces the wheel cylinder pistons onward. These pistons, in turn, force the brake shoes out against the brake drums. Thus, the brakes are applied.

When the driver releases the brake pedal, the master cylinder piston returns to its original position due to the return springs pressure; and thus the fluid pressure in the entire system drops to its original low value, which allows retracting springs on wheel brakes to pull the brake shoes out of contact with the brake drums into their original positions. This causes the wheel cylinder pistons also to come back to the original inward position. Thus, the brakes are released.

MASTER CYLINDER

Construction → The master cylinder is the heart of the hydraulic brake system. It consists of two main chambers - the fluid reservoir which contains the fluid to supply to the brake system, and the compression chamber in which the piston operates. The reservoir supplies fluid to the brake system through two ports. The larger port is called the filler or intake port and is connected to the hollow portion of the piston b/w the primary and secondary cups which act as piston seals. The smaller port is called the relief, bypass or compensating port which connects the reservoir directly with the cylinder and lines when the piston is in the released position. The reservoir is vented to the atmosphere so that the atmospheric pressure causes the flow through the filler port. The vent is placed in the filler cap. The boot covers the push rod and the end of the cylinder to keep it free from foreign matter.

MASTER CYLINDER



WORKING ⟹ When the break pedal is depressed, the master cylinder piston moves forward to force the liquid under pressure into the system. The relief port is sealed out of the system. The liquid pressure is conducted to the wheel cylinders, where it forces the wheel cylinder pistons outward. These pistons force the brake shoes out against the brake drums.

When brake pedal is released, the return spring quickly force the master cylinder piston back against the piston stop. Because the fluid in the line returns rather slowly a vacuum tends to form in the cylinder in front of the piston. This causes the primary cup to collapse to allow the liquid to flow from the reservoir through the filler port past the piston to fill the vacuum. When the pedal is in "off"

The purpose of emission control is to reduce amount of pollutants and environmentally damaging substances released by the vehicles. If not controlled, the automobile can emit pollutants from fuel tank, carburettor, crank case and exhaust system into the atmosphere.

The emission of pollutants in automotives can be reduced by

1. Closed crank case ventilation
2. Fuel tank and carburettor ventilation
3. Redesigning the engine. [NO_x, HC, CO]
   i) Combustion chamber
   ii) Cooling system.
   iii) Fuel supply system and
   iv) Ignition system

CLOSED CRANK CASE VENTILATION [Controlling Crank Case Emi]

This system consists of two types

8(A) (i) Positive crankcase ventilation ✓
(ii) Fixed orifice system. ✓

i) Positive crank case ventilation Systems [PCV Systems]

When engine is running, some unburned fuel and combustion products leak past the piston rings and move into the crankcase. This leakage is called (blow by). This blow by must be removed from the engine crank case, before it condenses and reacts with oil form (sludge) which may corrodes and accelerates wear of pistons, piston rings, valves, bearings, etc. Sludge can also clog oil lines and (starve the lubricating system). As the engine oil circulates, it also carries blow by and some unburned fuel particles which are formed due to incomplete combustion of air-fuel mixture in the crank case. If not removed, this dilutes the engine oil and hence the oil does not lubricate the engine properly resulting in excessive wear. Filtered air from the carburettor air cleaner must be circulated through the crank case to remove blow by gases and gasoline vapours from the crank case. To prevent atmospheric pollution modern engines have a closed system called PCV system. The blow by gases and gasoline vapours are picked up by filtered air to the engine inlet manifold through a special PCV value and from there eners into engine combustion chamber with fresh charge and are burnt there.

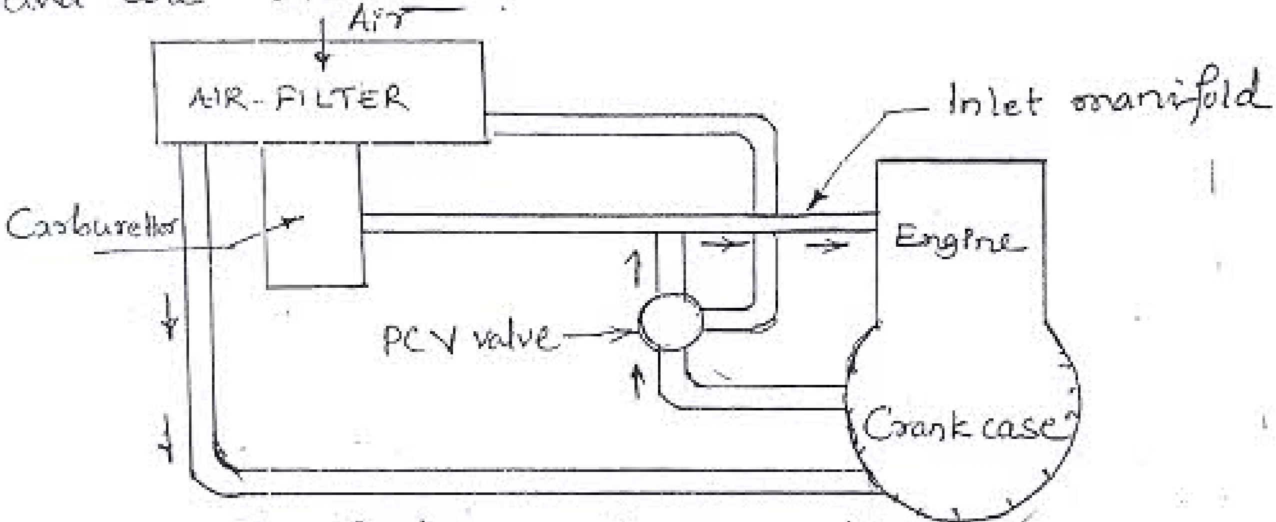


Fig1. Positive crank case ventilation

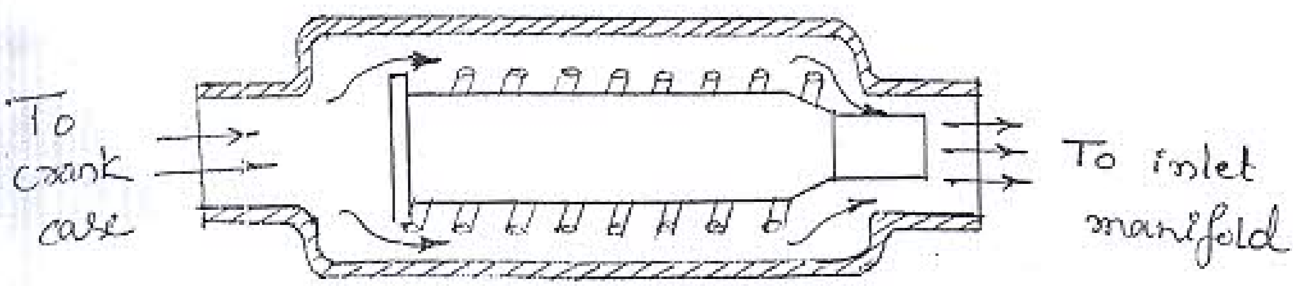


fig.2. PCV Valve

The PCV value consists of a spring loaded tapered valve. The valve is in closed position under the action of crank case pressure and manifold vacuum where as the spring pressure keeps the valve open thereby regulate the flow of blow by gases. During idle or deceleration (low speed) amount of blow by gas is less due to lesser engine load and a small PCV valve opening is needed to move blow by gases out of crank case. The high intake manifold vacuum moves the tapered valve against spring pressure, thus provides small opening in the valve for the flow of blow by gases. During part throttling, engine load is higher than at idle, blow by increases and manifold vacuum decreases. The spring moves the tapered valve to increase the opening. The larger opening allows all the blow by gases to enter into the intake manifold. At high speeds or when the engine is operating under heavy load, the throttle valve opens widely and decreases intake manifold vacuum. The spring moves the tapered valve further downward to provide a larger opening through the valve. The amount of blow by gases is more, when engine load is high, hence larger PCV valve opening is essential to allow these gases to flow through the valve into the intake manifold.

Fixed orifice tube PCV System

Some engines are not fitted with PCV valve. The blow by gases are routed into the intake manifold through a fixed orifice tube. This system works similar to PCV valve, except that the system is regulated only by the vacuum on the orifice. The amount of blow by gas, flows into the intake manifold is limited by the size of the orifice.

ical valve is operated by the throttle linkage. ... ling, it is open and causes the vapour to flow from float chamber in the canister. The opening of throttle closes the vent valve, like wise, the electrical vent valve is open when ignition is off. when the ignition is on, the vent valve is closed by the energization of solenoid.

Evaporative Control System (ECS) for fuel injected engines

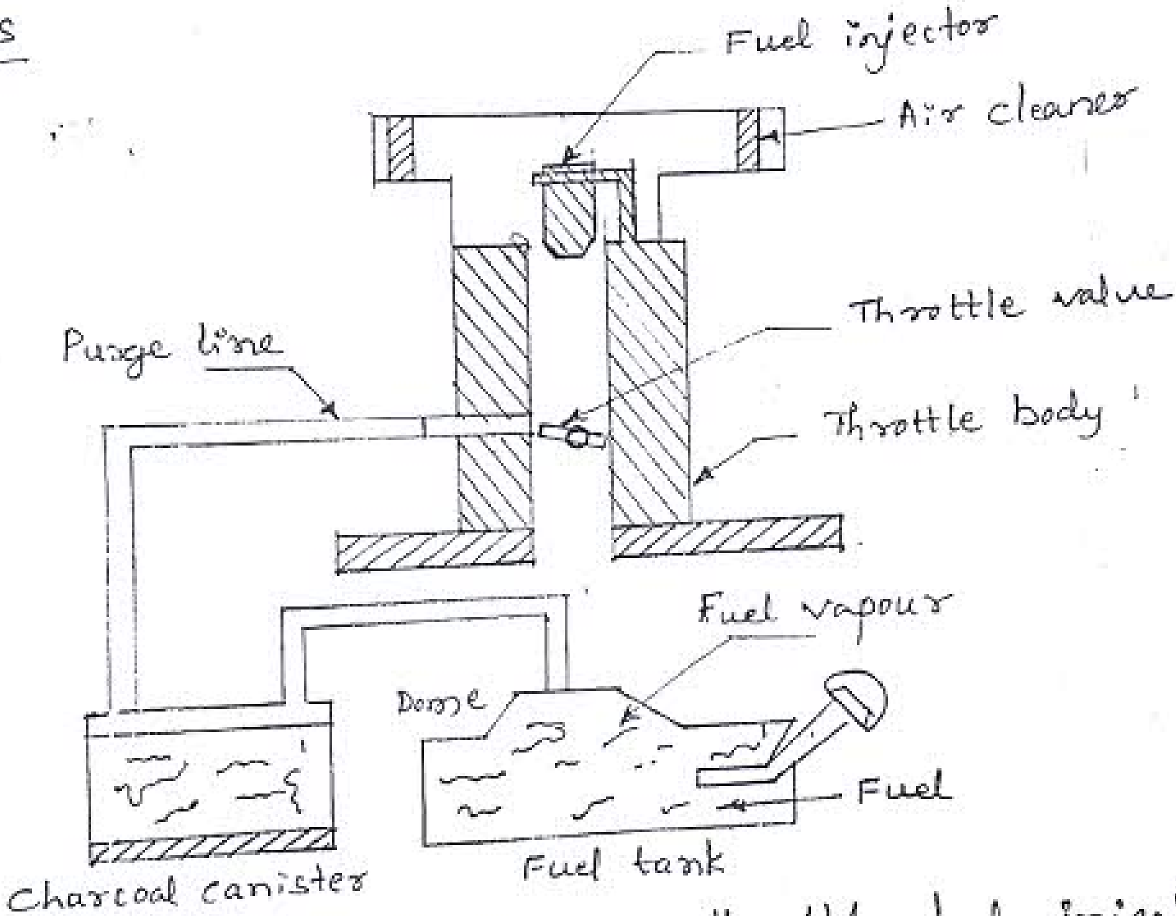


Fig. ECS for an engine with throttle body injection

The fuel injection system do not have float bowl, therefore ECS controls escape of fuel vapour from the fuel tank only. The canister is connected to hose from the fuel tank. The purge line from the canister is connected to the throttle body. An electric purge control solenoid may be used instead of vacuum operated purge valve. The solenoid valve may be fitted on the canister in the purge line and is normally open.

(a) Transmission controlled spark (TCS) or Transmission regulated Spark (TRS) system: It delays vacuum advance when the transmission is in neutral, reverses and low forward gears,

(b) Spark Delay Value (SDV) It prevents vacuum advance during certain conditions of vehicle acceleration.

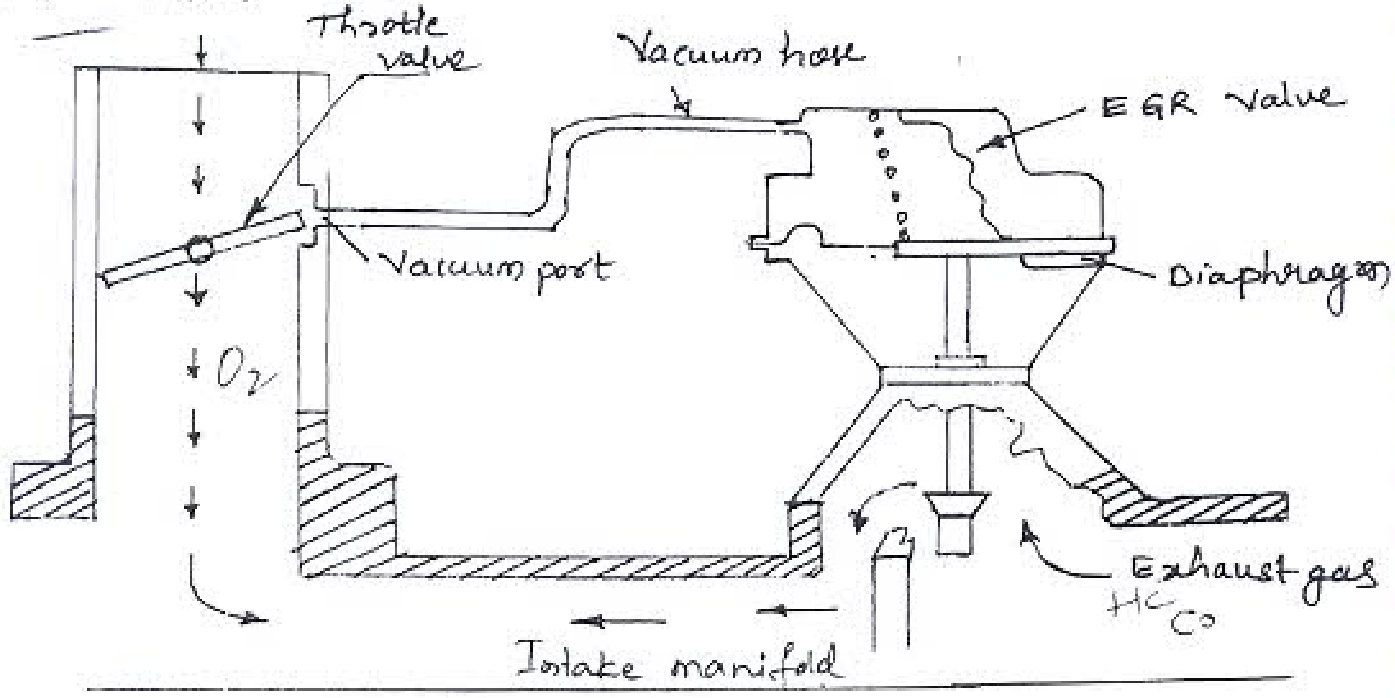
4. The carbon deposites present in the combustion chamber absorb air-fuel mixture and during exhaust releases air-fuel mixture. The HC in the exhaust gas, add pollutants to the atmosphere.

8(b) **Exhaust gas recirculation [EGR]** — T↑ NO_x↑

The higher combustion temperature (more than 1927°C) results in the formation of more Nitrogen oxides. The exhaust gas recirculated or (EGR system is used to lower the combustion temperature) and hence to reduce NO_x emissions in the exhaust gas. A small metered quantity (6 to 13%) of inert exhaust gas is sent back into the intake manifold to reduce combustion temperature and formation of NO_x. The exhaust gas is relatively at low temperature and absorbs heat from the much hotter combustion process, thereby reduces peak Combustion temperature and hence formation of NO_x)

The simplest form of EGR system is as shown in fig. It consists of a passage which connects exhaust manifold and intake manifold. The EGR valve opens and closes the passage and it consists of a spring loaded diaphragm that forms a vacuum chamber at the top of the valve. A tube connects vacuum chamber and vacuum port in the throttle body or throttle body ...

... spring
will close the passage. In this situation no exhaust gas recirculates, engine is idle and formation of NO_x is minimum.



Schematic diagram of EGR system.

When the throttle opens, it moves past the vacuum port. This allows the intake manifold vacuum to act through the port and moves the diaphragm up to open the valve. As the valve raises up, some exhaust gases passes through the valve into intake manifold. The exhaust gases mixes with air-fuel mixture and then enters into engine cylinders. This reduces combustion temperature and hence formation of NO_x.

When the throttle valve is fully opened, a little vacuum exists at the vacuum port and hence EGR valve is nearly closed. However No EGR is needed due to rapid combustion and there is less time for NO_x formation.

In most of the engines, vacuum is applied to the EGR valve through a ported vacuum switch (PVS) or thermal

... As vehicle population grow ...

8(c) become more congested the allowable emissions from engines have been lowered to maintain air quality in major cities. The pollutants from vehicles cause several health problems, leads to formation of smog and affects environment. Many countries are aiming at achieving safe concentrations of these pollutants by regulating their level of emissions. Emission standards are requirements that set specific limits to the amount of pollutants that can be released into the environment. These emission standards regulates pollutants realeased by automobile industry, power plants and diesel generators etc. Generally these standards regulate the emissions of nitrogen oxides, sulfer oxides, particulate matter (PM) or soot, carbon monoxide and volatile hydrocarbons. These emission standards puts limits for conventional pollutants and regulate green house gases particularly carbon dioxide. In USA, emission standards are managed by The Environmental Protection Agency. In the state of california, California's emission standards are set to influence emission requirements that major automakers must meet. The European Union has set its own emission standards for all road vehicles, trains, barges etc. No standards apply to seagoing ships or aeroplanes. The European Union have introduced Euro 4 from 1-1-2008, introducing Euro 5 from 1-1-2010 and Euro 6 from 1-1-2014. Many of the other countries also confirm to the euro 4 standard from Jan 2009. In 1989, India introduced first Indian emission regulations to

5(a)

5.52 Cone Clutch

In a cone clutch, the friction surfaces are made in the form of cones as shown in figure. Whe he clutch is in engaged position, one cone is fully inside the other and friction surfaces are i omplete contact. From the engine fly wheel, the torque is transmitted to splined gear box shat hrough cone 'A'. When the clutch pedal is operated, the cone 'A' is pulled out by using a leve ystem and the clutch is said to be disengaged. The springs keeps the cone 'A' pressed all the time gainst cone 'B'.

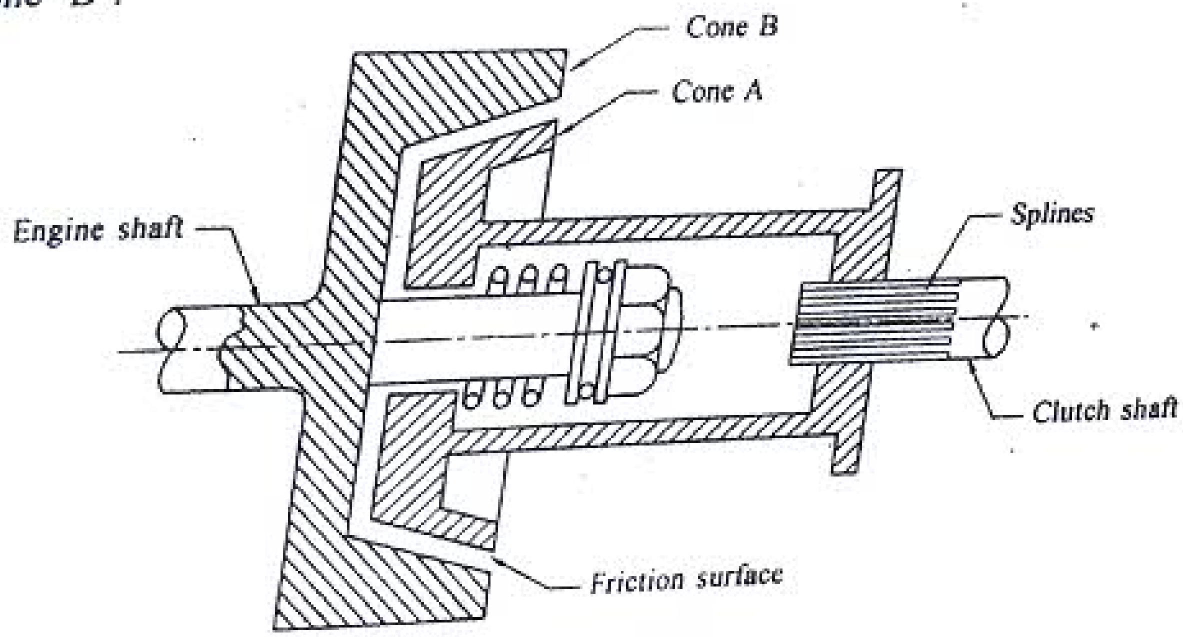


Fig. 5.4 : Cone Clutch

ntages

. When compared to single plate clutch, the normal force on friction surfaces is greater than axial force.

antages

It is difficult to disengage the clutch if cone angle is less than 20°, as one cone tends to bind in the other.

Even a small amount of wear on friction surface results in more axial movement of the cones.

5.(b) THREE SPEED SYNCHROMESH TRANSMISSION

In this type, all the gears on the main shaft are in constant mesh with the corresponding ge on the counter shaft. The main shaft gears are free to rotate, while counter shaft gears are fixed it. Since all the gears are in constant mesh, the gears on the input (clutch) shaft, main shaft (ou shaft) and counter shaft are always rotating with the running condition of engine. i.e. when t clutch gear is rotating. The figure shows a fully synchronized transmission, with all forward spe having synchronizing devices. The different gear ratios are obtained as follows :

Low Gear (First Gear)

Low gear is obtained by moving the synchronizer 'B' to the left and synchronizer 'A' is still the neutral position. Friction surfaces rubs against each other and the friction makes their sp equal. Further pushing of synchronizer 'B', causes it to mesh with teeth of low gear (No. 4) and drive is transmitted through 1–2–12–10–4–B–6 (input shaft – gear 2, 12, 10, 4 – Synchronizer through the splines to the output shaft) and low gear is obtained.

Second Gear

When the synchronizer 'A' slid to the right it meshes with gear 3 and second gear is obtain The drive is transmitted through 1–2–12–9–3–A–6 [B is in neutral].

Third (High) Gear [Direct Gear]

When the synchronizer 'A' slid towards left with 'B' is in neutral, it meshes with teeth of g 2. This locks the input and output shaft together and the power flow is direct. The cluster is dri and still turns the second gear which is free to turn on the output shaft.

Reverse Gear

Reverse gear is obtained by moving synchronizer 'B' to the right with 'A' in the neu position. The input shaft turns the cluster which in turn drives the gear '5' through '11' and '8'. T idler gear '8', changes the direction of rotation of input shaft [1–2–12–11–8–5–6].

5.12 SYNCHROMESH GEAR BOX (4 SPEED)

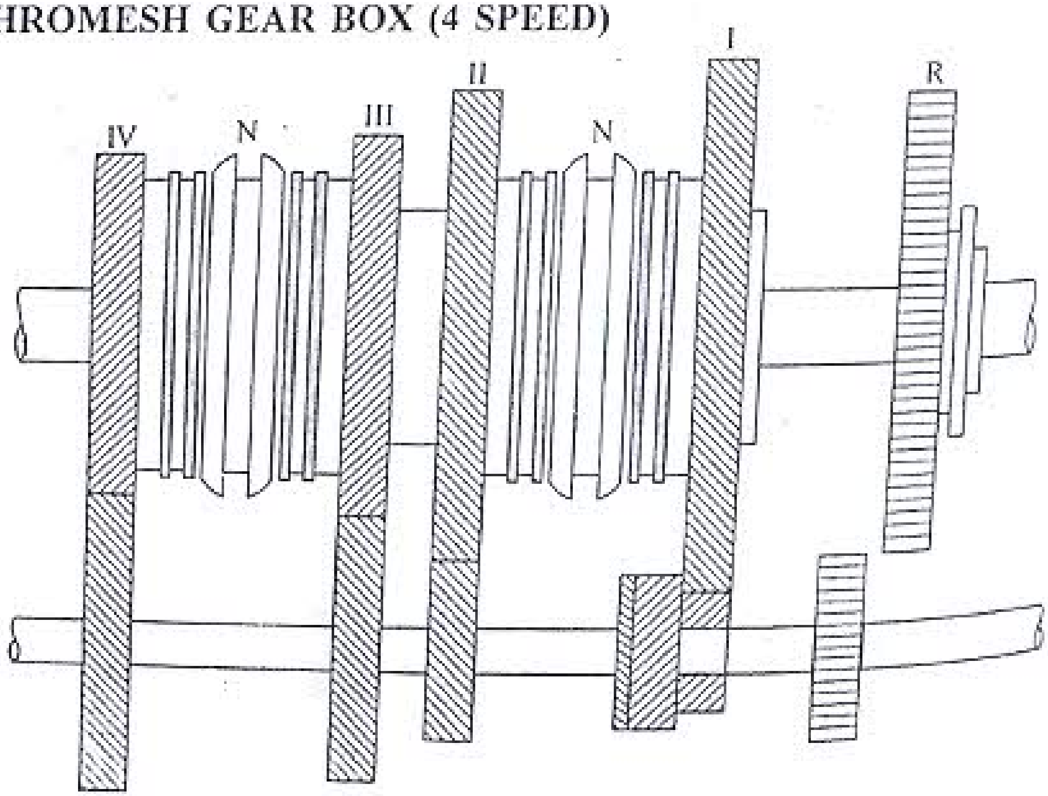


Fig. 5.11 : *Four speed transmission with all forward speed synchronised*

2(a)

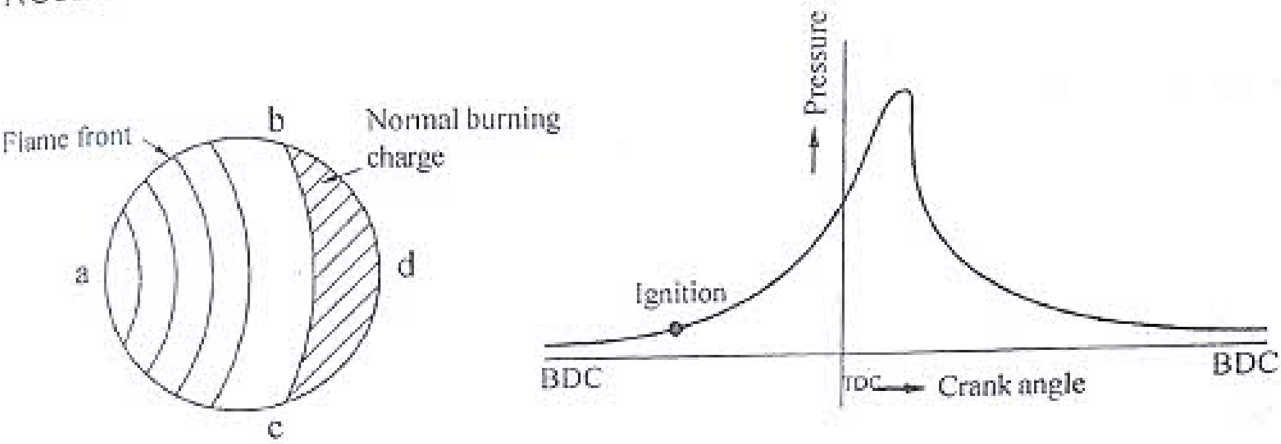


Fig. 2. 2 (a) Normal combustion

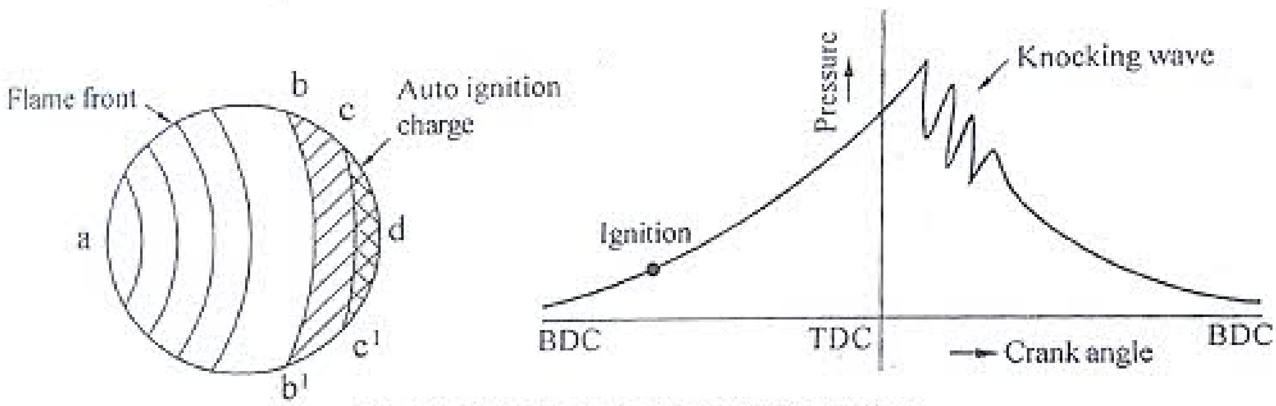


Fig. 2.2 (b) Combustion with detonation

In normal combustion the flame initiated by the spark moves across the combustion chamber a fairly uniform way i.e., it travels from *a* to *d* in a normal way. The speed of the flame front is)out 15 to 30 mis. The movement of the flame front compresses the unburned charge '*bcd*' thus ising its temperature. The reactions in the unburned mixture and radiation from flame front also icreases its temperature. If there is no auto ignition of unburned charge (temperature lesser than 'itical temperature), the flame front *bc* will move across through the unburned charge to the irthest point *d* in a normal manner. The corresponding pressure-crank angle diagram for normal ombustion is as shown in figure 2.2 (a).

2.5 CETANE AND OCTANE NUMBERS

Cetane numbers: In diesel engines, cetane number is a measure of ignition lag. Cetane is a str chain paraffin assigned with a rating of 100 cetane numbers (CN) and it has good ignition qu It is mixed with alpha-methyl naphthalene a hydrocarbon with poor ignition quality i.e., with cetane number. A CFR engine running under prescribed conditions test the fuel with this mix Thus the cetane number of the fuel is defined as the percent by volume of cetane in a mixtu cetane and alpha-methyl-nephthalene that produces same ignition lag as the fuel being tested, i same engine and under the same operating conditions.

For a diesel fuel, cetane rating is a measure of its ability to autoignite rapidly when it is inj in to the compressed air in the engine. The ignition delay is influenced by several engine de parameters such as compression ratio, injection rate, injection time inlet air temperature etc. hydrocarbon composition of the fuel and its volatality characteristics also affects the ignition d The cetane rating of diesel fuels ranges from 40 to 60. The octane fuels (gasoline) have ce numbers ranging from 10 to 20 showing their poor suitability as a diesel fuel. High cetane nur results in pre-ignition in diesel engine.

Octane numbers: The composition of fuel affects detonation. In SI engines, for a particular the rating is done by comparing its performance with that of a standard reference fuel which combination of Iso octane and n-heptane. Iso octane offers great resistance to detonations a assigned a rating of 100 octane number. On the other hand, n-heptane is a straight chain par and is assigned with a rating of '0' octane number. The percentage of ISO-octane by volume mixture of ISO octane and n-heptane, which exactly matches the knocking intensity of a given in a standard engine under prescribed operating conditions is terned as "octane number" of the If octane number of a fuel is 80, it means that it has a same knocking tendency of a mixture 80% ISO octane and 20% n-heptane by volume. The engine used to conduct test is CFR operative fuel research) variable compression ratio engine. The fuel is to be tested in the engine until the condition of detonation is reached in the engine. Then a mixture of ISO-octane n-heptane is prepared to produce detonation under the same conditions as the fuel under test. percentage by volume of ISO-octane in the mixture is nothing but the octane number of the f

2.83 S.U. Carburettor

S.U. Carburettor is a constant vacuum or depression type with automatically variable ch or venturi. The mixture compensation is achieved by maintaining constant vacuum over the jet varying the effective size of the jet. A S.U. Carburettor of horizontal type is as shown in figure separate idling or acceleration device is used here.

A spring loaded piston controls the air passage (Venturi) which is in the form of rectang opening of constant width and adjustable height. A slot is made in the piston which connects up side of suction disc and throttle passage. The lower side is exposed to atmospheric pressure. Th the position of piston at any instant depends upon the balance of it's own weight (down) against vacuum force (up). As piston weight is constant, vacuum also remain constant.

A Tapering needle is fixed to the piston. The piston movement varies the air passage a hence size of the petrol jet. The lower end of the needle is inside the main jet and the needle mov up and down as the piston moves up and down. This changes annular area for the fuel flow. Whe the needle moves up area increases and vice versa.

A damper plunger is used to regulate the rate of lift of the piston, but allows the same to f freely when throttle valve is closed. For acceleration, if the throttle valve is opened suddenly, th piston lifting speed is retarded by the damper plunger and provides additional depression over th fuel jet. This causes flow of more fuel and hence no seperate acceleration pump is required.

Jet adjusting nut is used to adjust mixture strength. Tightening the nut will raise the jet and th reduces the annular area for fuel flow. Similarly loosening the nut lowers the jet and thus increas fuel supply.

The unique feature of S.U. Carburettor is that it has only one jet. A constant high air veloci across the jet is maintained even under idling condition and the necessity for a seperate idling jet i obviated.

For cold starting a rich mixture is required. This is done by lowering the jet tube away from the needle by means of the jet lever, there by enlarging the jet orifice. The lever is operated from the dash board in the car.

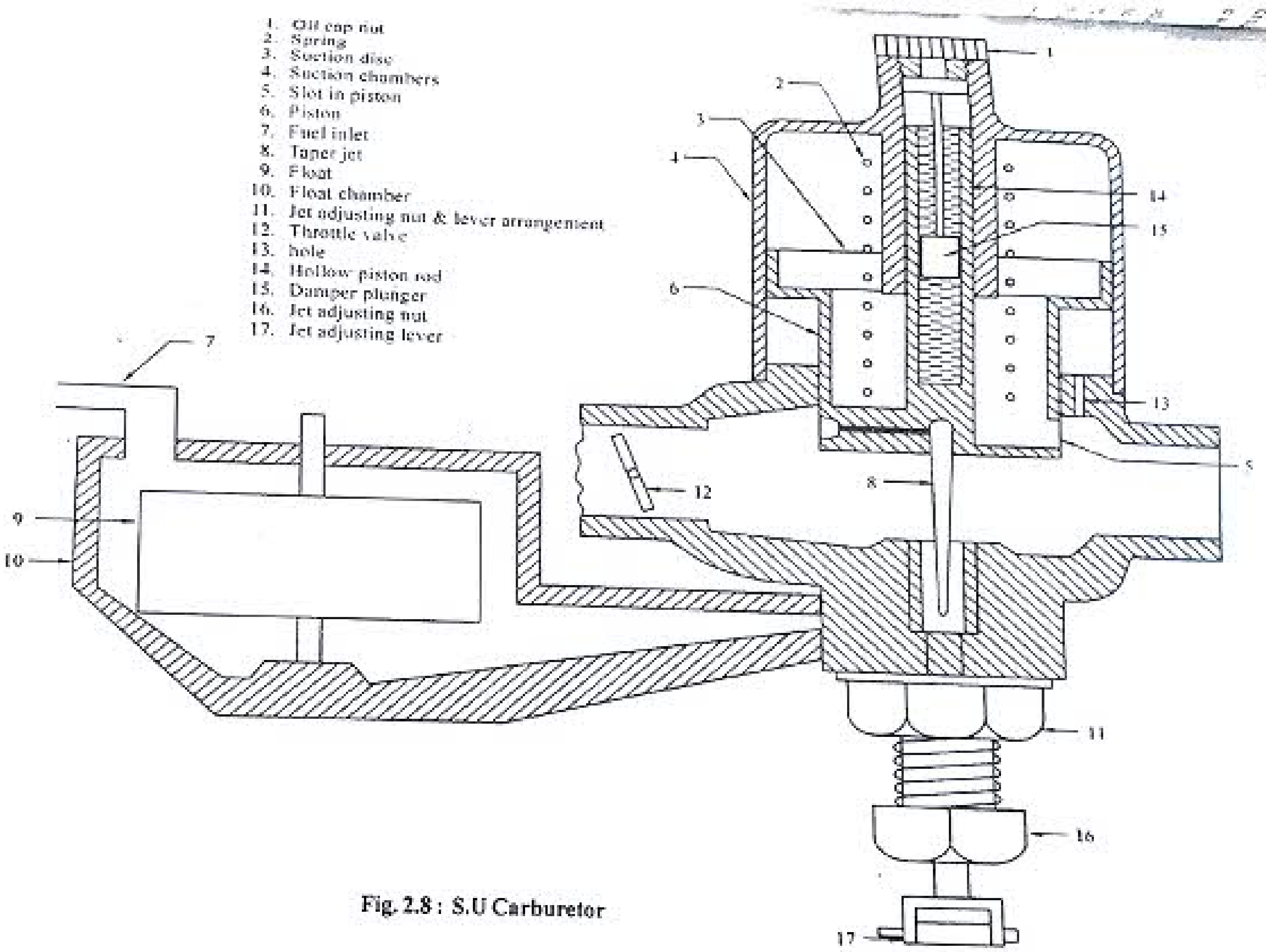


Fig. 2.8 : S.U Carburetor