



Lectures notes

On

**AUTOMOBILE ENGINEERING & HYBRID
VEHICLES**

Course Code-TH2

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Introduction to automobiles

①

CHAPTER-01

An automobile is a self-propelled vehicle which is used for transportation of goods and passengers upon the ground.

Motor vehicle

A vehicle or motor vehicle is a machine which is used for the transportation of goods and passengers.

Self-Propelled vehicle

It is a vehicle in which power required for the working is produced from within.

Ex:- Aeroplane, ship, motor boat, car, bus etc

Automobile Engineering

Automobile engineering is the branch of engineering science where we study all about automobiles and various systems of the automobile.

The automobile consists of various systems they are

1) Braking system.

2) Cooling and lubrication system

3) Fuel supplied system

4) Ignition system

5) Transmission system

6) Suspension System

(2)

Classification of automobiles

The automobiles can be classified on the following bases.

- 1) According to the purpose
 - a) Goods carrying vehicles (Ex:- Truck)
 - b) Passenger carrying vehicles (Ex:- Bus, car)
- 2) According to capacity
 - a) Light motor vehicle
 - b) heavy motor vehicle
- 3) According to fuel used
 - a) Petrol vehicles
 - b) Diesel vehicles
 - c) Electric cars
 - d) Steam based vehicles
 - e) CNG based vehicles
- 4) According to number of wheels :-
 - a) Two wheeler
 - b) Three wheeler
 - c) Four wheeler
 - d) Six wheeler etc
- 5) According to the drive of the vehicle
 - a) Single wheel drive vehicle
 - b) Two wheel drive vehicle
 - c) Four wheel drive vehicle

Classification of engine

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Engines can be classified on the following basis:-

1) According to combustion :-

- a) Internal combustion Engine
- b) External combustion Engine

2) According to fuel :-

- a) Petrol Engine
- b) Diesel Engine
- c) Steam Engine
- d) Alternative energy engine

3) According to number of strokes :-

- a) Two stroke Petrol
- b) Two stroke Diesel
- c) Four stroke Petrol
- d) Four stroke Diesel

4) According to Ignition :-

- a) Spark Ignition
- b) Compression Ignition

5) According to number of cylinder :-

- a) Single cylinder
- b) Two cylinder
- c) Four cylinder
- d) Six cylinder
- etc

6) According to method of cooling:-

(4)

- a) Air cooled engine
 - b) Water cooled engine
 - c) Oil cooled engine
- 7) According to the arrangement of cylinder
- a) Radial
 - b) Inclined
 - c) Horizontal etc
- 8) According to capacity ~~load~~
- a) Light weight engines
 - b) Heavy weight engine
- 9) According to the motion of piston
- a) Reciprocating
 - b) Rotary
- 10) Types of load

Load :-

Load is any external agent that applies force on a given body.

There are four types of load

- a) Dead load
- b) Variable load
- c) Suddenly applied load
- d) Impact load

Layout of Automobile :-

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Considering the external frame the layout of an automobile can be classified into two parts they are

- 1) Body
- 2) Chassis

1) Body :-

The Body of an automobile consist of the external frame such as gates, seats, windows, internal Accessories.

2) Chassis :-

It is the backbone of an automobile. The important components of the automobile such as transmission system, suspension system, Braking system, steering system are mounted on the chassis frame.

Function of chassis frame :-

- 1) It carries the load of all the system of an automobile.
- 2) To withstand the ~~the~~ forces caused due to sudden braking.
- 3) To withstand the stresses due to bad road condition.
- 4) To support the load of the passengers and goods.
- 5) To withstand the centrifugal force while turning of an automobile.

Main Components of the chassis :-

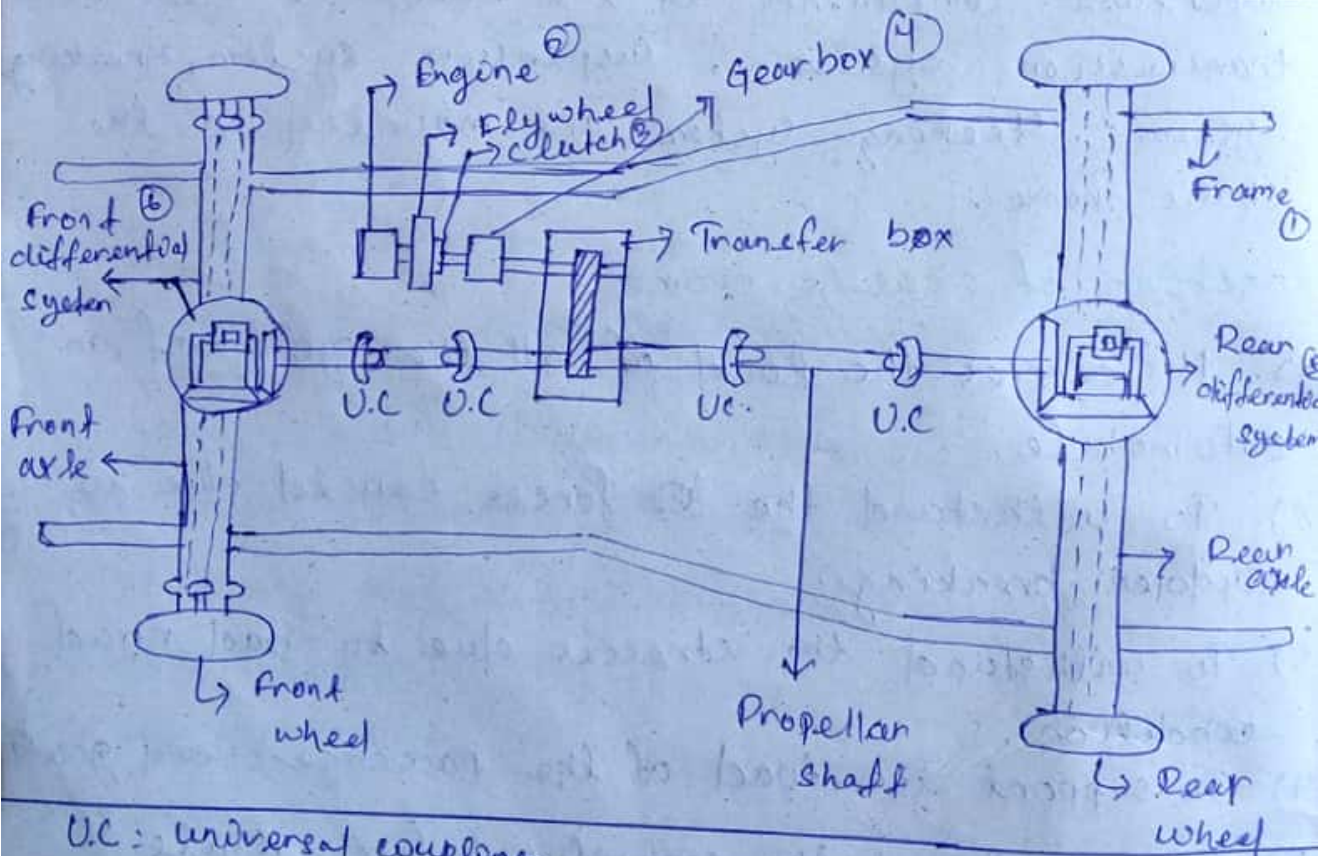
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There are various component of the chassis.

They are :-

- 1) Frame
- 2) Engine
- 3) Clutch
- 4) Gear box
- 5) Differential
- 6) Propeller shaft

Layout of chassis of an automobile :-



U.C.: Universal coupling

* Draw the layout of an automobile chassis showing its different components.

Specification of an automobile :-

(7)

There are different types of automobile running in day to day world.

- The automobile can be classified according to the five basic concept.
- These five basic concept describes the automobile according to its various features by they are :-

1) Type

This specification describes the class of automobile to which it belong for example :- Truck, bus, scooter etc.

2) Capacity :-

This specification of an automobile specified the load carrying capacity of the automobile for ex :- 100 kg, 200 kg, 1 tonne etc.

3) Drive :-

This specification of an automobile specified the number of gears to which power is transmitted by the engine with the help of transmission system.

4) Make :-

This specification of an automobile specified the name / ~~of the~~ company of the manufacturer. for ex :- Honda, Bentley, Volce Royce ,

5) Model :-

(8)

This specification of an automobile refers to a particular model manufactured by a company. ~~model~~ Ex :- Hyundai - i10, i20

Q. Specify a car, truck, motorcycle, scooter.

Braking System

Braking system of an automobile is the system which is responsible for stopping or carrying out controlled motion of an automobile.

Function Brakes in an Automobile / Requirement

for a brake :-

- 1) It is used to stop the vehicle in a smallest possible distance.
- 2) It is used to maintain and control the motion during the motion of the automobile on a slope.
- 3) It must absorb all shocks produced during the braking action.

Properties of a good brake :-

- 1) It must stop the vehicle in a smallest possible distance.
- 2) It should be strong enough to sustain the braking force.
- 3) It must be instantaneous.
- 4) It must be very accurate and it should not allow the wheels to ~~steer~~ slip and skid.
- 5) The brakes must be operated with least efforts of the driver.

Classification of Brakes :- (10)

Brakes can be classified according to various ways

- 1) According to the location in the vehicle
 - a) wheel mounted ~~brakes~~ brakes
 - b) Transmission mounted brakes
- 2) According to the actuating method
 - a) Mechanical Brakes
 - b) Hydraulic brakes
 - c) Pneumatic brakes (Air brake)
 - d) Air assisted hydraulic brake
 - e) ~~Vacuum~~ Vacuum brake
- 3) According to the basis of purpose served
 - a) Primary Brake
 - b) Secondary Brake
- 4) According to construction
 - a) Disc Brake
 - b) Drum Brake
 - c) Band Brake
- 5) According to the basis of Application of brake
 - a) Manual Brake
 - b) Servo Brake
 - c) Power Brake

- 6) According to the basis of combination:-
- Drum and Disc brake (11)
 - Mechanical and servo brake
- 7) According to the action of brake shoes:-
- Internal expanding Brake
 - External expanding Brake
- 8) According to the basis of Application of ~~by~~ brake by the driver
- Hand brake
 - Foot brake

Air Brake / Pneumatic Brake

The ~~can~~ braking system on which the brakes are applied with the help of pneumatic force are called air brakes or pneumatic brakes.

Construction of a Pneumatic Brake / Air Brake

The main components of the air brake consist of the following parts:

a) Compression:-

It is the component which is used to compress the atmospheric air and increase its pressure energy and kinetic energy.

b) Storage Tank:-

It is the reservoir for the storage of compressed gas produced by the compression.

It also consist of a safety valve to regulate the pressure inside the storage tank. (12)

c) Valve System

The valve system consist of 3 parts, one part is attached to the storage tank, one part is open to the atmosphere and the third part is attached to the break chamber. It also consist of a spring mechanism which is attached to the foot wear.

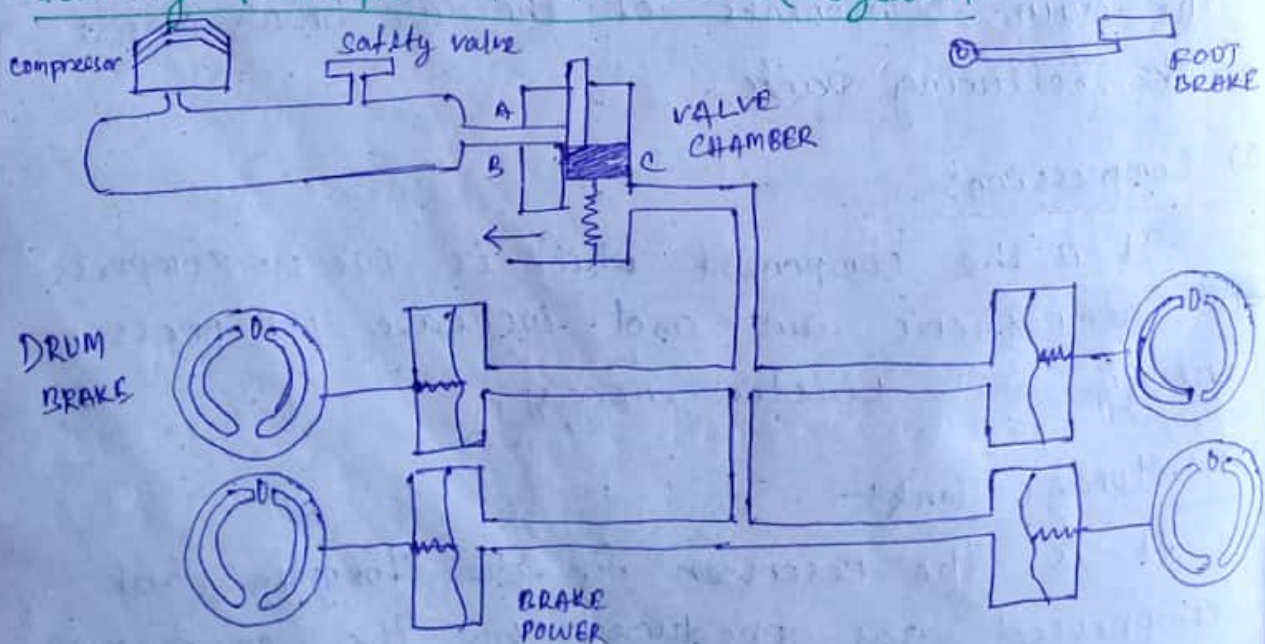
d) Break Chamber

The break chamber consist of a diaphragm which is attach to the break chamber. The break chamber is also connected to the cam by a connecting shaft.

e) Drum brake

The drum brake consist of the drum, break shoe & a cam attach to the break shoes. The pair of break shoes are connected to one another by means of a flexible connecting element.

Working Principle of Air brake System



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The compressor the atmospheric air & delivers it to the storage tank. The compressed air gets filled in the valve chamber through part 'A'. When the break pedal is applied to the spring mechanism in the valve chamber get compressed & the compressed air reaches the brake chamber. The pressure energy and kinetic energy of the compressed air pushes the diaphragm. This results in the movement of the connecting shaft attached to the cam. The cam thus rotates by 90° . which result in the movement of the break shoes towards the drum lining in this way the movement of the drum stops when breaks are applying.

Hydraulic Brake

Hydraulic Brake are the brakes in which the braking action is carried out with the help of the pressure exerted by the hydraulic fluid.

Construction

Hydraulic brakes consist of mainly two cylinder i) master cylinder and ii) wheel cylinder

Master cylinder

The master cylinder consist of a piston which reciprocating in nature. It is also connected with the fluid supply system.

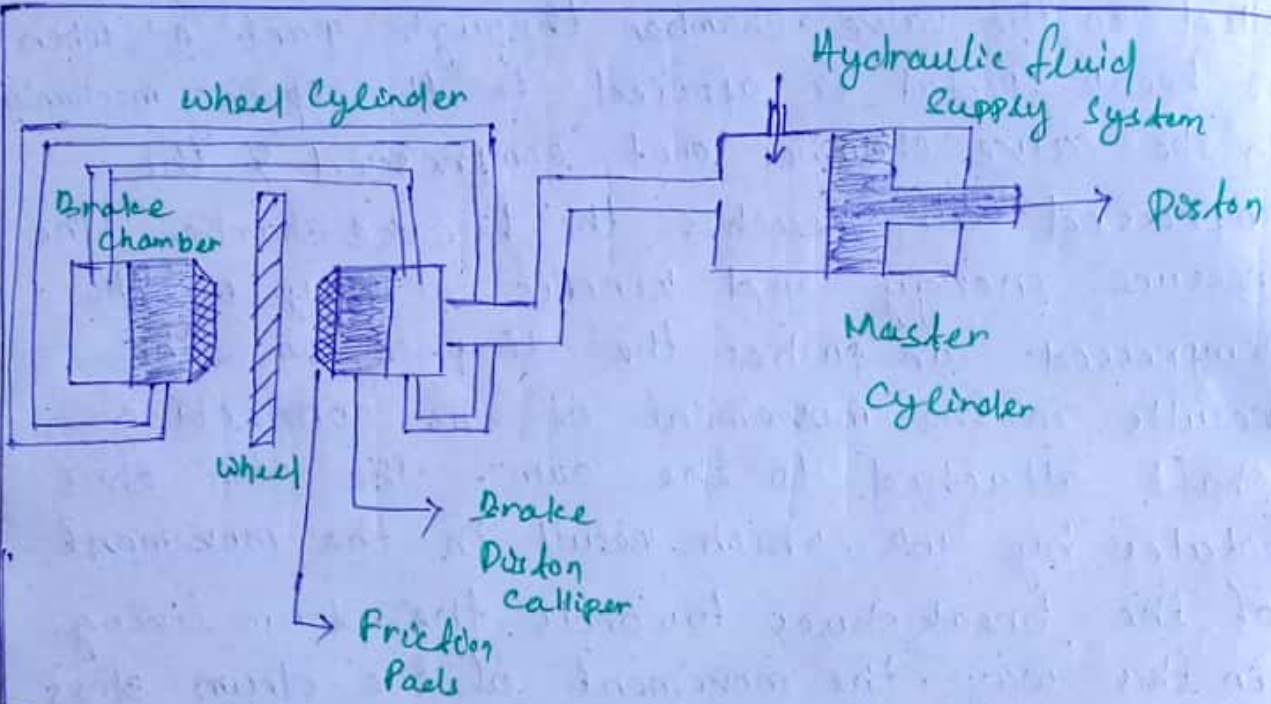
Wheel cylinder

The wheel cylinder consist of two brake chambers. Each brake chamber has a brake caliper ~~system~~ piston and friction pads are

attached to both brake caliper piston.

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Working Principle

When the brakes are applied then the piston in the master cylinder pushes the fluid towards the wheel cylinder. The fluid pressure reaches the brake chamber and there by pushes the brake caliper piston in the brake chamber.

When the brake caliper system moves towards one another then the friction pads attached to the brake caliper piston comes in contact wheels of the automobile. In this way hydraulic braking action is executed when the friction pads produce frictional effect and stops the motion of an automobile.

Vacuum Braking System

The braking system in which the brakes are applied with the help of vacuum pressure is known as vacuum braking system.

Construction of Vacuum Brake

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Master Cylinder :-

The master cylinder of vacuum brake consist of a piston arrangement which is attached with the foot brake pedal. The other end of the master cylinder is connected with the control unit.

Control Unit :-

The control unit of the vacuum brake is attached to the master cylinder with the help of a braking fluid. The control unit of the vacuum brake consist of two chambers with piston and spring arrangement in each chamber. One chamber of the control unit is connected with the vacuum reservoir and the other chamber is open to the atmosphere. The first chamber is also connected to the servo cylinder.

Servo Cylinder :-

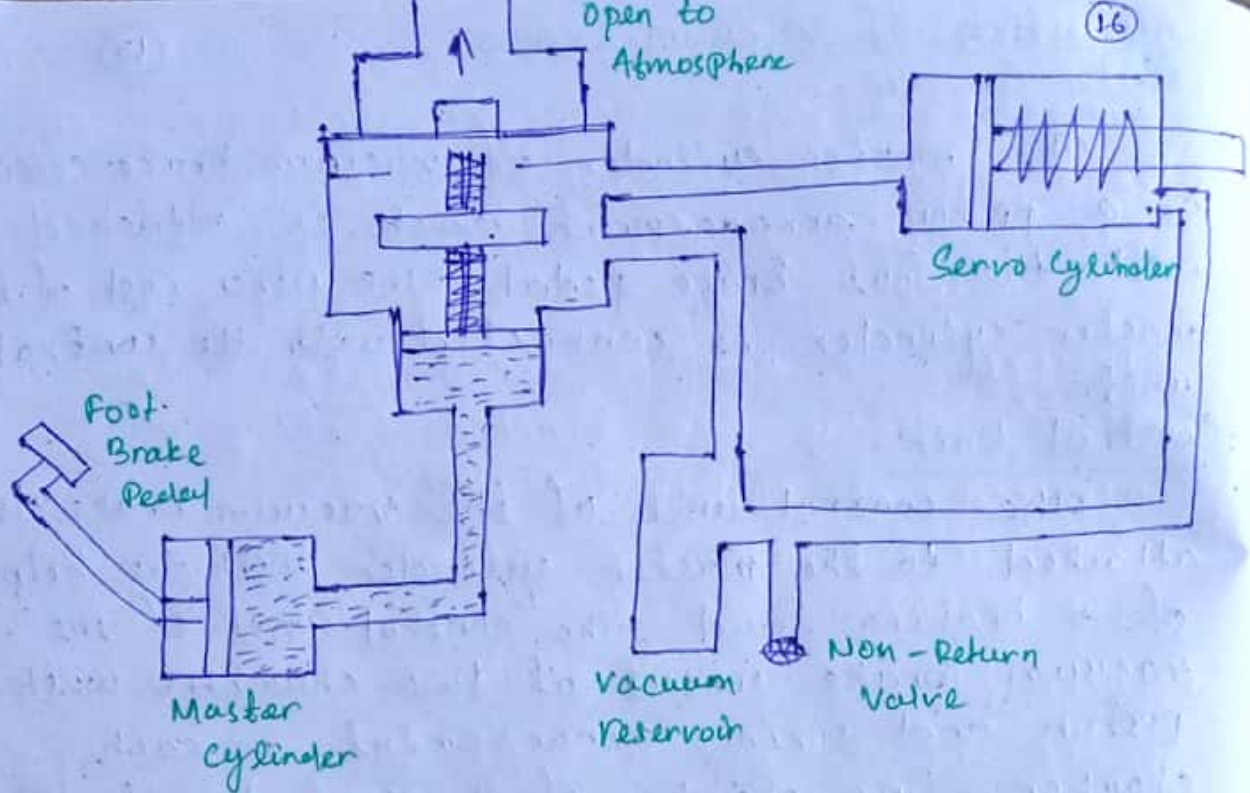
The servo cylinder of the vacuum brake is connected to the vacuum reservoir and the other end of the servo cylinder is attached to the control unit. The servo cylinder also consist of piston and a spring arrangement.

Vacuum Reserver :-

It is the place where the vacuum created by the vacuum pump is stored and supplied to control unit and servo cylinder.

Non-Return Valve :-

The reserver is also attached to a non-return valve so that the vacuum generated is stored safely.



Working Principle :-

When the vehicle is in motion then the first chamber of the control unit is opened and the second chamber of the control unit is closed. Both the chamber are filled with vacuum the servo cylinder also filled with vacuum in both side.

When the brake pedal are pressed then the piston in the master cylinder pushes the brake fluid towards the control unit. This results in the movement of piston and spring arrangement in both the chamber of the control unit. As a result of which the first chamber of the control unit is closed and the second chamber of the control unit is open. Atmospheric air rushes into the second chamber of the control unit and reaches to the servo cylinder.

We know that Atmospheric pressure is always greater than the vacuum pressure so difference in pressure in side the servo cylinder pushes the piston and spring arrangement and hence the brakes are applied.

Mechanical Brakes

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The mechanical brake can be classified into two types they are:-

- i) Internal expanding brake or drum brake
- ii) Disc brake.

i) Internal expanding brake or Drum brake :-

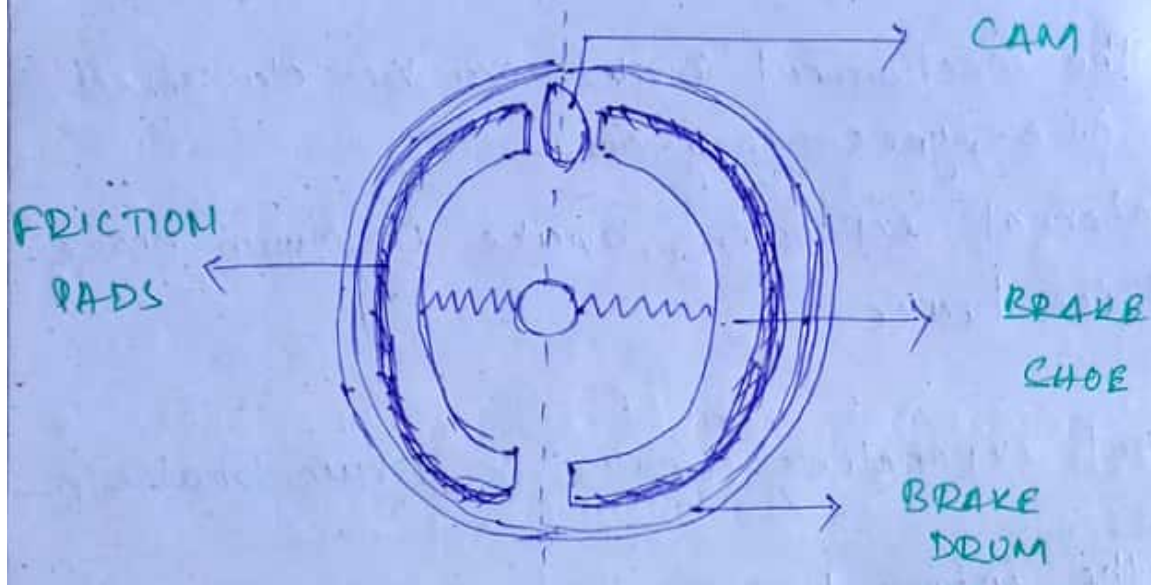
Construction:-

The internal expanding brake or drum brake consist of a brake chamber having two brake shoes. To each brake shoes there is a friction lining in

A cam is attached to both the brake shoe and the cam is rotated with the help of motion or movement of the brake ^{Pedal} ~~pedal~~.

Working Principle

When the brake pedal is applied then the cam rotates by 90° which results in the motion of the brake shoe towards the brake drum. This movement of the cam causes the friction pad to come in contact with brake drum. As a result of the contact between the drum brake and the friction line the movement of the automobile stops and braking action takes place.



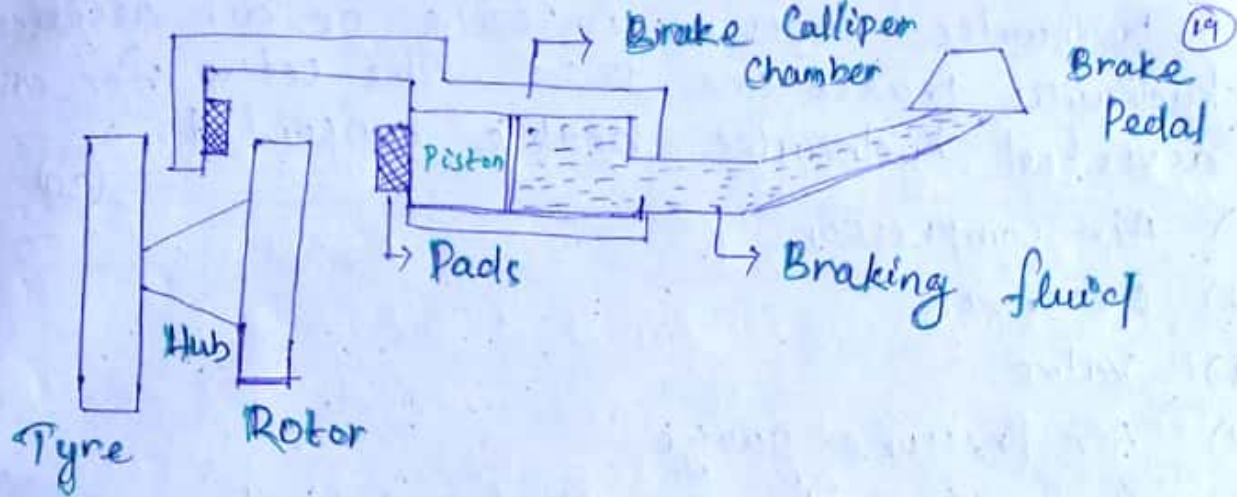
ii) Disc Brake :-

Construction :-

The Disc brake setup consist of a wheel hub that is attached to the rotore. The rotore is the moving element in case of disc brake setup. A brake calliper arrangement is present with two brake pads and one piston. The brake calliper chamber is also connected to the brake fluid. The movement of brake fluid depends on the movement brake padel.

Working Principle

When the brake padel are applied then the brake fluid starts flowing towards the brake calliper chamber. The brake fluid then pushes the piston which results in the movement of pads towards the rotore. When the pads comes in contact with the rotor then the motion of the automobile stops and braking action takes place.



→ Mechanical Brakes can be defined as the brakes in which the braking action takes place with the help of forces exerted by the components movements.

- In other words mechanical brake are the brake in which braking action takes place with the help of mechanical forces.

Air Assisted Hydraulic Brake System

Air assisted hydraulic brake are the brake where the air pressure is converted into hydraulic pressure.

In other words air assisted hydraulic brake in which braking action is performed with the help of both air pressure & hydraulic pressure.

Construction

In this type of brake the power cylinder containing air is connected to the hydraulic master cylinder and the reservoir. The ratio between the

hydraulic pressure in case of air assisted hydraulic brakes are 15:1. The setup for air assisted hydraulic brake consists.

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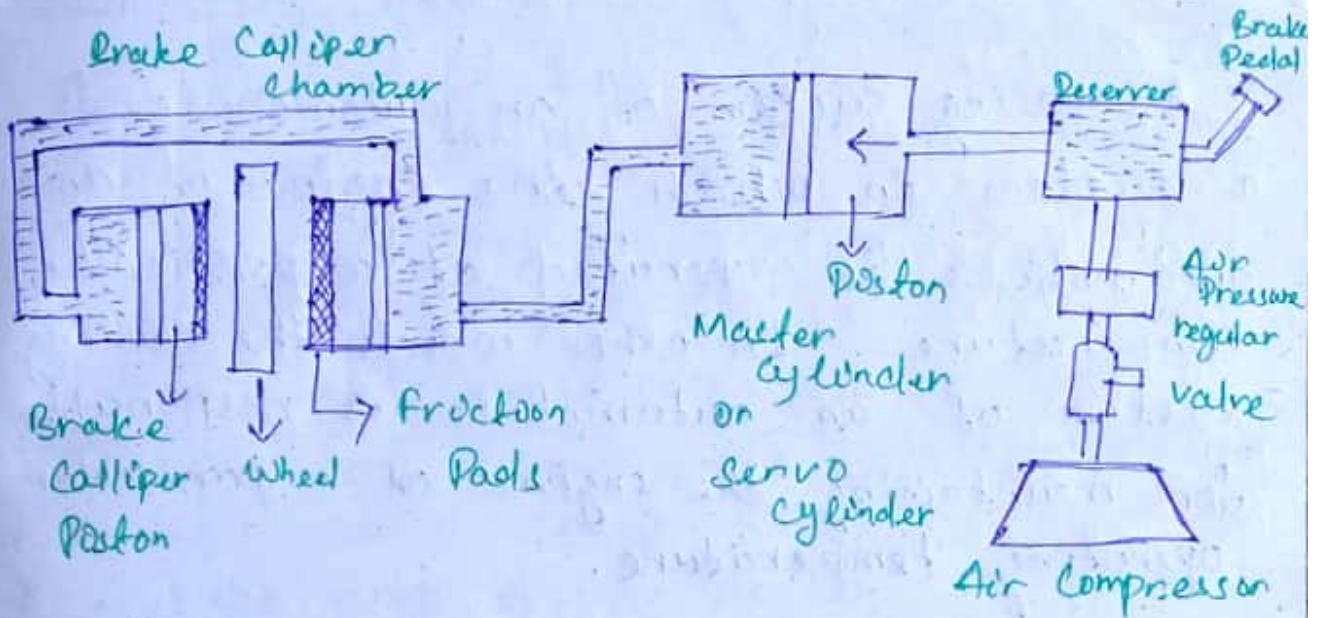
- 1) Air Compressor
- 2) Reserver
- 3) Valve
- 4) Air Pressure gauge
- 5) Servo cylinder or Master cylinder
- 6) Air pressure Regulator

The compressed air is developed by the air compressor and it is used to the assist the hydraulic brake system for the braking action in an automobile.

Working Principle

When the brake pedal is pressed by the driver then the air stored in the reserver is moved with the help of the input rod. The input rod opens the inlet valve and the air pressure is admitted into the space behind which moves the piston in the servo cylinder. The movement of piston in the servo cylinder guides the hydraulic fluid ~~and~~ or braking fluid into the brake calliper chamber. Inside the brake calliper chamber the braking fluid pressurises the brake calliper pads. As a result of the contact between the brake calliper pad and the wheel of an automobile, Braking action takes place.

and the motion is prevented. (21)



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Cooling & Lubrication System [Ch-02]

A cooling system of an automobile is a system in which the engine of an automobile is operated at a particular temperature. In other words the cooling system of an automobile is responsible for maintaining the engine at a particular operating temperature.

⇒ Why do we need a cooling system in an automobile?

Ans When combustion takes place inside the engine cylinder then a large amount of heat is generated which is about 1400°C .

One third of the heat is utilised for the piston work and another one third of the heat is liberated through exhaust valve in the form of burned gases and the rest one third of the heat is removed by the cooling system.

In absence of the cooling system the high temperature inside the engine cylinder may cause severe damage to the walls of the cylinder, piston ring, piston head so a cooling system is very necessary for maintaining the engine ~~oper~~ at a particular operating temperature.

Types of cooling system:-

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In case of automobile there are various types of

- i) Air cooled automobiles
- ii) Water cooled automobiles
- iii) Oil cooled automobiles

i) Air cooled ~~system~~ cooling:-

- In case of air cooled automobile air is used as a cooling medium. In this case the air is in direct contact with the external surface of the engine.

- The heat exchange takes place between the moving air and the external surface of the engine.

- There are two types of air cooled automobile

a) Air Jacket Cooling:-

In this type of cooling system the air is made to pass through the small passages formed in the cylinder block. The construction is made in such a way that the air is passed through single or multiple passage either naturally or artificially.

b) Natural Cooling System:-

In this type of air cooling system the heat exchange directly takes place between the air and external surface of the engine.

In this case larger part of the engine is exposed to the atmosphere.

i) Water Cooling System:-

In this case water is used as the cooling medium here different arrangements are made in the engine cylinder so that water can circulate around the engine cylinder.

(24) The heat transferred to the water surrounding the cylinder. The liquid is pass through a radiator designed to exposed as large as area possible to the air. Air is circulated over the radiating surface by means of fan. There are two types of water cooling system. They are

- a) Thermo-siphon System
- b) Pump-circulating System

a) Thermo Siphon System :-

In this type of cooling system the water is stored in a space surrounding the engine cylinder. Here the exchange of heat takes place between the water and the engine cylinder. Since the water in the jackets is heated it becomes lighter and rises up in the jacket and the cold water in the jacket settles down. This process continuous and the water circulation around the engine cylinder removes the unwanted heat.

b) Pump Circulating Cooling System :-

In this type of cooling system the water is circulated around the engine cylinder to remove the heat generated inside the cylinder due to the combustion of air fuel mixture.

Here a pump simple in construction is utilised to add the velocity to the water during circulation. It causes the water to

reach all the complicated regions of the engine cylinder and ensure the quick removal of unwanted heat inside the engine cylinder. (25)

Defects in cooling system and its possible remedies :-

<u>DEFECT</u>	<u>REMEDIES</u>
1) Coolant leakage due to	
i) Radiator core →	Use radiator sealing compound
ii) Water Pump →	Weld the crack
iii) Cylinder head →	Replace the cylinder head
iv) Hoses and hose connection →	Repair or replace the hoses & hose connection
2) Engine Overheating due to	
i) clogged radiator	i) clean the radiator by cleaning compound
ii) Hoses	ii) Repair if possible or replace the hoses
iii) Thermostat	iii) Repair if possible or replace the thermostat
iv) Piston & bearing	iv) Free up the piston & bearings if they are too tight
v) Broken shaft of the water pump	v) Repair if possible & replace the pump
3) Engine overcooling due to thermostat	Repair if possible or replace the thermostat
i) Thermostat	
ii) Improper flow of coolant	check the spring valve repair if possible replace the thermostat

4) coolant freezing

Add anti-freezing solution

(26)

5) Noises due to

- i) Dry bearings
- ii) Loose pulley
- iii) Loose impeller
- iv) faulty shaft

- i) Lubricate or apply grease
- ii) Tighten or replace pulley
- iii) Tighten or replace impeller
- iv) Repair or replace shaft

Lubrication System :-

- The lubrication system of an automobile is the system which removes the excess heat between the two moving parts.

- In other words the lubrication system of an automobile is responsible for reducing the friction between the two surfaces which are in contact with each other.

The main parts of the engine where the lubrication is strictly needed is

- i) Crank shaft and bearing
- ii) Cam shaft and cam bearings
- iii) Piston ring and engine cylinder
- iv) Bearing present in the connecting rod etc.

Need of the lubrication system :-

→ It reduces the force of friction between the two surfaces in contact.

→ Loss of power due to friction is also reduced.

→ Heat produced due to friction is also removed by the lubricating ~~agents~~ agents.

- Heat generated due to the combustion of fuel inside the engine cylinder is also somehow removed by the lubrication system. (27)
- Lubrication system helps in the removal of dust, dirt and other unwanted matter from the surface of the various parts.
- Carbon deposits from the surface of engine parts are also removed with the help of lubrication system.
- A good lubrication system also act as a good shock absorber between the parts in contact.

Types of lubrication system in Automobile:-

There are various types of lubrication system which are used in different automobiles according to its needs and necessity.

There are

- 1) Petrol lubrication system
- 2) Super lube lubrication system
- 3) Splash lubrication system
- 4) Pressure feed lubrication system
- 5) Semi-pressure feed lubrication system
- 6) Dry sump lubrication system.

1) Petroil Lubrication System :-

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- The substance petrole is nothing but the combination of petrol & oil. In this method the shorter amount of lubrication oil is mixed with petrol.
- The amount of oil in 1 ltr of petrol is about ~~20ml~~ 20 ml to 40 ml. The mixing of petrol and oil is done manually.
- In this type of lubrication system is mixing of petrol and oil and this petrol is distributed to the various part which are in contact with each other.
- One major disadvantages of the petroil lubrication is that it is uniformly distributed over the parts in contact with each other.

2) Superlube lubrication system :-

The superlube lubrication system is preferred over petroil lubrication system. In this method the oil tank is situated at a higher position just below the rockers seal. From the tank the oil is connect to the oil pump. The oil pump outlet is connect as the carburetor with the help of check valve. The check valve operates at a particular pressure of the oil. In this system after passing through the check valve the oil is supplied to a rotary valve fitted to a nozzle. This nozzle is used to

inject oil into the parts which are in ⁽²⁹⁾ direct contact with each other. In this case the amount of oil supplied can be increased with the increase in speed of the automobile.

3) Splash Lubrication System :-

In case of splash lubrication the parts are lubricated by a splash of oil which is made from a scoop present near the end of the connecting rod. The action takes place when the scoop dips into the oil reservoir, lift some amount of oil and splash the oil under the effects of centrifugal force.

This splashing action creates a mist which reaches the parts which are in contact with each other.

The scoop are made of a hollow semi-circular container which can keep the oil with them.

4) Pressure feed lubrication system (80)

In this type of lubrication system the oil necessary for lubrication is stored inside the engine from where it is circulated to the various parts where friction occurs.

In this case the oil necessary for that why it is called wet sump lubrication system.

In this system the oil is circulated under pressure that's why it is known as pressure feed lubrication system.

* Why Pressure feed lubrication system is known as wet sump lubrication system.

Ans:- Because the oil necessary for the lubricating action is stored inside the engine cylinder so it is called wet sump lubrication system.

5) Semi Pressure feed lubrication system

The semi pressure feed lubrication system is the combination of pressure feed lubrication system and splash lubrication system. In this case the oil from the oil tank is transported through the oil pipe with the help of oil pump.

The oil goes through the oil pipe to top of the engine then reach the cam and cam shaft for the lubrication of cam surface.

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The oil then flows down the sump and reaches the other part due to gravity it cylinder wall piston and piston ring are lubricated with the help of splash lubrication.

6) Dry Sump Lubrication System

This type of lubrication system is used in racing car and air craft. where the position of the vehicle is not same all the time and the position keeps on changing.

In this case the oil from the lubricating system reaches the parts where ~~friction~~ friction is produced under the effect of thermal pressure ~~arised~~ inside the engine. In normal type of lubrication system a problem may arise the oil will roll down to a side from where it is impossible for the pump to collect and circulate the oil. In case of dry sump lubrication system pressure valve are utilised which operates according to the rise in temperature between the parts generating ~~friction~~ friction.

Ignition System

Ignition System of an automobile is the system which is responsible for igniting the air fuel mixture inside the engine cylinder. There are two type of Ignition system which are responsible for combustion of air fuel mixture.

- 1) Battery Ignition System
- 2) Magneto Ignition System

There are two types of engine which are generally used as a part of ignition system they are

- 1) CI Engine (Spark Ignition Engine)
- 2) CI Engine (Compression Ignition Engine)

1) Battery Ignition System

Battery Ignition System is the Ignition system in which voltage is produced by a battery. It works on the principle of mutual electromagnetic induction.

Construction:-

It consist of various devices which are used to deliver electric current and generate a spark. They are

- 1) Battery:-

Battery is a mechanical device which is

use to produce voltage and delivers electric current. Normally lead acid battery are used in battery ignition system. (33)

2) Ignition Switch:-

The Ignition switch of a battery ignition system is a device which allows the flow of electric current in the circuit whenever it is necessary.

3) Ammeter:-

It is a device which is used to measure the magnitude of electric current.

4) Ignition Coil:-

An Ignition coil is nothing but a step-up transformer. It consist of a laminated core made of iron, primary winding and secondary winding.

a) Primary winding:-

The primary winding of the Ignition coil consist of 200 - 300 turns of thick wires producing a voltage of about 400 volts.

b) Secondary winding:-

The secondary winding of ignition coil consist of about 15000 - 20000 turns of thick wires producing a voltage of upto 15000 volt.

Contact breaker :

(34)

The contact breaker is used in battery ignition system works with the help of a cam. The contact breaker is responsible for the making and breaking of the circuit. The contact breaker is generally connected to the primary winding where the voltage produced is transferred to the secondary winding without any burning of the circuit.

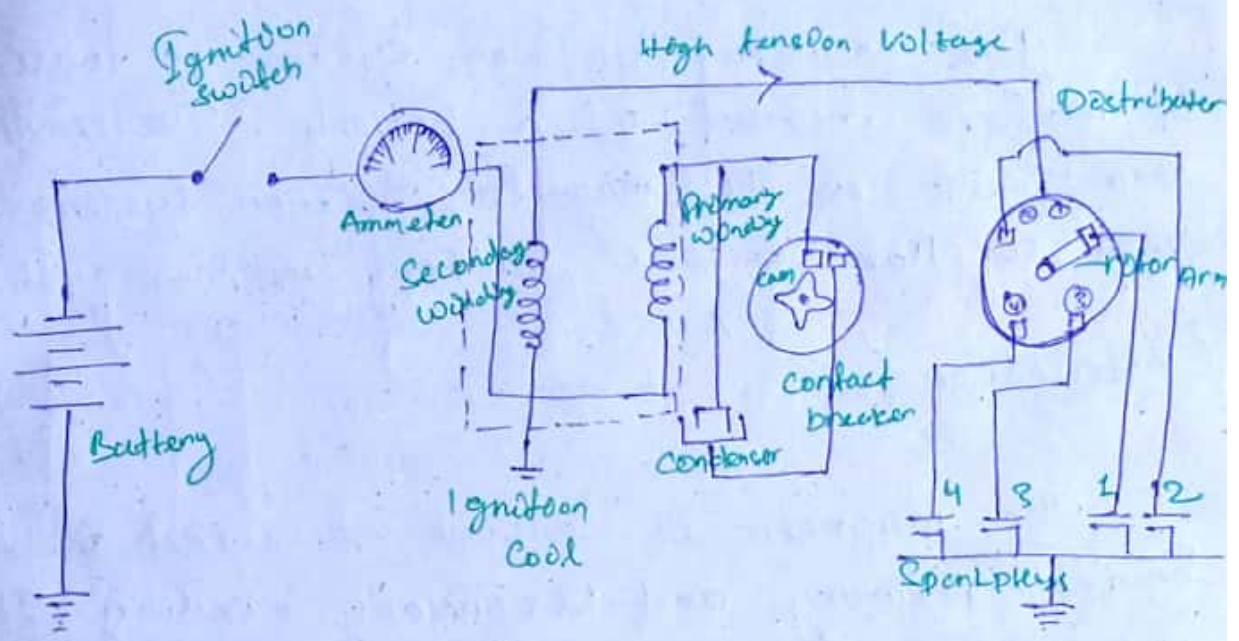
Condenser :-

A condenser is a device which is used to induced a required voltage into the secondary winding. The condenser absorbed the electricity in the primary winding so that a required voltage is passed to distributor which do not burn or arc the points of the distributor.

Distributor :-

A distributor is a device which consist of rotor arms. The rotor arms revolves and delivers the electric current in the spark plug attach to the four segment. The main function of the distributor is

- 1) The distribute high tension current to the proper spark plug at the correct time.
- 2) It also opens and flows the circuit in battery ignition system.



Working Principle

When the ignition switch is ON the current from the battery flows through the ammeter, where its magnitude is measured. The current then reaches the primary winding of ignition producing a voltage

As the current flows through the primary winding magnetic field is produced in the coil and as a result of mutual electromagnetic induction high voltage upto 20000 to 30000 is induced in the secondary winding of the ignition coil because the secondary winding has more number of turns therefore it jumps the spark gap and provides high tension voltage to the distributor. The distributor then distributes the high voltage to the proper spark plug producing

2) Magneto Ignition System

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The magneto ignition system is consist of magneto instead of a battery. The remaining arrangement in the magneto ignition system is very similar to the battery ignition system.

Construction:-

The magneto is consist of fixed armature having primary and secondary winding. It also consist of a rotating magnetic assembly which is driven with the help of an engine.

Ignition coil:-

Core tight ignition coil is used in case of magneto ignition system. ~~Primary~~

c) Primary Winding:-

The primary winding is consist of about 200 - 300 turns of thick wire producing 6-12 volt.

d) Secondary Winding:-

It consist of 15000 - 20000 turns of thin wire producing upto 15000 - 20000 volt

Contact Breaker :-

(37)

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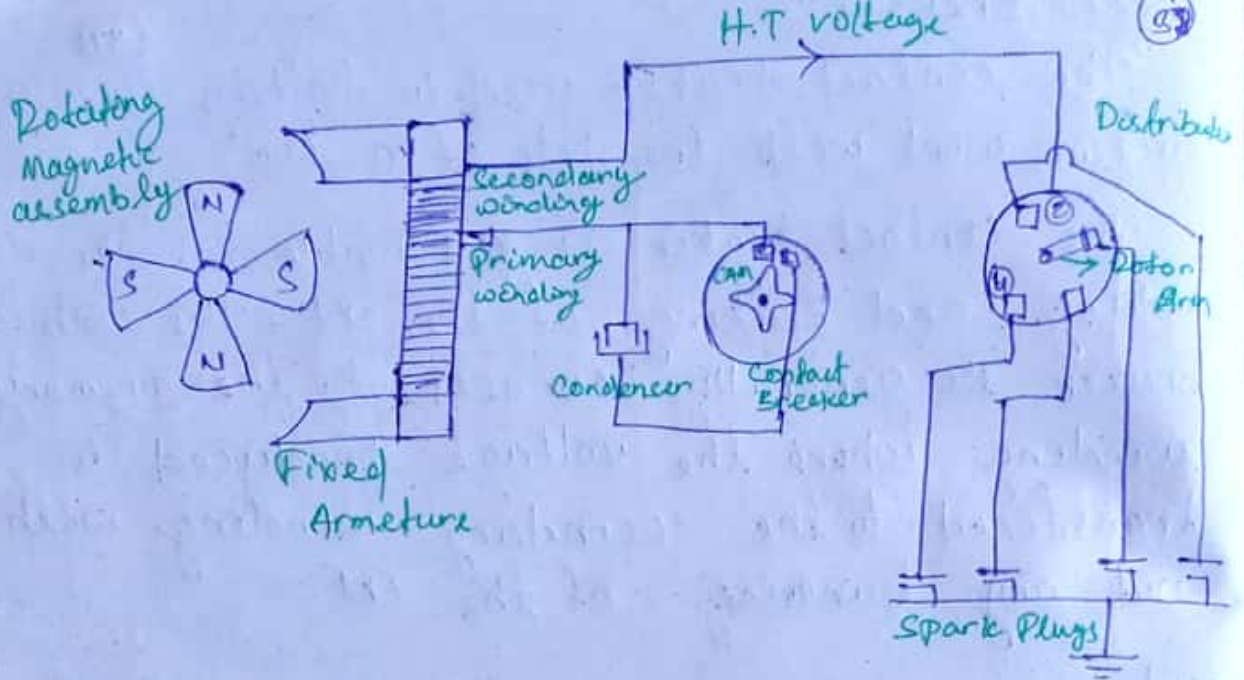
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- b) To distribute high tension current to the proper spark plug at the current time
- ii) It also opens and close the ckt in battery ignition system.



Working Principle: —

When the magneto rotates with the help of at engine current flow into the primary winding and due to mutual electro magnetic induction the voltage is induced in the secondary winding producing a high tension voltage of 20000-30000 volt. The secondary winding gives the high tension voltage to the distributor which distributes it to the respective spark plugs and then combustion of air fuel mixture takes place inside the engine cylinder. In magneto ignition system the magnetic field is produced with the help of permanent magnets.

Difference between Battery Ignition System & Magneto Ignition System

Battery Ignition System

Magneton Ignition System

(29)

- | | |
|--|---|
| → Current is obtained from the battery. | → Current is obtained from magneto |
| → It is less costly | → It is more costly |
| → Sparking is good at low speed | → Poor sparking at low speed |
| → Starting of the engine is very easy | → Starting of the engine is very difficult |
| → If the battery is discharge the engine can not be started. | → There is no such problem in this case because battery is not used here. |
| → It occupies more space | → It occupies less space |
| → The wiring is complicated | → The wiring is simple |
| → Spark intensity decreases when the engine speed increases. | → Spark intensity increases when the engine speed decreases. |
| → It is used in cars, buses, and trucks | → It is used in motorcycle scooter etc. |

Fuel Supply System in Petrol engine:-

Air fuel ratio is the ratio in which the air and fuel are mixed in proper proportion under different condition such as speed, load, etc by the carburetor.

For example:-

Requirement

Air fuel ratio
Petrol: Air

(40)

i) Starting of engine	1:10
ii) Cold-starting of engine	1:7
iii) Continuous driving on highway	1:18
iv) City-driving	1:14

Carburation :-

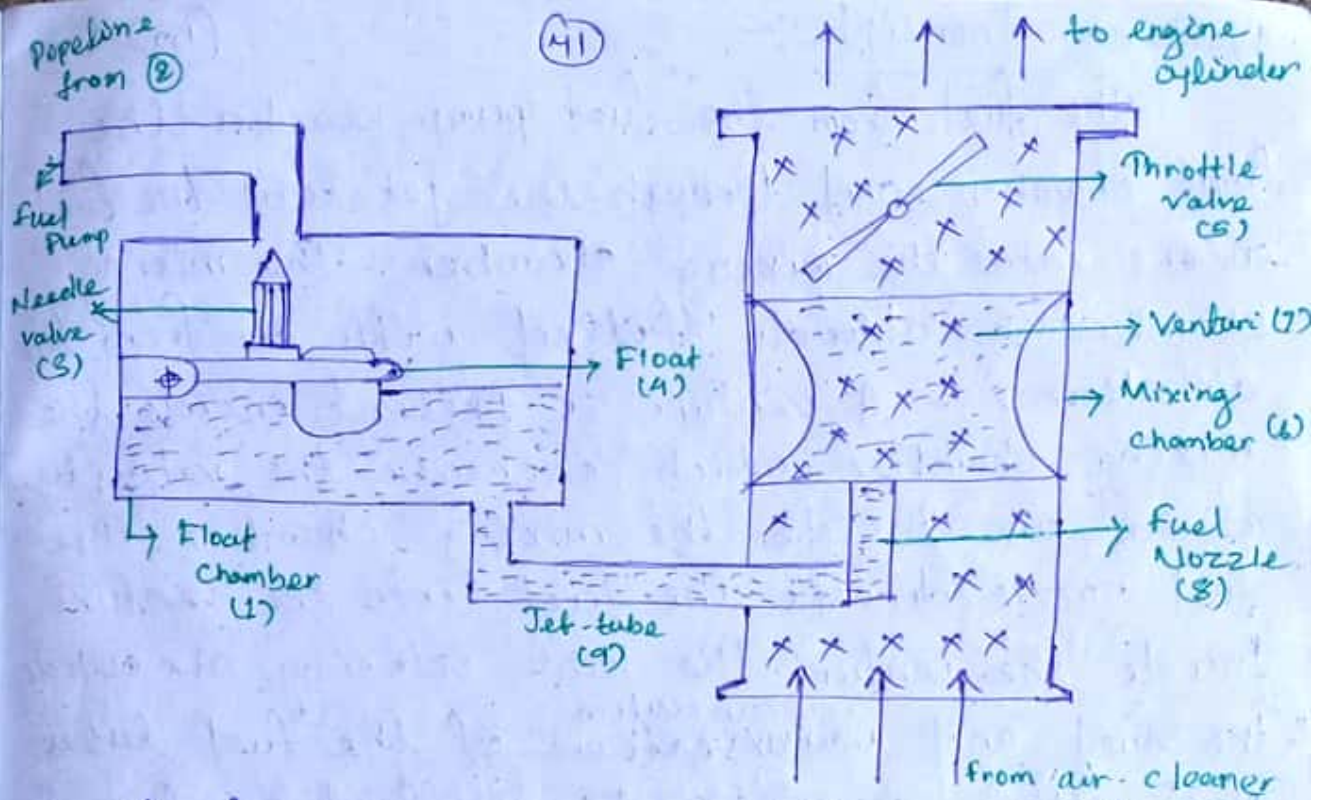
Carburation is the process in which the carburetor vaporises the petrol and mixes it with the air according to the correct proportion needed in any driving condition.

Carburetor is a device which mix the air and fuel in proper proportion.

Construction of Carburetor :-

A carburetor consist of the following parts

- 1) Float chamber
- 2) Pipeline from the fuel pump
- 3) Needle valve
- 4) Hollow float
- 5) Throttle Valve
- 6) Mixing chamber
- 7) Venturi
- 8) Fuel Nozzle
- 9) Jet-Tube



A float is a hollow part made of thin metal sheet. The float chamber is connected to the float and also to the pipeline from the fuel pump. The float is connected with a needle valve. When the level of fuel inside the float chamber rises then the float is lifted up and the needle valve close the pipeline from the fuel pump. and when the level of fuel decreases then needle valve moves down and fuel supply is started.

The float chamber is connected with the mixing chamber with the help of Jet-tube. The jet-tube is again connected with the fuel nozzle. The fuel nozzle opens into the venturi which increases the velocity of air. The throttle valve is present to deliver the air fuel mixture inside the engine cylinder. The throttle valve is operated by the driver.

Working Principle :-

(42)

The fuel from the fuel pump reaches the float chamber and through the jet tube the fuel enters into the mixing chamber. The mixing chamber is already filled with air from the air cleaner. A venturi is present inside the mixing chamber which increases the velocity of the air inside the mixing chamber. The fuel nozzle directs the fuel into the venturi. Inside the venturi the high velocity air collides with the fuel and ~~vaporization~~ ^{vapourisation} of the fuel takes place. This vapourised air fuel mixture is delivered to the engine cylinder with the help of throttle valve, according to the need inside the engine cylinder.

Troubles and its Remedies in Case of Carburetor :-

TROUBLES

- 1) Float level is set high
- 2) Punctured float ball
- 3) Loose or worn-out needle valve
- 4) High fuel pump pressure
- 5) worn throttle valve
- 6) choked air cleaner

REMEDIES

- Adjust the float ball
- Replace the float ball
- Adjust or place the needle valve
- Adjust the pump pressure
- Replace the throttle valve
- clean up air cleaner

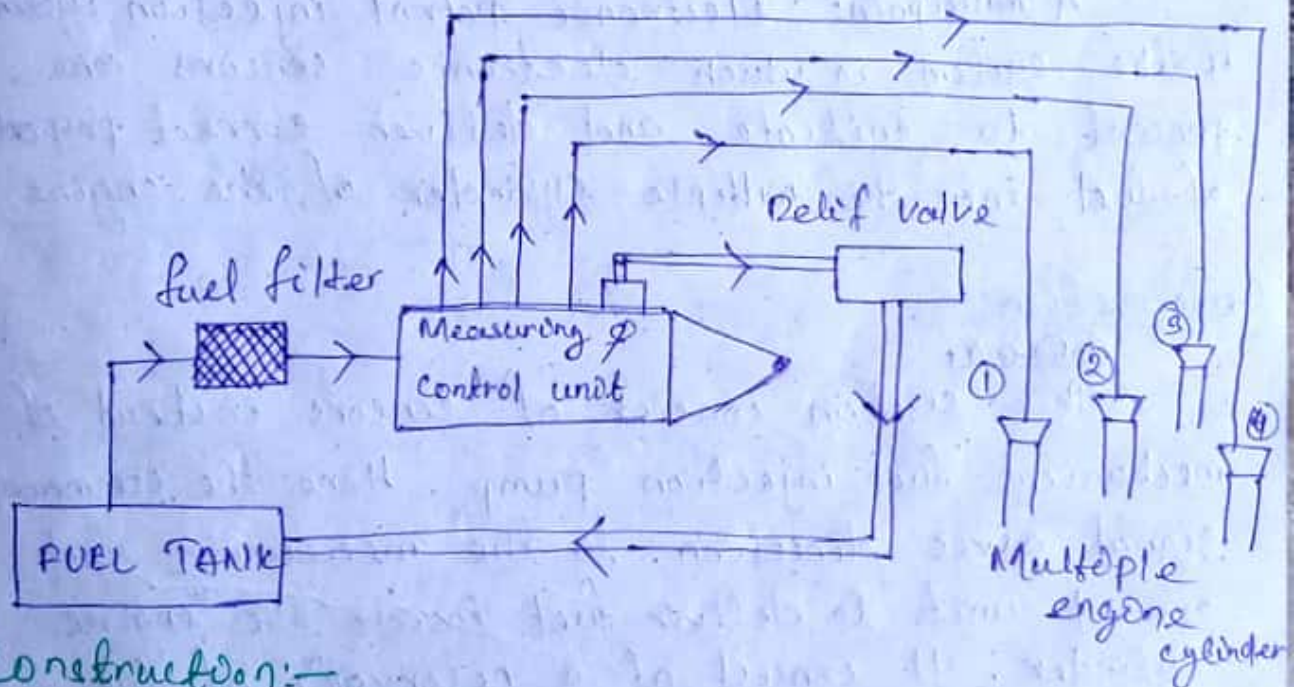
Multipoint fuel Injection System In petrol Engines :-

(43)

Multipoint fuel injection system are the system in which the fuel supply is provided to the multiple cylinder simultaneously for combustion. The multiple fuel injection system can be classified into 2 types

- 1) Mechanical multipoint fuel injection system
- 2) Multipoint Electronic petrol Injection system.

1) Mechanical Multipoint petrol injection system:-



Construction:-

It consist of fuel tank which is connected to a relief valve and fuel filter. ~~Fuel filter~~ is present to filter the impurities from the fuel. The relief valve is present to direct the fuel unnecessary towards the fuel tank. Measuring and control unit supplies the correct amount of fuel into the respective engine cylinder

Working Principle:-

(44)

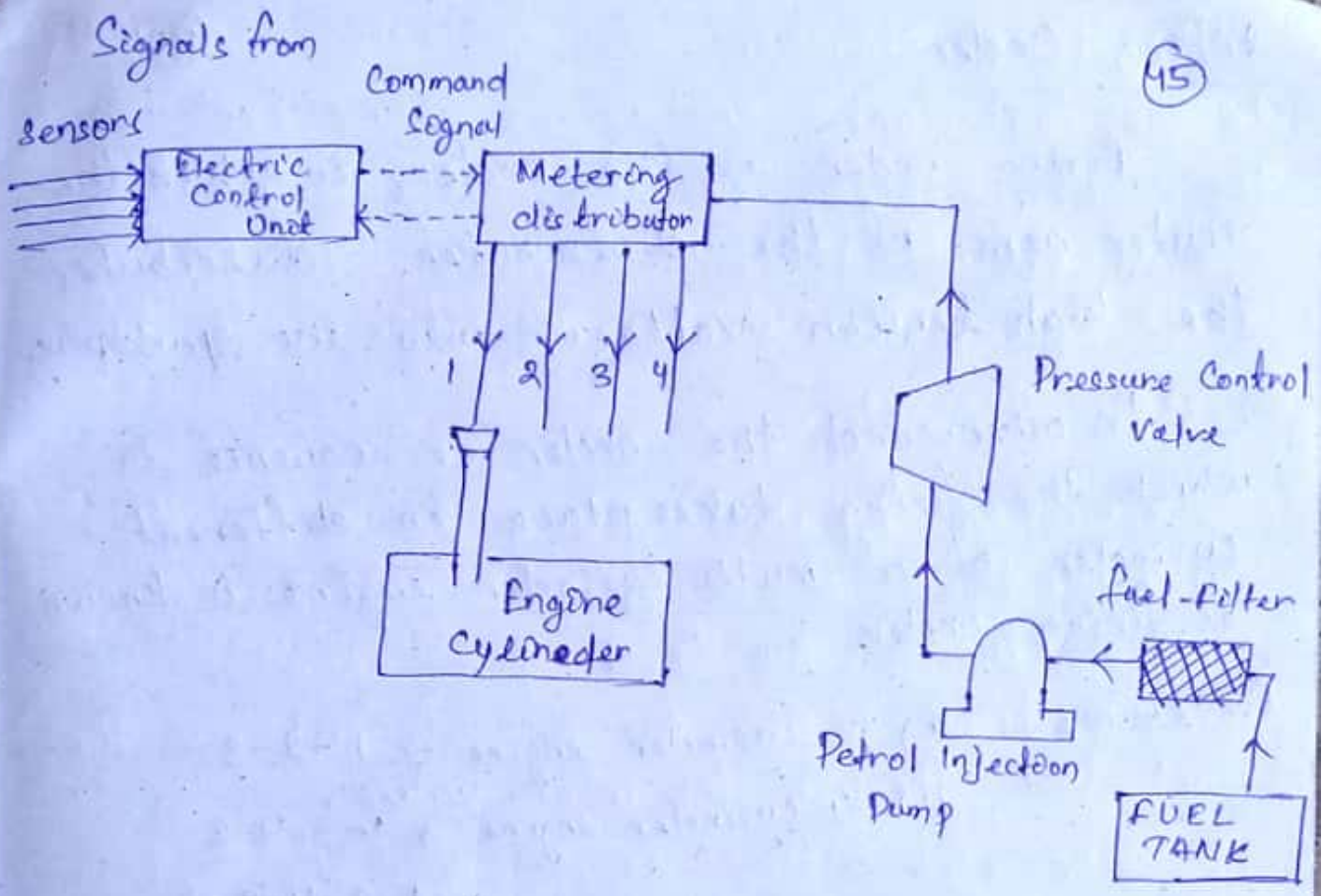
The fuel from the fuel tank is delivered to the fuel filter. Then fuel filter remove the impurities and send the fuel towards measuring and control unit. Here correct amount of fuel is measured and sent into the respective Engine cylinder for combustion. A relief valve is also present to direct the remaining fuel in the control unit towards fuel tank.

Q) Multipoint electronic Petrol injection System:-

A multipoint Electronic petrol injection system is the system in which electronic sensors are present to initiate and deliver correct proportion of fuel into the multiple cylinder of the engine.

Construction:-

~~Construction~~
This system consist of sensors instead of mechanical fuel injection pump. Here the command signal gives direction to the measuring and control unit to deliver fuel inside the engine cylinder. It consist of a reservoir of fuel known as fuel tank. The fuel tank is attached to the fuel filter. The fuel filter is connected to the control and measuring unit. It also consist of a pressure control valve to regulate the pressure into the control and measuring unit.



Working Principle:-

Multipoint electronic petrol injection system consist of a electrical control unit which receive the signal from the sensors and send the command signal towards the metering and control unit. The fuel from the fuel tank passes through the fuel filter and with the help of petrol injection pump and control valve reaches the metering and control unit. After receiving the command signal the metering and control unit distribute correct amount of fuel into the respective engine cylinder. The metering unit is also responsible for the sending of feedback signal towards the electronic control unit.

Firing Order

(46)

Firing order is the order in which the router arm of the distributor distributes the high tension voltage into the spark plug.

In other word the order or sequence in which the firing takes place in different cylinder of a multi cylinder engine is known as firing order.

For example:-

i) 3 cylinder engine \rightarrow 1-2-3

ii) 4 cylinder engine \rightarrow 1-3-4-2

1-2-4-3

iii) 6 cylinder engine \rightarrow 1-5-3-6-2-4

b) 1-4-2-3-5

c) 1-3-2-6-4-5

d) 1-2-4-6-5-3

iv) 8 cylinder engine \rightarrow a) 1-6-2-5-8-3-7-2

b) 1-4-7-3-8-5-2-6

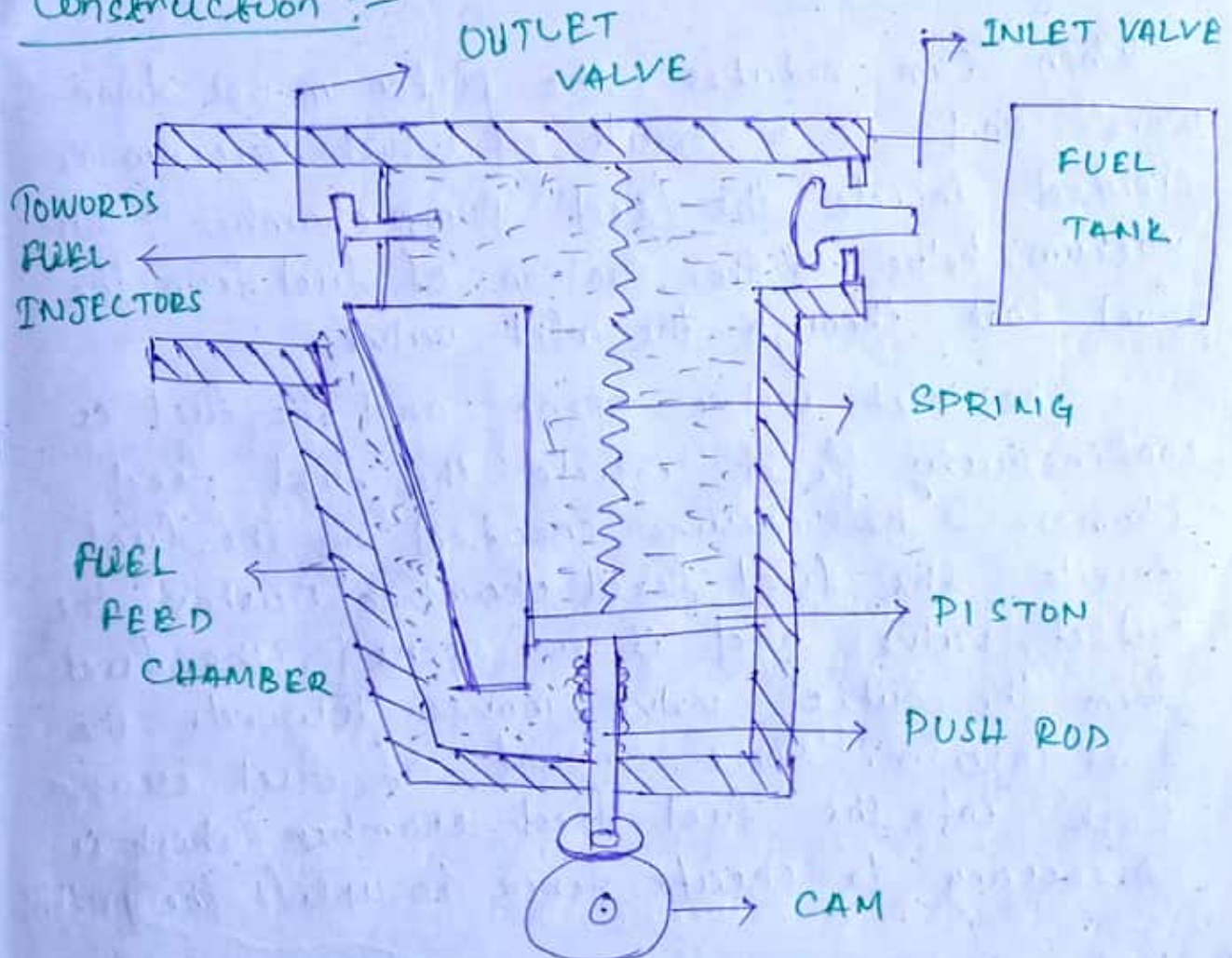
DIESEL ENGINE :-

(47)

Fuel Feed Pump :-

Fuel feed pump used in diesel engine are used to deliver fuel from the fuel tank to the fuel injector.

Construction :-



The fuel feed pump consists of a chamber with piston and push rod arrangement. The piston is connected to the cam which helps in its motion upward & downward. The piston is also connected to a spring mechanism.

The pump chamber on one side is connected to the fuel tank and it is connected to the fuel injector on the other side. The fuel feed chamber consists of two valves inlet valve & Outlet valve. (48)

Working Principle:-

When Cam rotates, the piston moves downwards and as a result of which vacuum is created inside the feed pump chamber. This vacuum helps in the suction of fuel from the fuel tank through the inlet valve.

The inlet valve opens and the fuel is continuously feed inside the fuel feed chamber. The pressure created by the fuel inside the fuel feed chamber pushes the outlet valve and it is opened. The fuel from the outlet valve moves towards the fuel injector. Some amount of fuel escapes back into the fuel feed chamber which is necessary to create force to uplift the piston.

Fuel Injector in Diesel Engine :-

In case of Diesel Engine fuel injectors are present to spray fuel into the engine cylinder in atomised form.

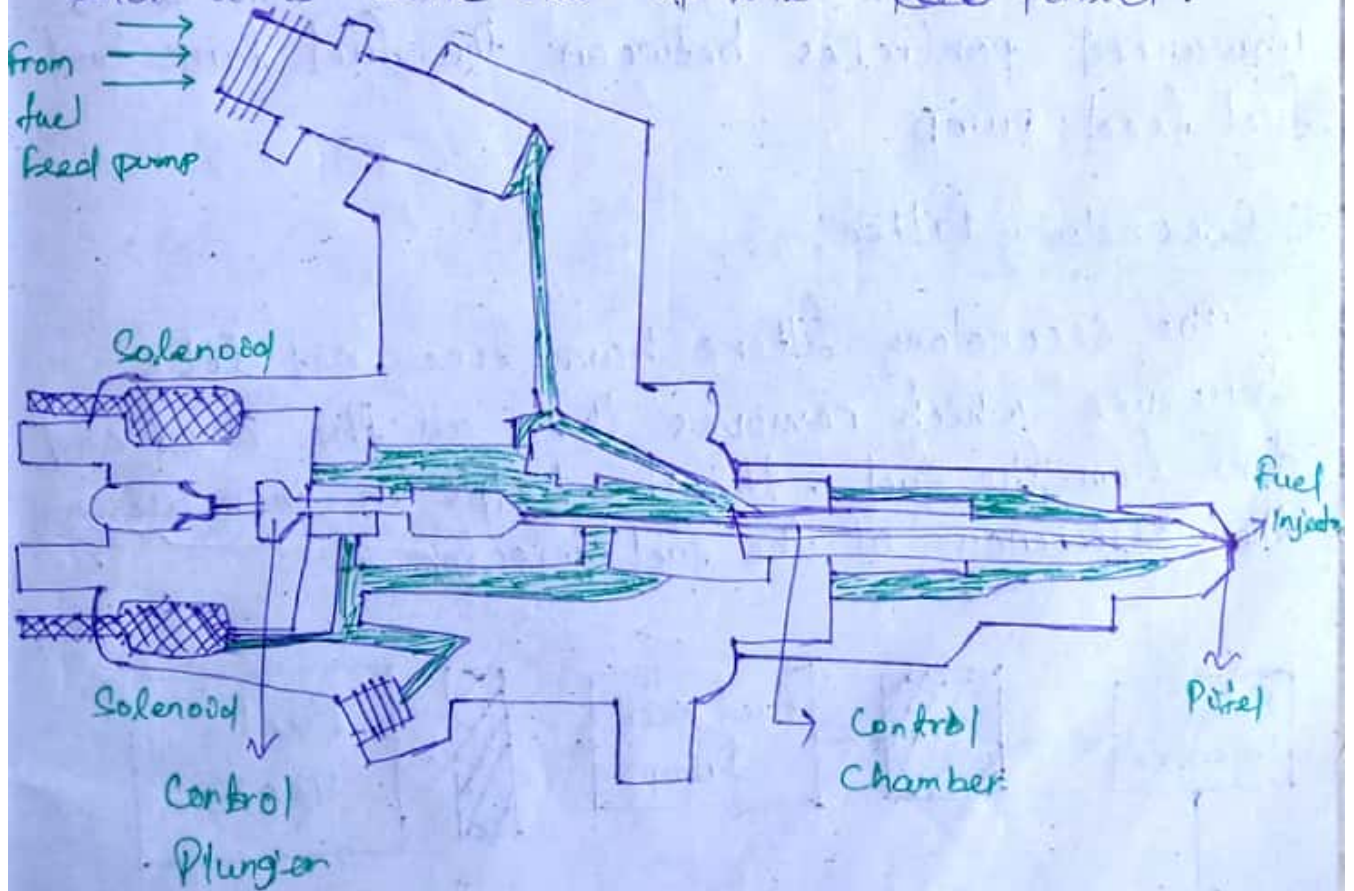
Construction of fuel Injector :-

(49)

The fuel injector is connected to fuel feed pump on one side and the other end of the fuel injector is connected with the engine cylinder.

Working Principle :-

High pressure fuel from the fuel feed pump enters into the fuel injector. The pressure is equal through out the injector when the solenoid are energized with the help of the changing then it pulls the control plunger upwards. This results in the release of small amount fuel which creates a differential pressure and it is come out of the ~~Pistol~~ Pintel.



Fuel Filter In Diesel Engines :-

Fuel filter ~~are~~ used in diesel engines are used to remove the unwanted materials, dust and dirt from the ^{fuel & air} ~~oil~~. The fuel filter are employed in between the fuel tank and the fuel feed pump. The fuel filter are also employed between the fuel feed pump and fuel injector.

There are two types of fuel filters

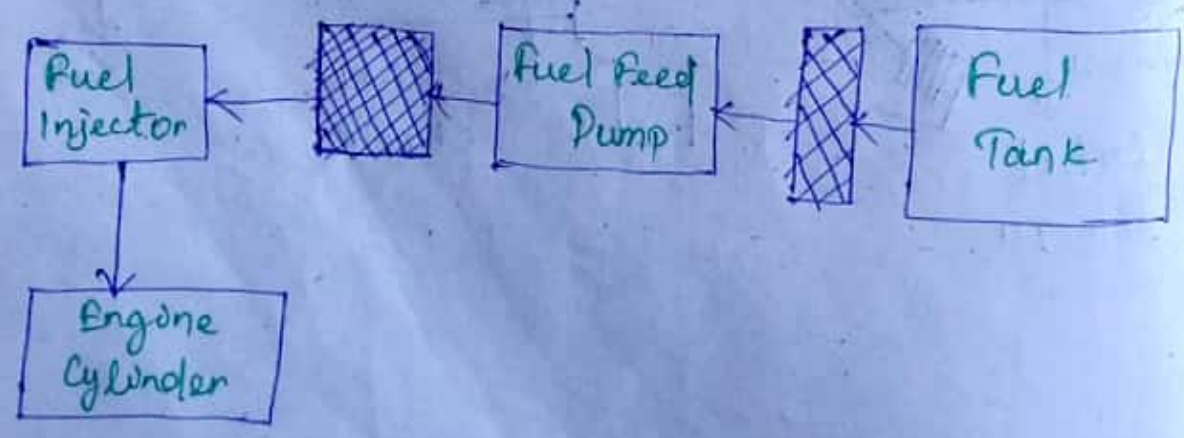
- 1) Primary filter / Coarse filter
- 2) Secondary filter / Fine filter

1) Primary filter :-

In case of primary filters, the net present have larger holes to prevent the movement of unwanted particles between the fuel tank and fuel feed pump.

2) Secondary filter :-

The secondary filters have fine net like structure which removes the all the dust and dirt from the fuel. It also helps in increasing the efficiency of the fuel injector.



Multi-point fuel Injection in diesel Engines :-

A multi-point fuel Injection system the fuel is transported to more than 1 cylinder so it is called multi-point fuel Injection system.

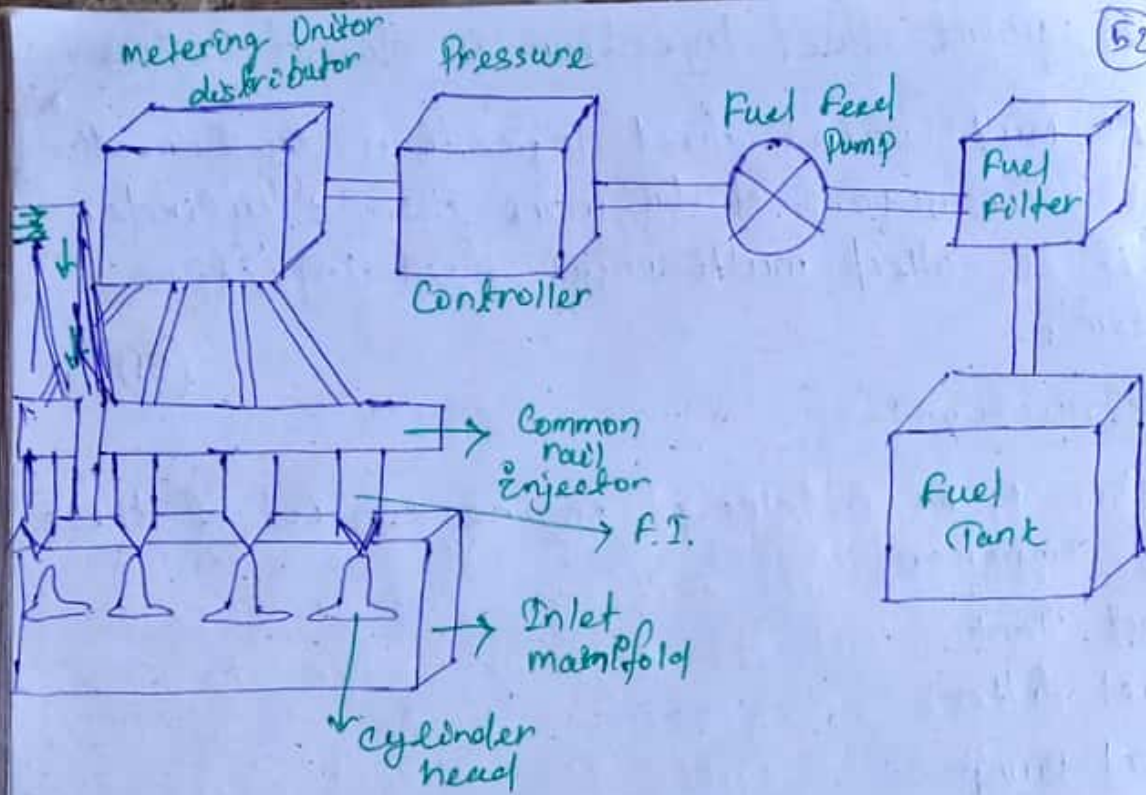
(51)

Construction :-

The MPFI in diesel engine consist of these main component.

- 1) Fuel Tank
- 2) Fuel filter
- 3) Fuel pump
- 4) Pressure Controller
- 5) Metering Unit / Distributor
- 6) Air Filter
- 7) Common Rail Injector
- 8) Inlet Valve

The fuel tank is connected to the fuel filter. The filtered fuel is passed on to the fuel pump. Pressure controller is present to control the pressure of fuel entering into the distributor. The distributor is attached to the common rail injector and the injectors are connected with respective cylinder.



Working Principle :-

The fuel from the fuel tank, reaches the fuel filter the impurities are removed from the fuel. The filtered fuel then reaches the pressure controller where the pressure of the fuel is maintained at a required level. The fuel then enters into the metering unit from where it is distributed to the common rail injectors. From the inlet manifold the fuel then is supplied to the respective engine cylinders through fuel injectors.

Lighting System :-

The auto electric system of an automobile consist of the devices which runs with the help of an electrical circuit.

The lighting system of an automobile consist of various lights and other signalling devices such as front light, side light and rear light etc.

Diagram of the system

The lighting system consist of various types of lights

1) Front light

It is used to light the road ahead of you. These lights are very power full and it can cover maximum distance possible.

2) Rear light :-

These lights are the light which are installed at the rear end. These lights are generally covered by a Red translucent body. Rear lights generally comes in pair.

3) Parking light :-

Parking lights are the light which is generally used during the parking of an automobile. These lights are used as a signalling device

4) Directional lights :-

These lights are automatically produced by the driver during the initiation of a new turn. (54)

5) Interior lights :-

Interior lights are the lights which are installed inside the automobile to enhance the visibility in the darkness and to check and operate other systems inside the automobile.

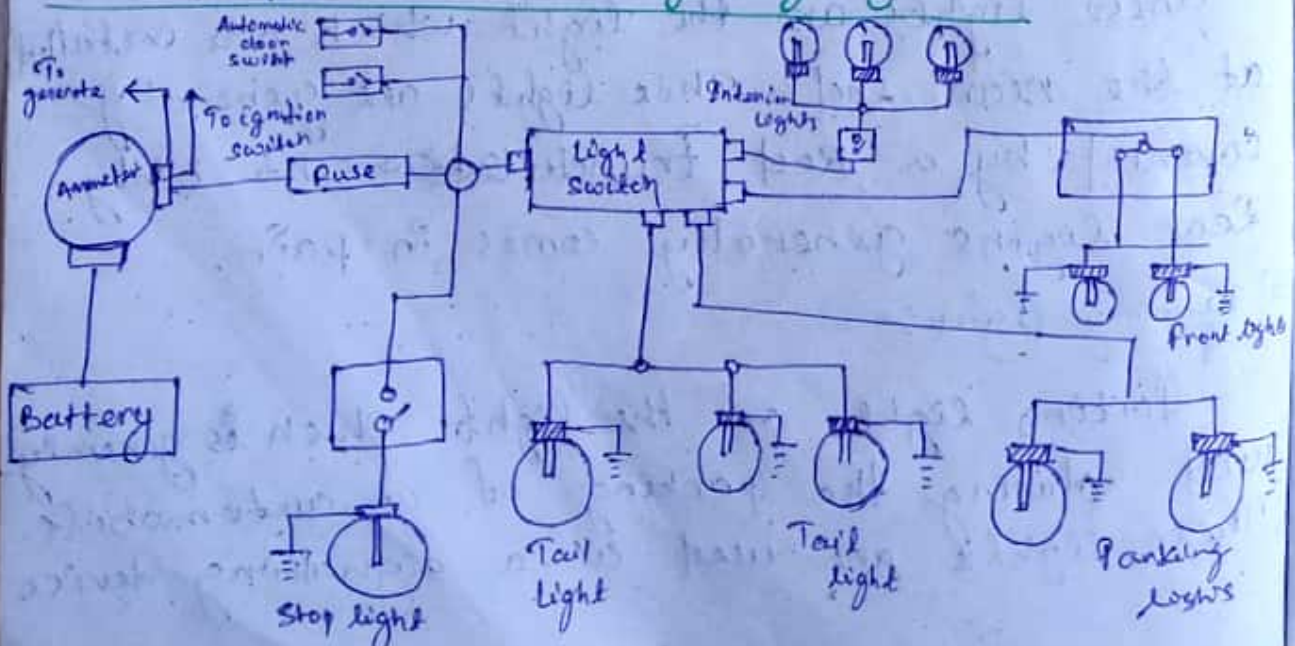
6) Stop lights :-

These lights are used to avoid accidents when the vehicle is at rest.

7) Blinker light :-

These lights are used as the lights which are used in the automobile to enhance the visibility of the automobile to other automobiles and it is also used to signal the vehicle way ahead.

Electrical Circuit of lighting system :-



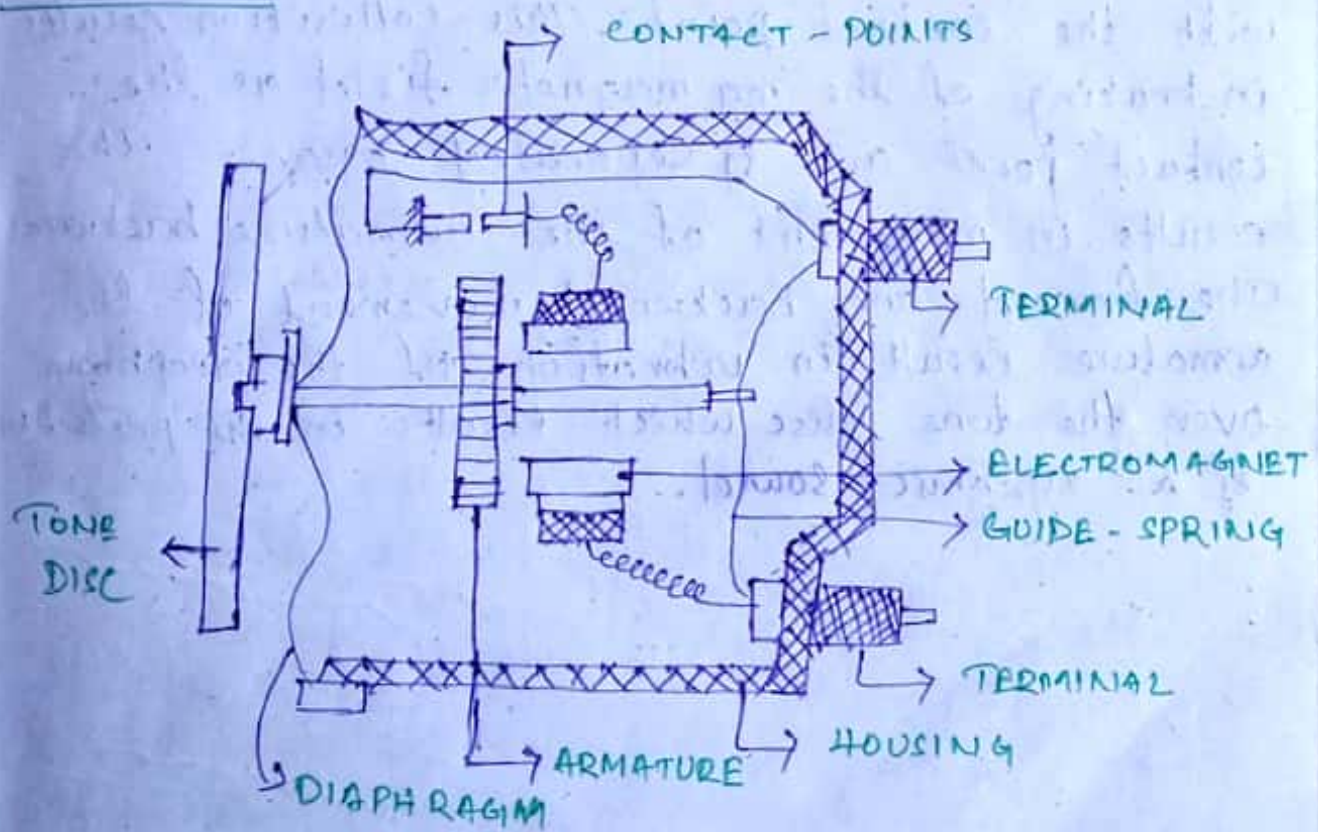
The function of lighting system in a Automobile

- 1) It is used to show the way ahead when the automobile is moving. (55)
- 2) Lighting system also helps in avoiding the accident during night.
- 3) The lighting system can be used to give signals such as signaling during a turn, during parking etc.

Horn relay circuit :-

A Horn is a device which is used in all the automobile as a sound producing device.

Construction :-

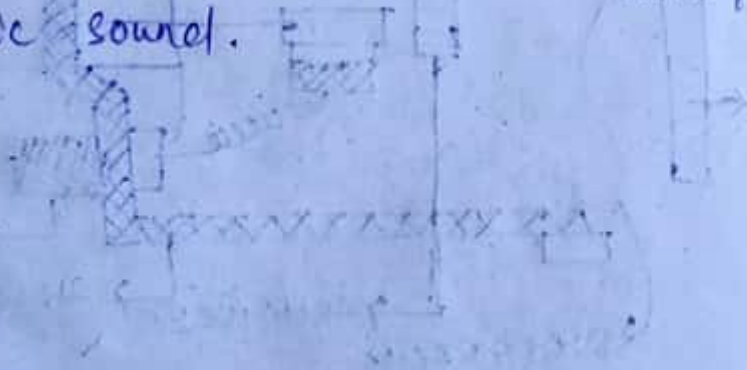


It consist of a tone disc attached to a shaft. The shaft is connected to the guide spring and an armature is also attached to the shaft. A diaphragm is also attached to the shaft and the tone disc. Horn circuit consist of two terminals into which the electricity

being passed. An electro magnet is also present to create magnetic field inside the horn circuit. It contains the contact points which receive electricity and helps in the production of magnetic field. (56)

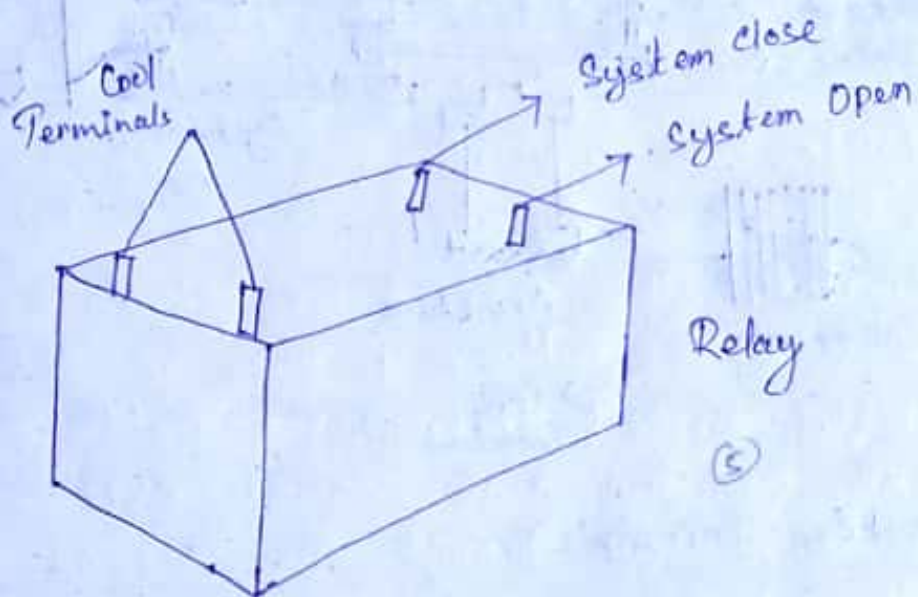
Working Principle:-

When the horn button is pressed then the electricity from the battery reaches the terminals. From the terminal the electricity is passed to the contact point. The contact point energized the electro magnet and magnetic field is produced. This magnetic field pulls the armature & it collides with the contact point. This collision results in braking of the magnetic field as the contact point are separated apart. This results in movement of the armature backwards. The forward and backward movement of the armature result in vibration of the diaphragm over the tone disc which results in the production of a rhythmic sound.



Cut out Relay:-

A relay is a machine component which has basically 4 points of transmission. (57)

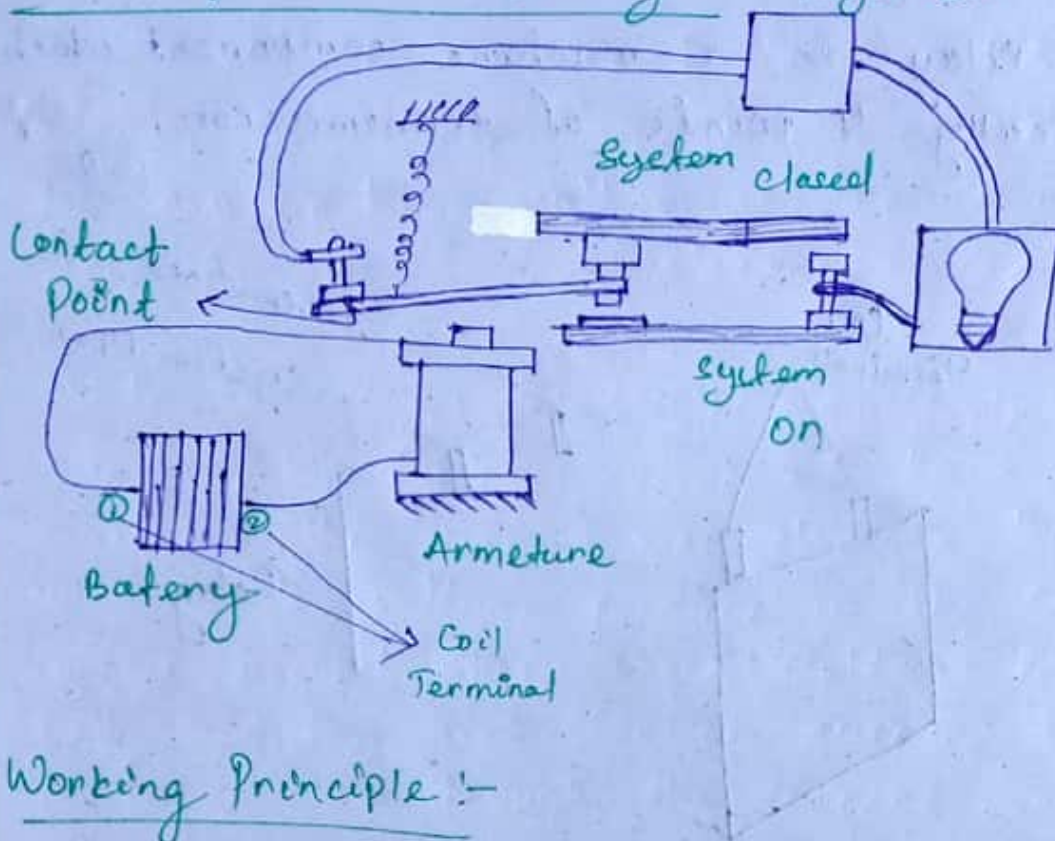


Construction:-

The cut out relay consists of a battery and both the terminals of the battery are attached to the armature. The armature is again connected to the contact point with the help of a spring mechanism. There are basically 2 contact points transmission way. One way is known as system open and the other way is known as system closed. The system open way is connected with the object to which electricity is to be passed and the system closed way is also connected dead end. The contact point are also connected to the object through a regulating device.

Circuit of cut out of Delay :- Regulation

(54)



Working Principle :-

The terminals of the battery at one end is connected to the armature and the other end of the terminal is also connected with the armature. When the circuit is incomplete and only one terminal is connected with the armature then the contact point remains attached to the system closed way, and there is no electricity supplied to the object.

When the both ~~the~~ terminals of the battery is connected with armature then magnetic field is produced and the Armature ~~attracts~~ the contact points towards itself. Now the contact point will be attached to the system open way and the circuit is finally completed. In this way, the current is supplied to the object.

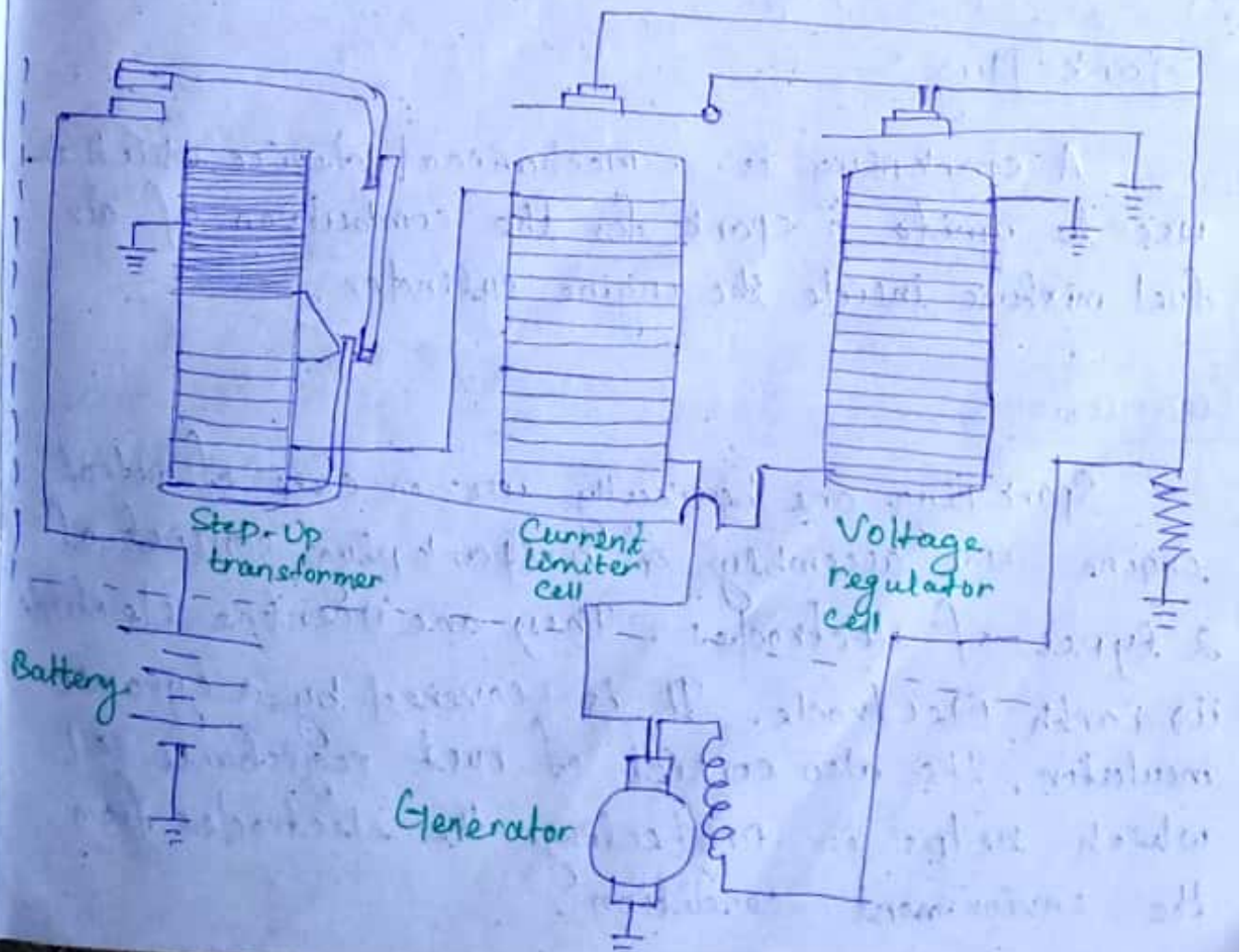
Voltage Current Regulator Circuit:-

(59)

A voltage current regulator ckt is a ckt where two other important element is known as current limiter cell and voltage regulator cell are utilised to correct the magnitude of current flowing through the ckt.

This type of ckt are generally used in step up transformer where a ~~massive~~ massive increase in the voltage takes place. The voltage regulator cells regulates the magnitude of voltage produced by the secondary coil.

The current limiter cell is responsible for the controlling of high tension - current flowing in the ckt.



Working Principle :-

(50)

The voltage from the battery is passed to the step up transformer. The primary winding induces the ~~the~~ ~~step~~ up high voltage in the secondary coil by the law of electro magnetic induction.

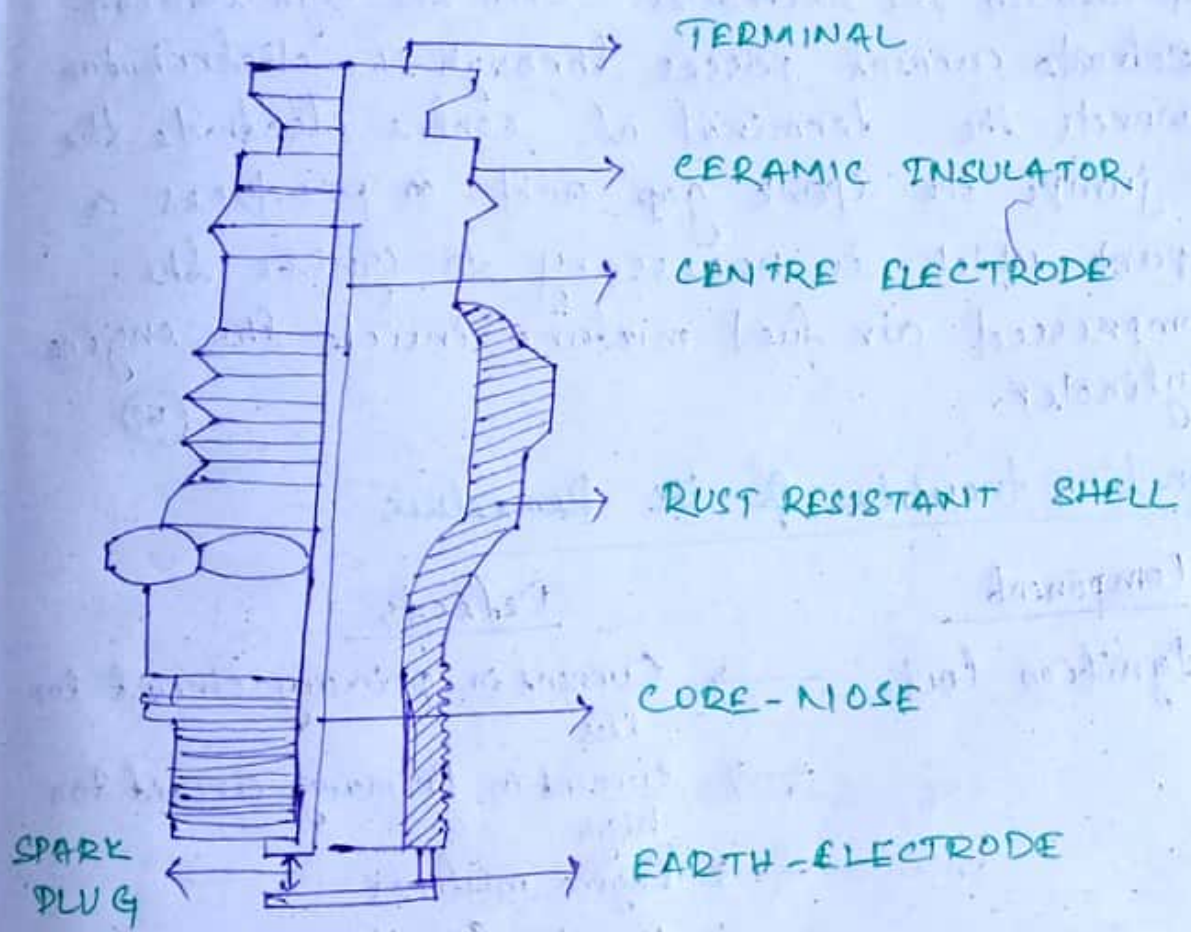
In some cases this high magnitude of voltage is responsible for generation of high tension current. This current may damage the distributor ~~ckt~~, so the voltage produce in the secondary coil is passed through a voltage regulator cell and the high tension current is also made to run through the current limiter cell. This arrangement regulates the ~~both~~ ~~mag~~ magnitude of both current and voltage passing through the distributor and then gradually to the spark plug.

Spark Plug :-

A spark plug is a mechanical device which is use to ignite a spark for the combustion of air fuel mixture inside the engine cylinder.

Construction :-

Spark plug are basically use in case of petrol engine. The assembly of a spark plug consist of 2 types of electrodes. They are i) centre electrode ii) Earth Electrode. It is covered by a ceramic insulator. Its also consist of rust resisstant cell which helps in protecting the electrodes from the environment condition.



Working Principle:-

The function of the spark plug is to produce an electric spark to ignite the compressed air fuel mixture inside the engine cylinder. It produces spark at the correct moment ~~and~~ i.e. at the end of compression stroke.

A proper gap is maintained between the centre electrode and the earth electrode of the spark plug so that the spark can take place.

When the spark plug is attached to the cylinder head then the ground electrode is said to be connected with the ground. The terminal of the centre electrode is directly connected to the high tension lead of the ignition coil through the distributor. The secondary ckt of the

electrical system is completed through the gap between the electrodes. When the high tension ~~electrode~~ current passes through the distributor towards the terminal of centre electrode the it jumps the spark gap and produces a spark which is necessary to ignite the compressed air fuel mixture inside the engine cylinder.

(62)

compressed air fuel mixture inside the engine cylinder.

Ignition troubles & its Remedies :-

Component

Defects

1) Ignition coil

- Current in primary circuit too less
- Current in primary circuit too high
- Engine misfires
- Hard Starting

2) Contact breaker

- Burns rapidly
- Burnt & abraded points

3) Distributor Assembly

- Engine do not start in wet weather
- Wearing of blocks

4) Condenser

- Breaker points burns rapidly

5) Ignition switch

- Deficient engine starting
- Low current in primary circuit

6) Spark Plug

- Over heating
- Misfiring
- Electrodes Erosion

Remedies

→ Test & replace the defective coil

→ Test & replace the defective coil

→ Test & replace the defective coil

→ Replace the defective cable.

→ Replace defective Condenser

→ Clean the points & Replace the resistance

→ Wipe off the moisture inside distributor cap

→ Lubrication the blocks or replace.

→ Tighten the loose condenser lead

→ Replace the low capacity Condenser

→ Replace the switch

→ Use correct plug & Adjust Carburetor

→ Adjust the gap or replace the plug.

→ Use proper fuel

Components

Defects

Remedies

→ Magneto

→ Noose

→ Repair & tighten screws, loose plates etc