LECTURE NOTE

ON

AUTOMOBILE ENGINEERING AND HYBRID VEHICLES

DIPLOMA 6TH SEM

DEPARTMENT OF MECHANICAL ENGINEERING

PREPARED BY:ER.AVAYA KUMAR BALIARSINGH

GANESH INSTITUTE OF ENGINEERING AND TECHNOLOGY (POLYTECHNIC)

(Approved by AICTE)

ANDHARUA,BHUBANESWAR

COURSE OBJECTIVES:

At the end of the course the students will be able to:

- Understand automobile chassis, transmission, breaking and fuel system etc.
- Understand the basics of electric vehicle kinematics.
- Understand the concepts of hybrid electric vehicles.

1.0 INTRODUCTION & TRANSMISSION SYSTEM:

1.1 Automobiles: Definition, need and classification: Layout of automobile chassis with major components (Line diagram)
1.2 Clutch System: Need, Types (Single & Multiple) and Working principle with sketch
1.3 Gear Box: Purpose of gear box, Construction and working of a 4 speed gear box
1.4 Concept of automatic gear changing mechanisms
1.5 Propeller shaft: Constructional features
1.6 Differential: Need, Types and Working principle

2.0 BRAKING SYSTEM:

2.1 Braking systems in automobiles: Need and types
2.2 Mechanical Brake
2.3 Hydraulic Brake
2.4 Air Brake
2.5 Air assisted Hydraulic Brake
2.6 Vacuum Brake

3.0 IGNITION & SUSPENSION SYSTEM:

3.1 Describe the Battery ignition and Magnet ignition system
3.2 Spark plugs: Purpose, construction and specifications
3.3 State the common ignition troubles and its remedies
3.4 Description of the conventional suspension system for Rear and Front axle
3.5 Description of independent suspension system used in cars (coil spring and tension bars)
3.6 Constructional features and working of a telescopic shock absorber

4.0 COOLING AND LUBRICATION:

4.1 Engine cooling: Need and classification
4.2 Describe defects of cooling and their remedial measures
4.3 Describe the Function of lubrication
4.4 Describe the lubrication System of I.C. engine

5.0 FUEL SYSTEM:

5.1 Describe Air fuel ratio
5.2 Describe Carburetion process for Petrol Engine
5.3 Describe Multipoint fuel injection system for Petrol Engine
5.4Describe the working principle of fuel injection system for multi cylinder Engine 5.5 Filter for Diesel engine
5.6 Describe the working principle of Fuel feed pump and Fuel Injector for Diesel engine

6.0 ELECTRIC AND HYBRID VEHICLES:

6.1 Introduction, Social and Environmental importance of Hybrid and Electric Vehicles
6.2 Description of Electric Vehicles, operational advantages, present performance and applications of Electric Vehicles
6.3 Battery for Electric Vehicles, Battery types and fuel cells
6.4 Hybrid vehicles, Types of Hybrid and Electric Vehicles: Parallel, Series, Parallel and Series configurations;6.5 Drive train
6.6 Solar powered vehicles

Introduction to automobiles

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

motor vechile

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

Self-Propelled vechile

It is a vechile 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 system of the automobiles.

- The automobile consist of various system they are

1) Breaking System.
2) Cooling and lubrication system
3) fuel supplied system
4) ignotation system
5) Transmission System

6) Suspension System

Classification of automobiles

The automobiles can be classified on the following basses.

1) According to the purpose
   a) Goods carryong vechiles (Ex:- Truck)
   b) Passenger Carryong vechiles (Ex:- Bus, car)
2) According to capacity
   a) Light motor vechile
   b) heavy motor vechole
3) According to fuel used
   a) Petrol vechiles
   b) Diesel vechiles
   c) Electric cabs
   d) Steam based vecholes
   e) CNG based vechiles
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 vechile
   a) Single wheel drive vechile
   b) Two wheel drove vechile
   c) Four wheel drove vechile

Classificatoon of engone

Engines can be classified on the following basis :-

1) According to combution :-
   a) Internal combution Engine
   b) External combution Engine
2) According to fuel :-
   a) Petrol Engone
   b) Diesel Engine
   c) Steam Engine
   d) Alternative energy engone
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 ignotoon :-
   a) Sparke ignitoon
   b) Compression Ignitoon
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 :-

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

a) Like weight engines
b) Heavy weight engine

9) Accoreling to the motion of poston

a) Raciprocating
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 :—

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) Chasis :-

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

function of chassis frame :-

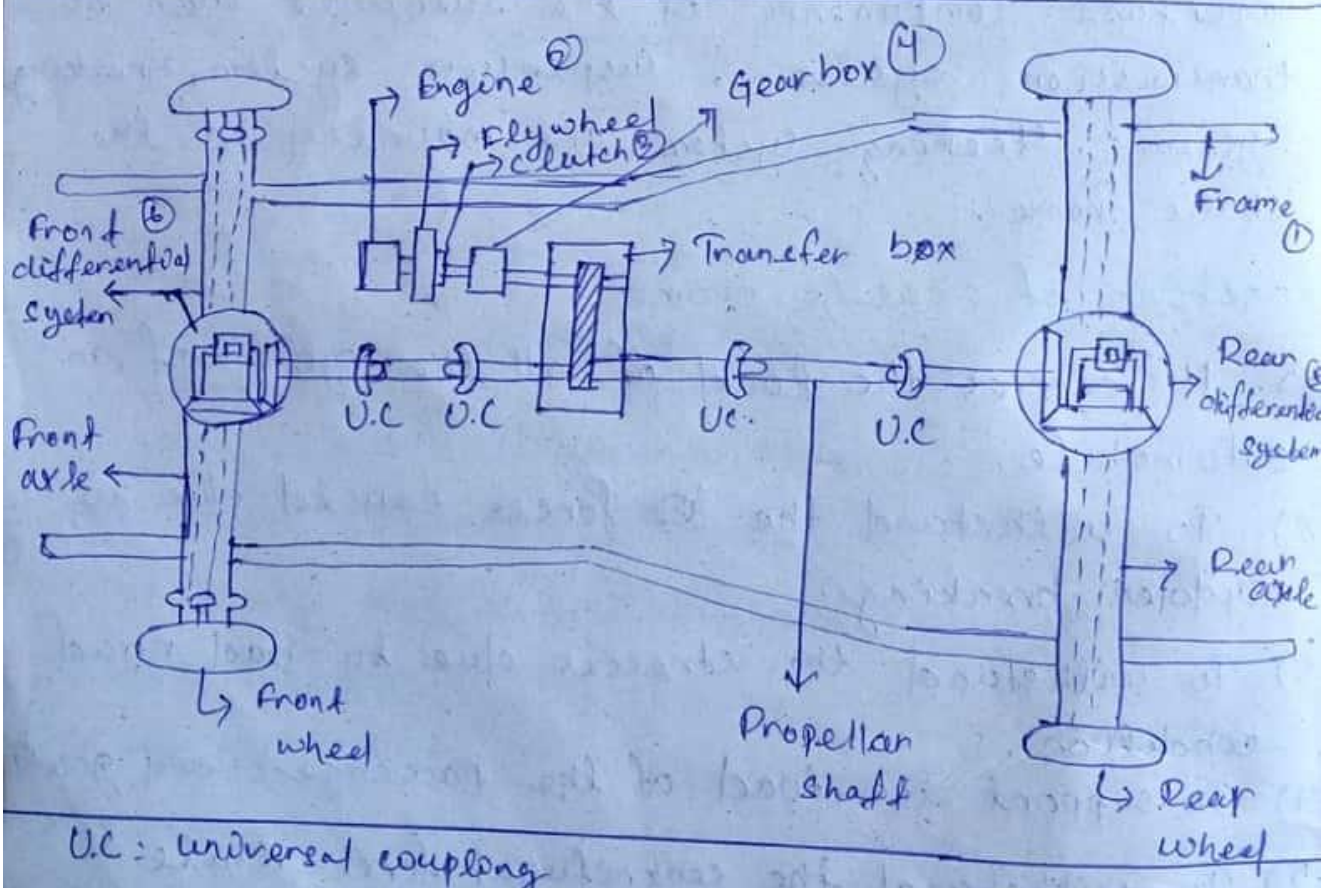
1) It carries the load of all the system of an automobile.
2) To withstand the forces caused due to sudden breaking.
3) To withstand the stresses due to bad road condition.
4) To support the load of the passengers and goods
5) To withstand the centrifugal force while turning of an automobile.

Main Components of the chassis :-

There are various component of the chassis. They are :-

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

Layout of chassis of an automobile :-



U.C : universal coupling

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

Specification of an automobile :- (7)

There are different types of automobile running on 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 ~~kg~~ 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 ~~boers~~ 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, Bentaly, Rolce Royce,

5) Model :-

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

Q. Specify a car, truck, motorcycle, scooter

Breaking System

Breaking system of an automobile is the system which is responsible for stoping or carrying out controled motion of an automobile.

Function Brakes in an Automobile / Requirement for a brake :-

1) It is used to stop the vechile in a smallest possible distance.
2) It is used to maintain and controled the motion during the motion of the automobile in a slope.
3) It must absorve all shocks produced during the braking action.

Properties of a good brake :-

1) It must stop the vechile 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 slip and skid.
5) The brakes must be operated with least afforts of the driver

Classification of Brakes :-

Brakes can be classified according to various ways

1) According to the location on the vehicle
   a) Wheel mounted 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) Vaccume 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) Round 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 :-

a) Drum and Disc brake (11)

b) Mechanical and servo brake

7) According the action of brake shoes :-

a) Internal expanding Brake

b) External expanding Brake

8) According the basis of Application of brake by the driver

a) Hand brake

b) foot brake

Air Brake / Pneumatic Brake

The 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 break consist of the following parts :

a) Compression :-

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

b) Storage Tank :-

It is the reserver 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.

c) Valve System

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

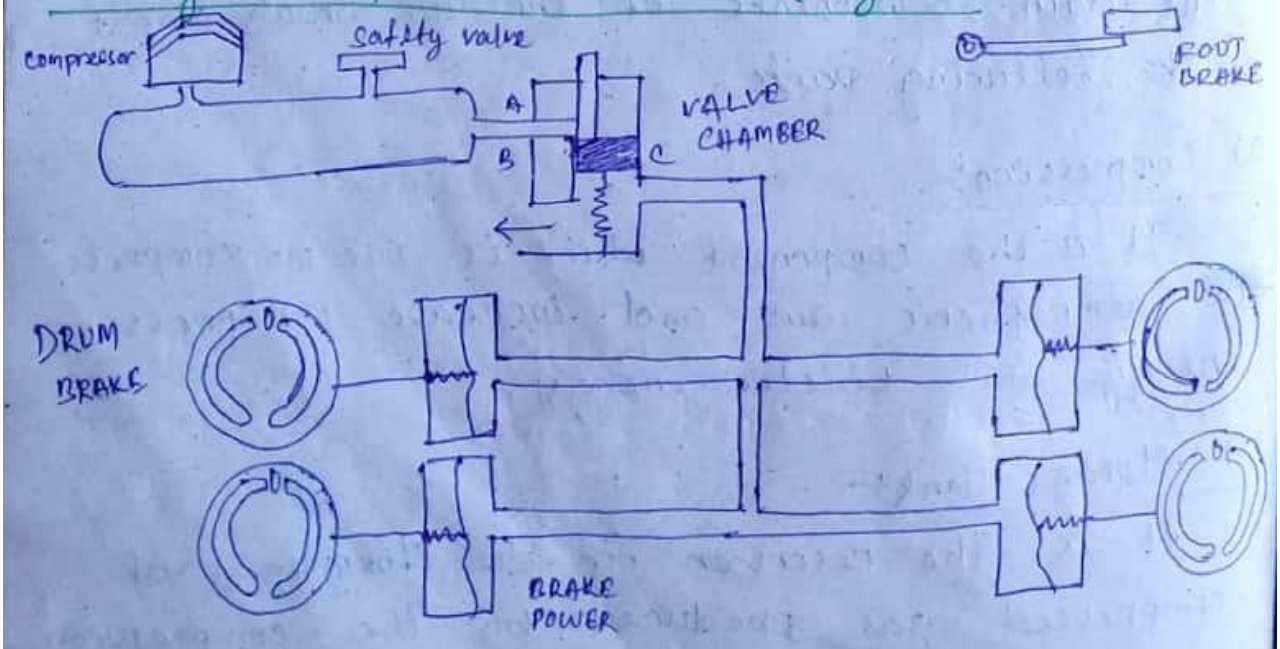
d) Break Chamber

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

e) Drum break

The drum break consist of the drum, break shoes & 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 break System



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 break chamber. The pressure energy and kinetic energy of the compressed air pushes the diaphragram. 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 living in this way the movement of the drum stops when breaks are applying.

Hydraulic Brake

Hydraulic Brake are the brakes in which the breaking 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

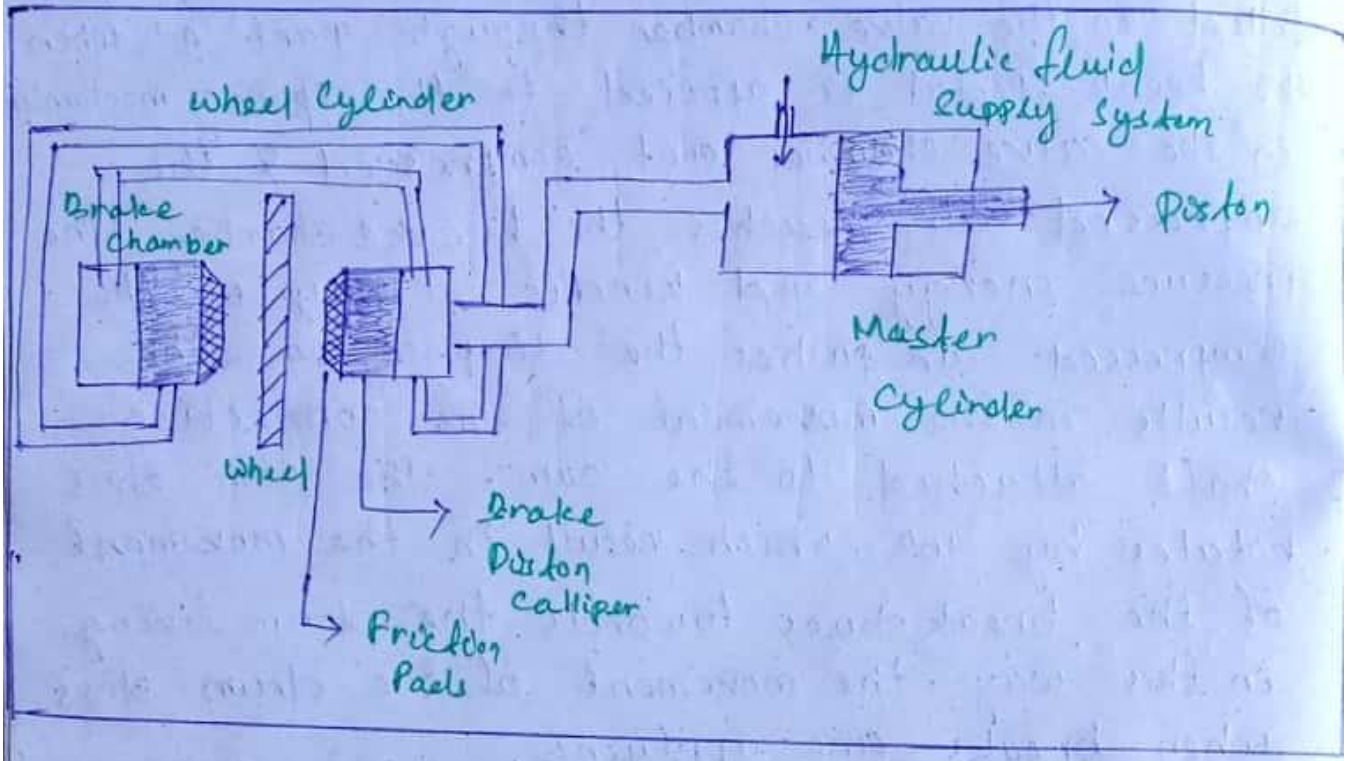
Master cylinder

The master cylinder consist of a piston which raciprocating 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 piston and fraction pads are

attached to both brake caliper piston.



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 calliper piston in the brake chamber.

When the brake calliper system moves towards one another then the friction pads attached to the brake calliper 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

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 reserver and the other chamber is open to the atmosphere. The first chamber is also connected to the servo cylinder.

Servo Cylinder :-

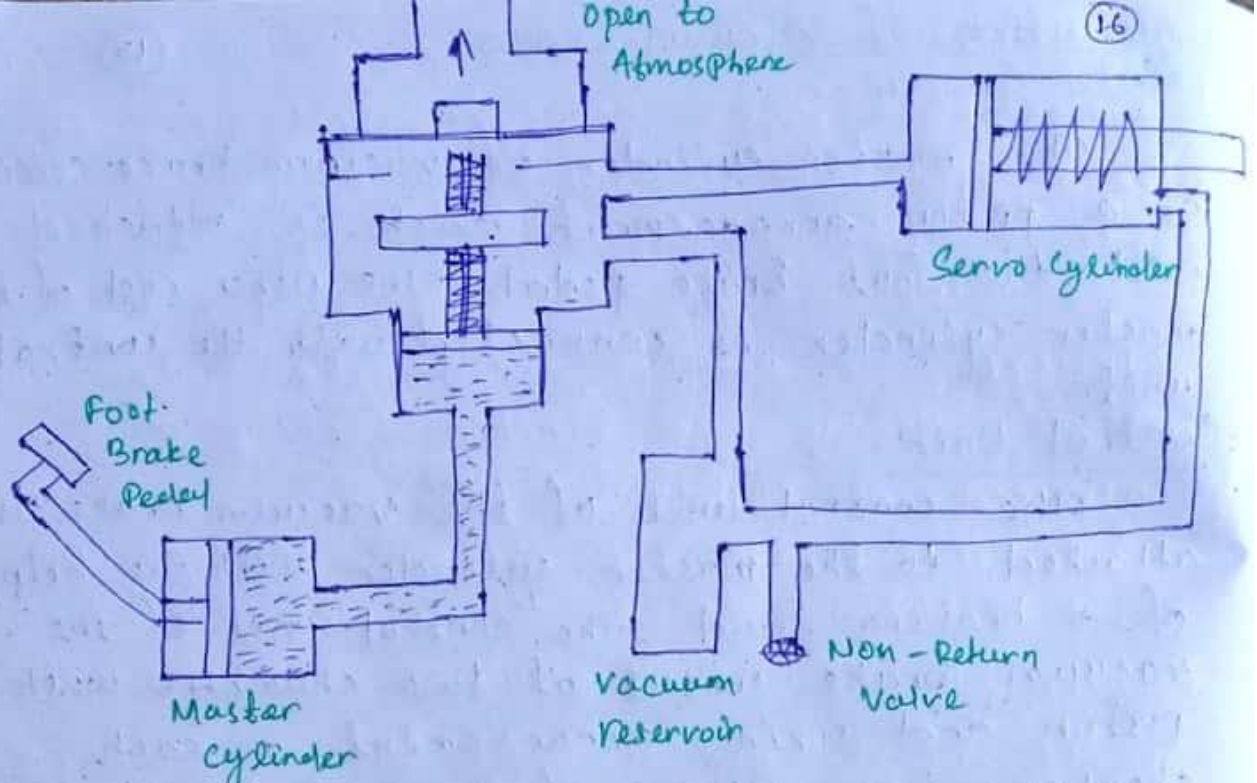
The servo cylinder of the vacuum brake is connected to the vacuum reserver and the other end of the servo cylinder is attached to the control unit. The servo cylinder also consist of piston and a spring arrangement.

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 vechile 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 seconds chamber of the control unit and reaches to the servo cylinder.

We know that Atmoshpheric pressure is always greater then 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

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 :-

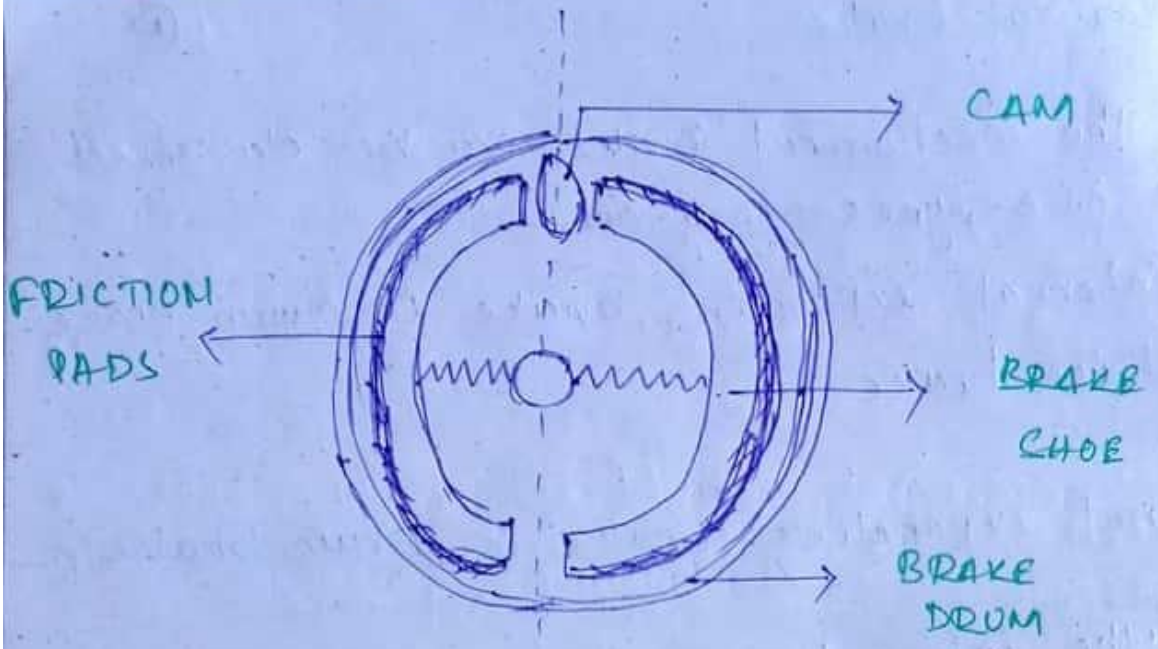
Construction :-

The internal expanding brake or drum brake consist of a brake chamber having two brake shoes. Two 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.

Working Principal

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.



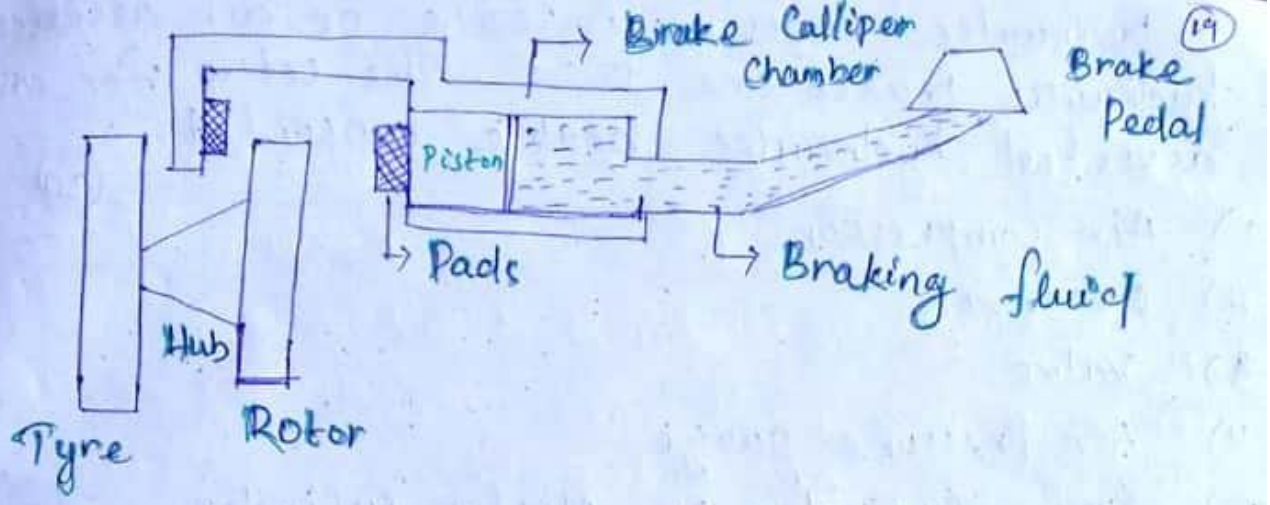
ii) Disc Brake :-

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 defond 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 withthe help of mechanical forces.

Air Assited Hydraulic Brake System

Air assited 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 an assisted hydraulic brake consisted.

(20)

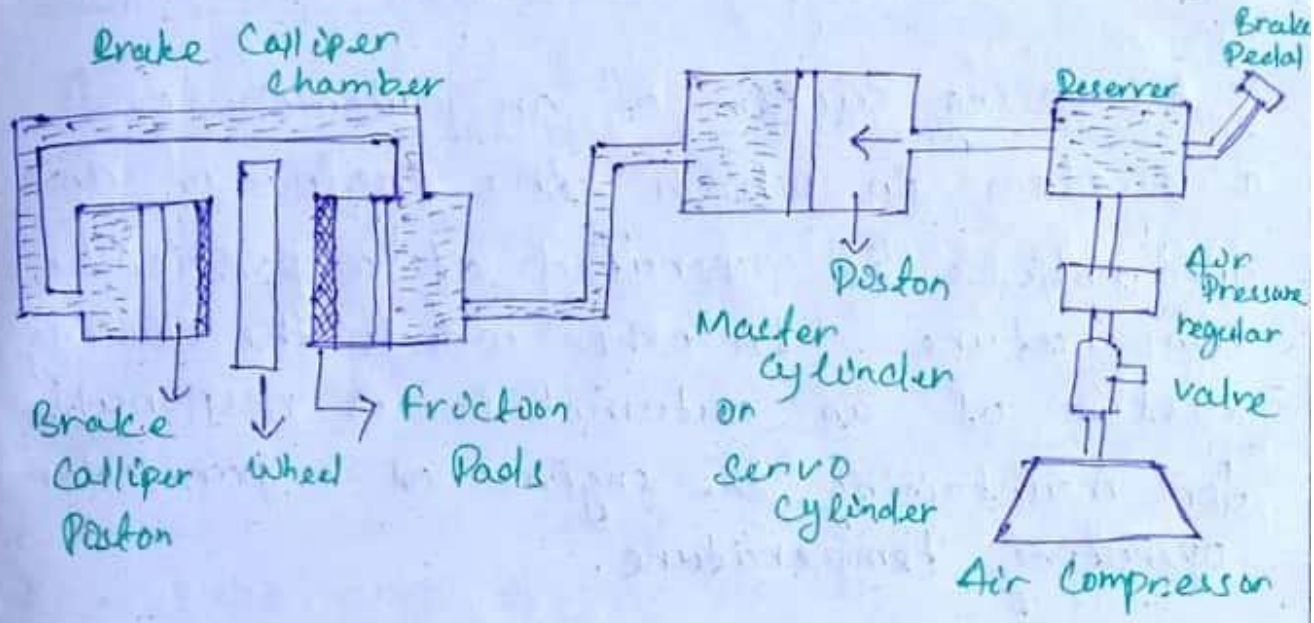
1) Air Compressor
2) Reserver
3) Valve
4) Air Pressure gauge
5) Servo cylinder or Master cylinder
6) Air pressure Regulator

The compressed air is developed by the air compressure 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 admited into the space behind which moves the piston in the servo cylinder. The movement of piston in the servo cylinder guides the hydraulic fluid 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)



Cooling & Lubrication System

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 combution 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 poston 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 absense of the cooling system the high temperature inside the engine cylinder may cause serior damage to the walls of the cylinder, poston rong, poston head so a cooling system is very necessary for maintaining the engine at a particular operating temperature.

Types of cooling System:-

In case of automobile their are various types of

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

i) Air 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 exterior 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:-

It 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 takesplace between the air and external surface of the engine. In this case larger part of the engine exposed to the atmosphere.

ii) Water Cooling System:-

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

(24) The heat transfered 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 takesplace 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 sattles 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 syetem the water is circulated around the engine cylinder to remove the heat generated inside the cylinder due to the cumbution 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 complecated regions of the engine cylinder and ensures the quick removal of unwanted heat inside the engine cylinder.

iii) Deffects in cooling system and its possible remedies :-

DEFECT	REMEDIES
1) Coolent leakage due to	
i) Radiator Core	→ Use radiator sealing compound
ii) Water Pump	→ Weld the crack
iii) Cylinder head	→ Replace the cyeinder 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~~	
i) Thermostat	Repair if possible or replace the thermostat
ii) Improper flow of coolant	check the sprog valve repair if possible replace the thermostat

iv) coolant freezing — Add anti-Freezing Solution

5) Noises due to
   i) Dry beerings — i) Lubricate or apply grease
   ii) Loose Pulley — ii) Tighten or replace pulley
   iii) Loose Impeller — iii) Tighten or replace impeller
   iv) faulty shaft — 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 lubricant is strictly needed is
i) Crank shaft and bearing
ii) Cam shaft and cam bearings
iii) Piston Rong 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 reduce.
→ Heat produced due to friction is also removed by the lubricating agents.

→ Heat generated due to the combustion of fuel inside the engine cylinder is also some how 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 deposite 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) Petrool Lubrocatoon Syatem :-

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

2) Superlube lubricatoon System :-

The superlube lubricatoon system is preferred over petroil lubriccatoon 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 direct contact with each other. In this case the amount of oil supplyed 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 amout of oil and splash the oil under the effects of centrifugal force.

- This splashing action creates ~~a~~ amost 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

In this type of lubrication system the oil necessary for lubrication is stored in side 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 thats 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 the reach the cam and cam shaft for the lubrication of cam surface.

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 lubricate

6) Dry Sump Lubrication System

This type of lubrication system is used in engi racing car and air craft. where the position of the vechile 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 is produced under the effect of thermal pressure arrised inside the engine. In normal type of lubrication system a problem may arrised the oil will roll down to aside 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.

Ignition System & Fuel Supply System

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 combution 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) S I 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 electromegnatic induction.

Construction:-

It consist of various devices which are use to deliver electric current and genarate of 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 on 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 moles.

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 :-

The contact breaker is used on 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.

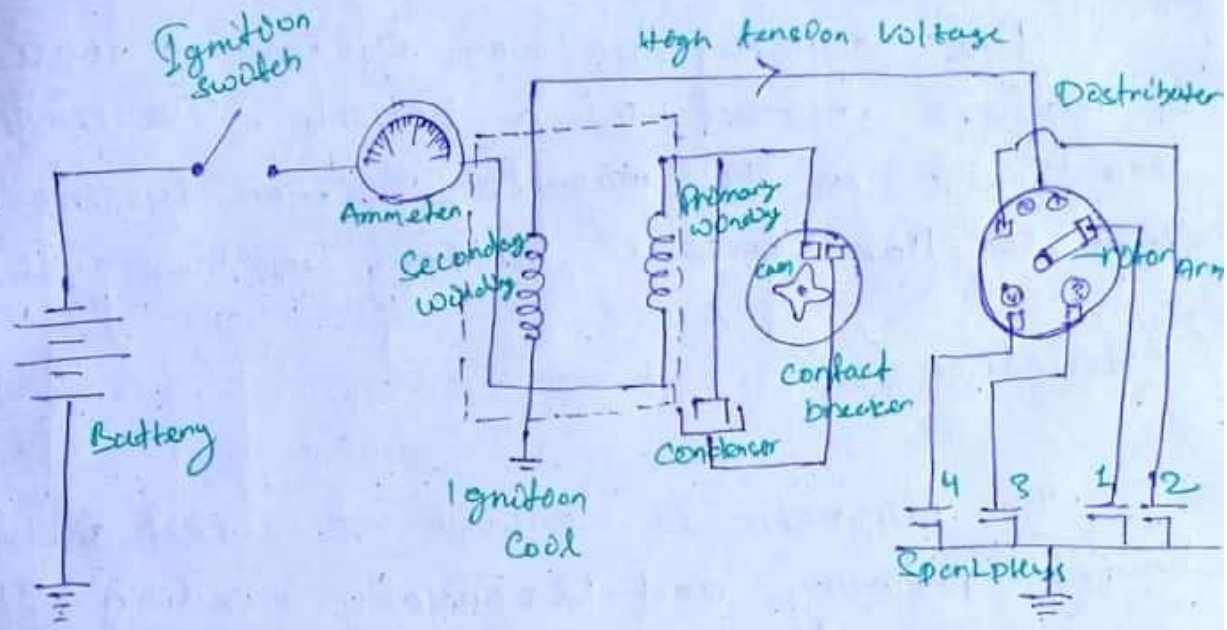
Condenser :-

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

Distibuter :-

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

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



Working Principle

When the ignition swith is ON the current from the battery flows through the ammeter, where its magnitude is measured. The current then the 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

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.

a) Ignition Coil :-

Core toght ignition coil is used in case of magneto ignition system.

c) Primary Winding :-

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

d) Secondary Winding :-

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

Contact Breaker :-

The contact braker used in battery ignition system work with the help of a cam.

The contact braker is responcible for the making and braking of the ckt. The contact braker is generally connect to the primary winding where the voltage produced & transfered to the secondary winding with out any burning of the ckt.

Condenser :-

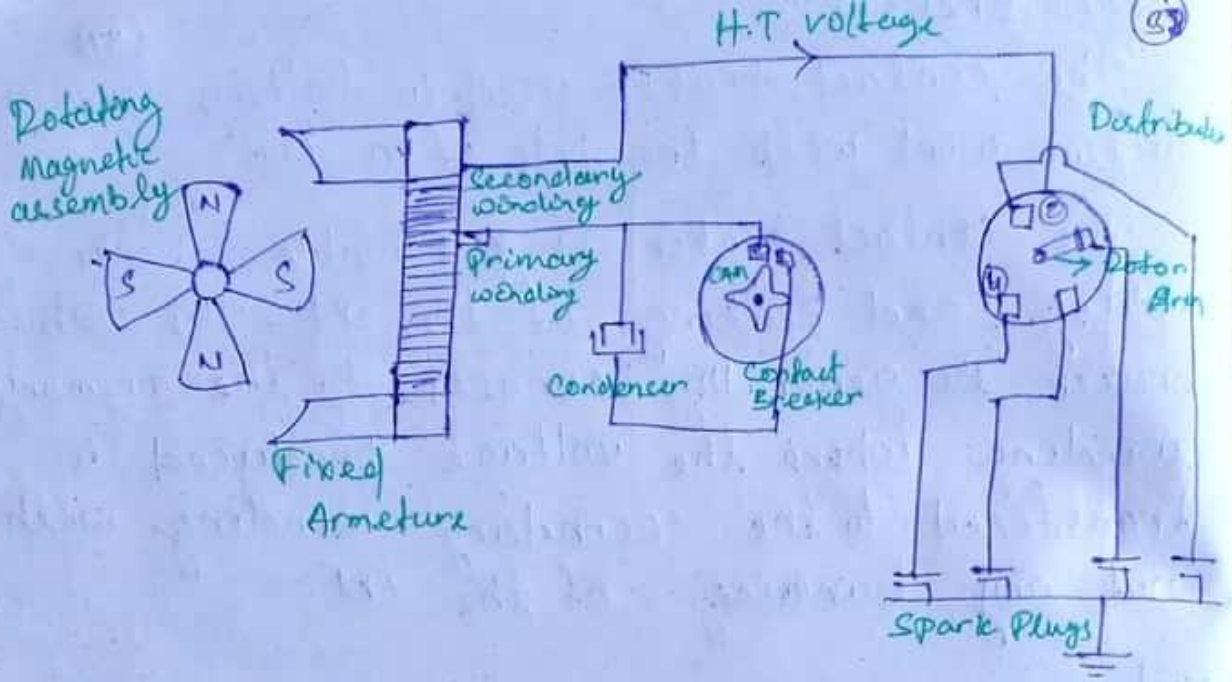
A condenser is device which is used to induced a required voltage into the secondary winding. The condenser absorber the electricity in the primary winding so that a required voltage is passed to the distributer which do not burn or arc the points of the distributer.

Distributor :-

A distributor is a device which consists of rotor arms. The rotor arm revolves and delivers the electric current in the spark plug attach to the four segament the major function of the distributor is.

i) 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 distributer 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	Magneto Ignition System
→ 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 intencity decreases when the engine speed increases.	→ Spark intencity increases whe 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
i) Starting of engine	1 : 10
ii) Cold - Starting of engine	1 : 7
iii) Continuous driving on highways	1 : 18
iv) City - driving	1 : 14

Carburation :-

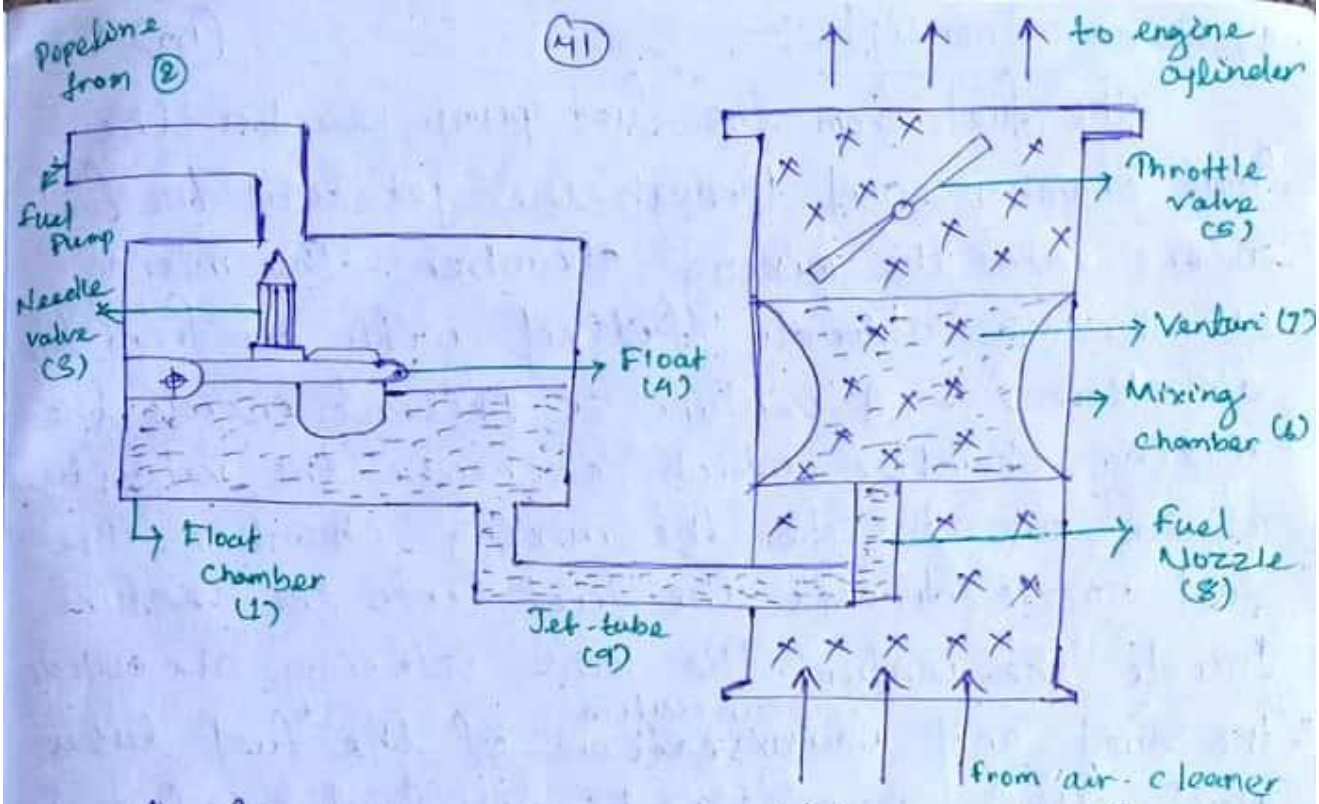
Carburetion is the process in which the carburetor vaporises the petrol and mixed it with the air according to the correct proportion needed in any driving condition.

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 fule 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 :-

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 increase 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 vapourisation of the fuel takes place. This vapourised air fuel mixture is deliver 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 :-

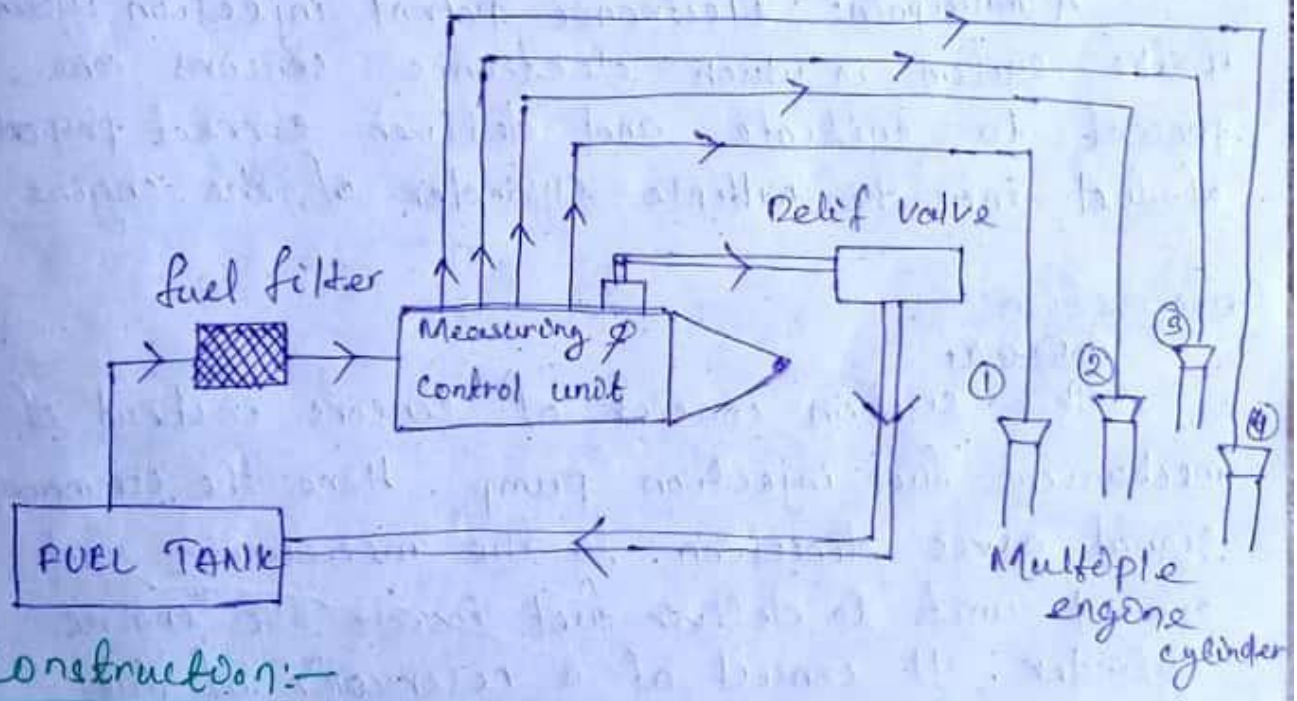
TROUBLES	REMEDIES
1) Float level is set high	Adjust the float ball
2) Punctured float ball	Replace the float ball
3) Loose or worn-out needle valve	Adjust or place the needle valve
4) High fuel pump Pressure	Adjust the pump pressure
5) Worn throttle valve	Replace the throttle valve
6) Choked air cleaner	Clean up air cleaner

Multipoint fuel Injection System In petrol Engines :-

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

1) Mechanical multipoint ~~fuel inje~~ petrol 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 relif valve and fuel folter. ~~Fuel folter~~ is present to folter the impurities from the fuel. The relif 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:-

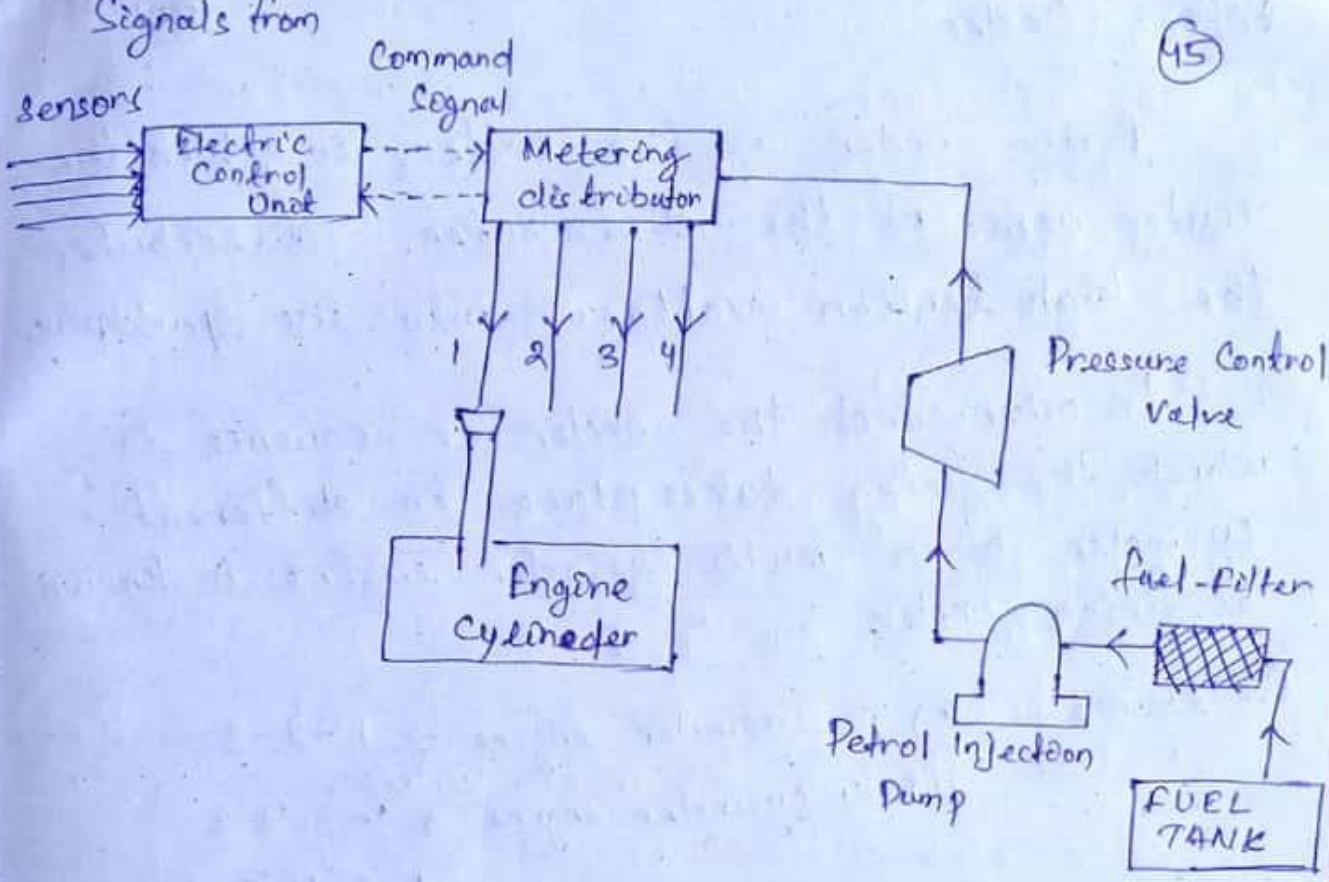
The fuel from the fuel tank is delivered to the fuel folter. Then fuel folter remove the impurities and send the fuel towards measuring and control unit. Here correct amount of fuel is measured and sent into the respective Engine cylinder for combustion. A relif valve is also present to direct the remaining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

2) 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:-

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 folter. The fuel folter 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 folter 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

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

In otherword 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 → 1-2-3

ii) 4 cylinder engine → 1-3-4-2

1-2-4-3

iii) 6 cylinder engine → a) 1-5-3-6-2-4

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

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

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

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

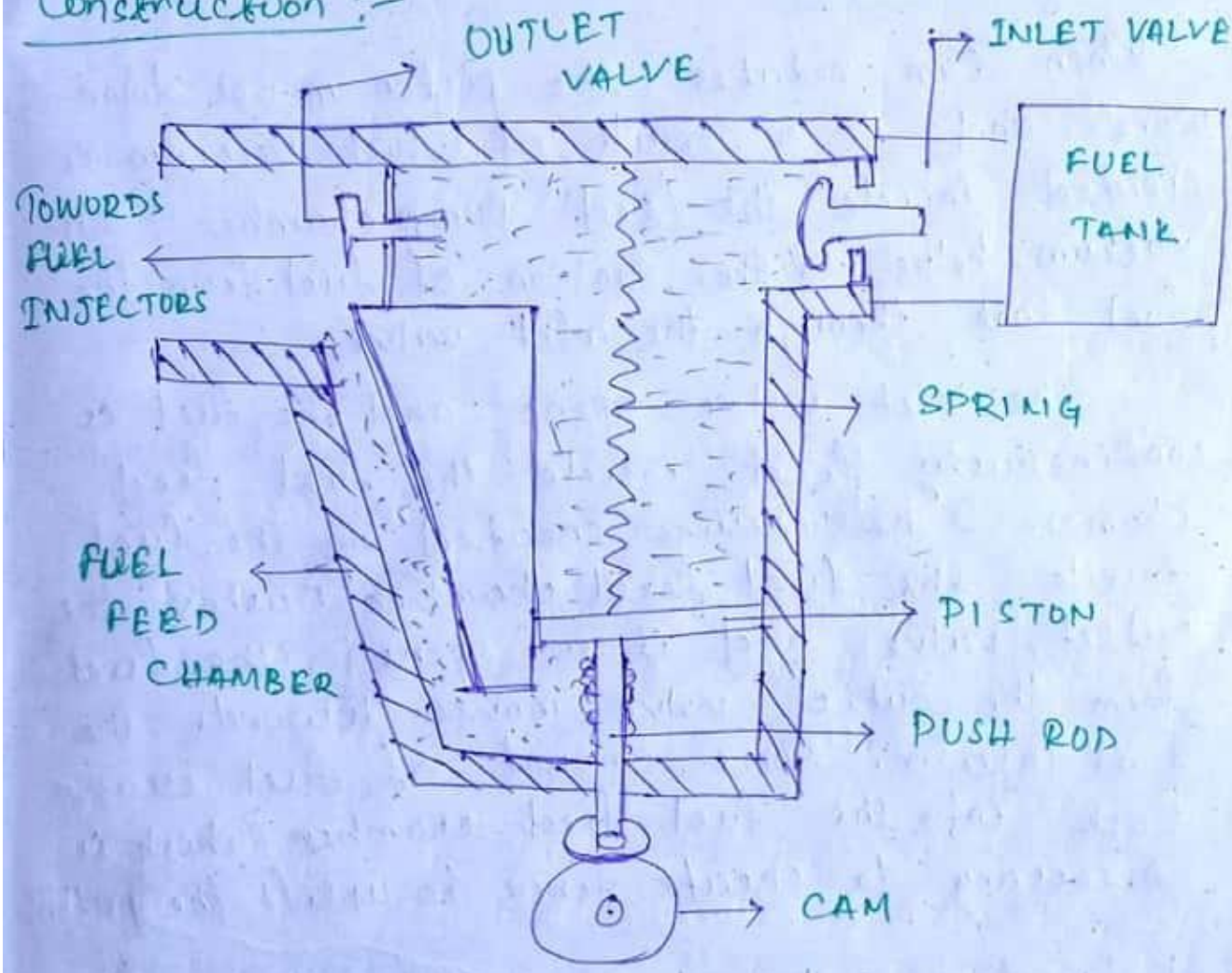
b) 1-4-7-3-8-5-2-6

DIESEL ENGINE :-

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 upword & downword. 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 vaccum is created inside the feed pump chamber. This vaccum 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 Injectors in Diesel Engine :-

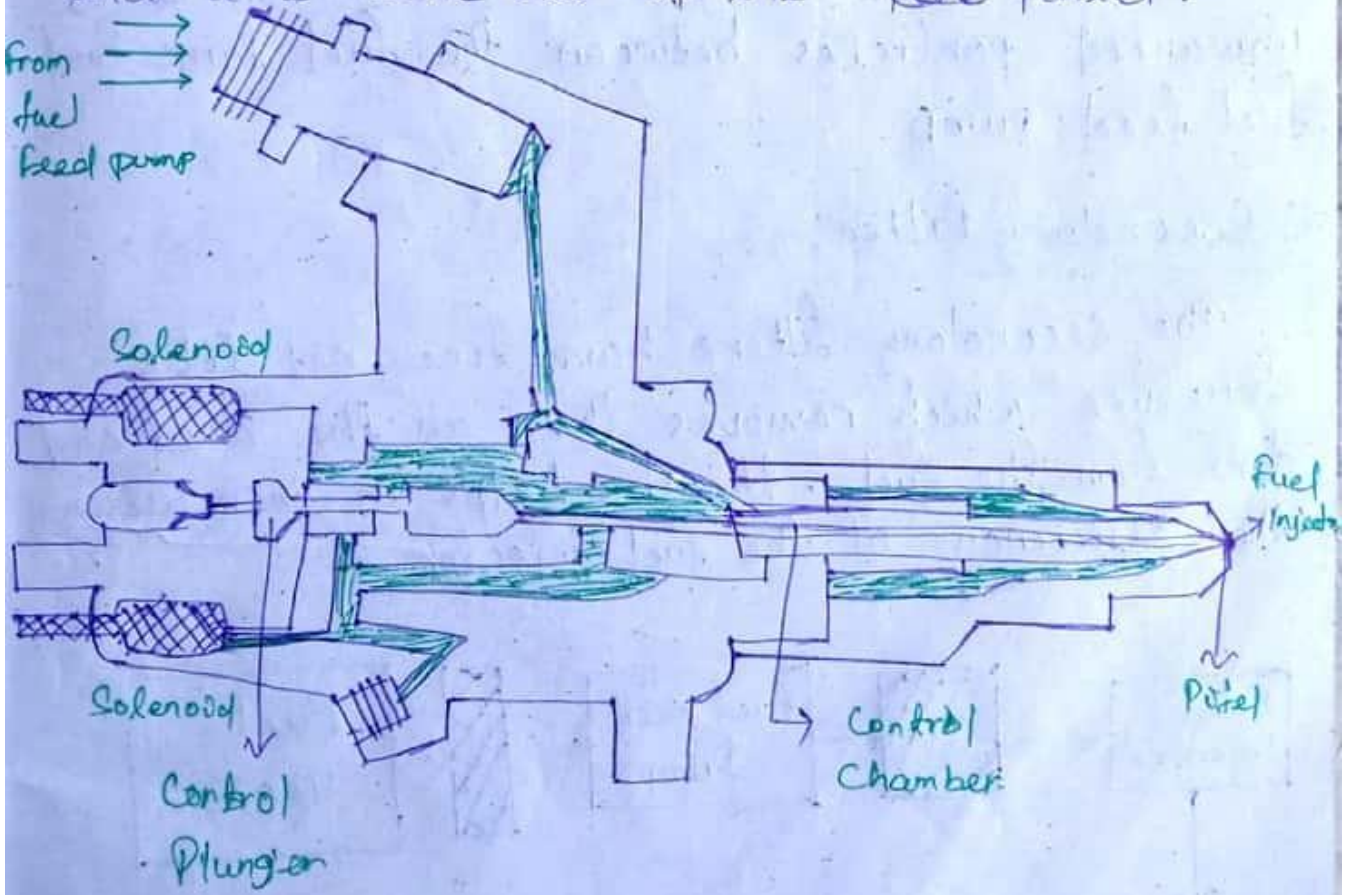
In case of Diesel Engine fuel injectors are present to spray fuel into the engine cylinder in atomised form.

Construction of fuel Injector :-

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 energised with the help of the charging then it pushes the control plunger upwards. Thus results in the release of small amount fuel which creates a differential pressure and it is come out of the Pintel.



Fuel- Filter In Diesel Engines :—

Fuel filter used in diesel engines are utilise to remove the unwanted materials, rust and dirt from the fuel/air. 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

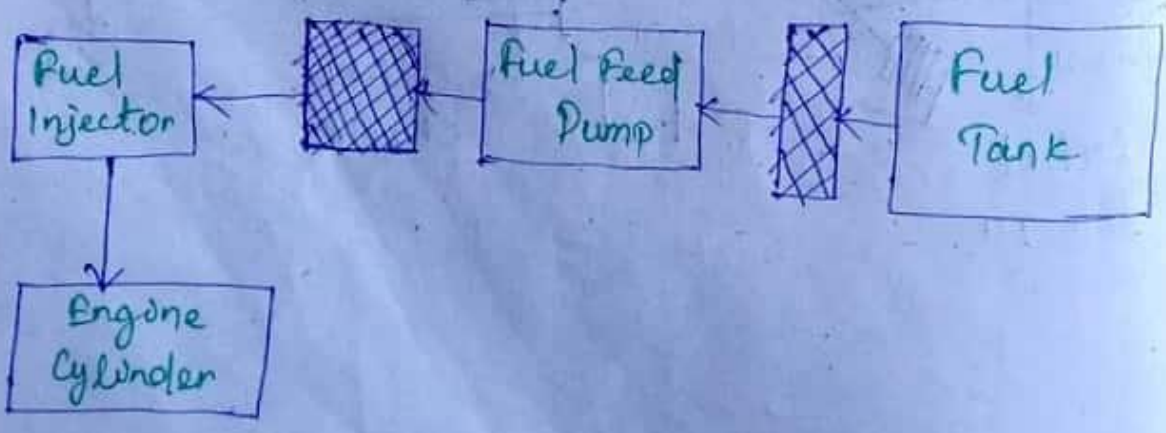
1) Primary filter / Coarse filter
2) Secondary filter / Fine filter

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 then 1 cylinder so it is called multi-point fuel injection system.

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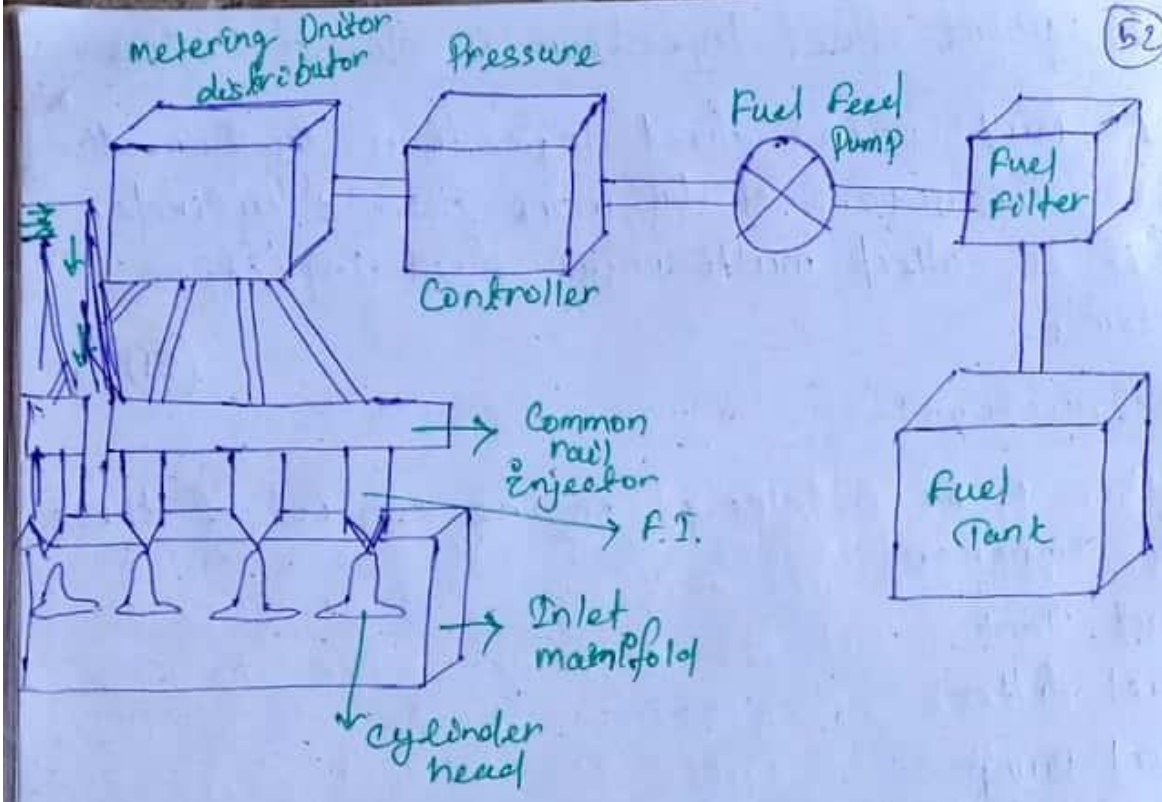
Construction :-

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 remove 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.

Block diagram of elec 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 powerful 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 :-

This lights are automatically produced by the driver during the indication of a new turn

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 system inside the automobile.

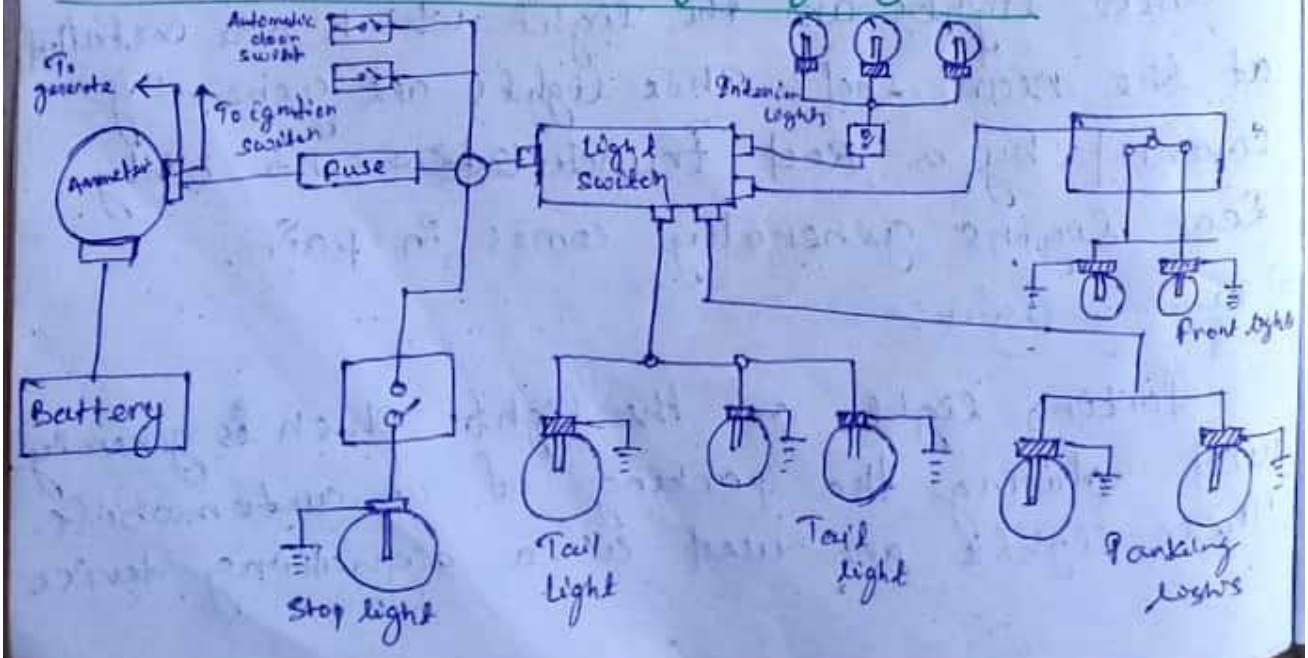
6) Stop lights :-

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

7) Blinker light :-

These lights are ~~used~~ the lights which are used on the automobile to enhance the visibility of the automobile to other automobile and it is also used to signal the vechile 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.

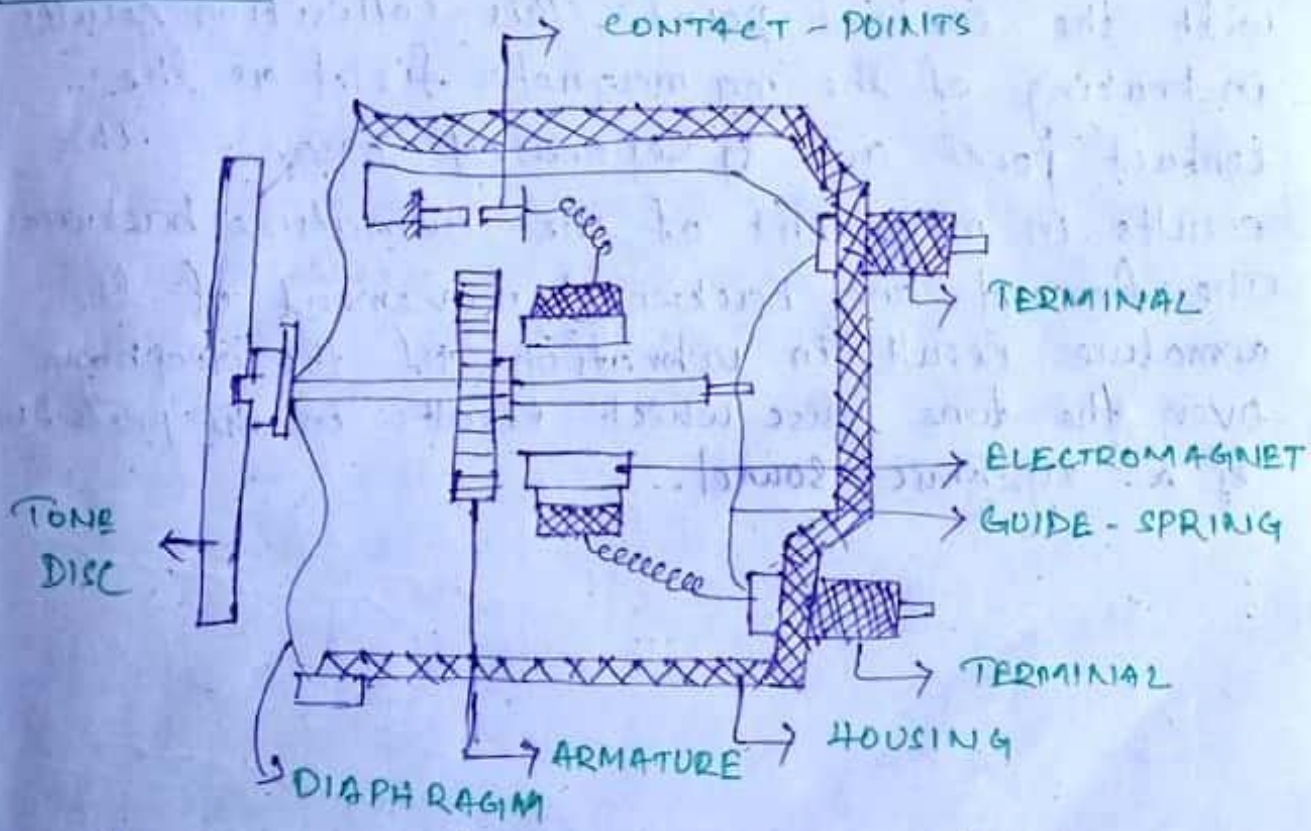
2) Lighting system also helps in avoiding the accident during night.

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 receives electricity and helps in the production of magnetic field.

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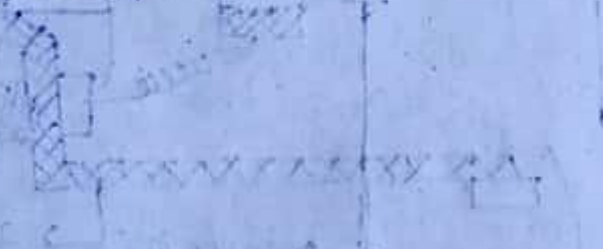
Working Principle :-

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 rythmic sound.



Cut Out Relay :-

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

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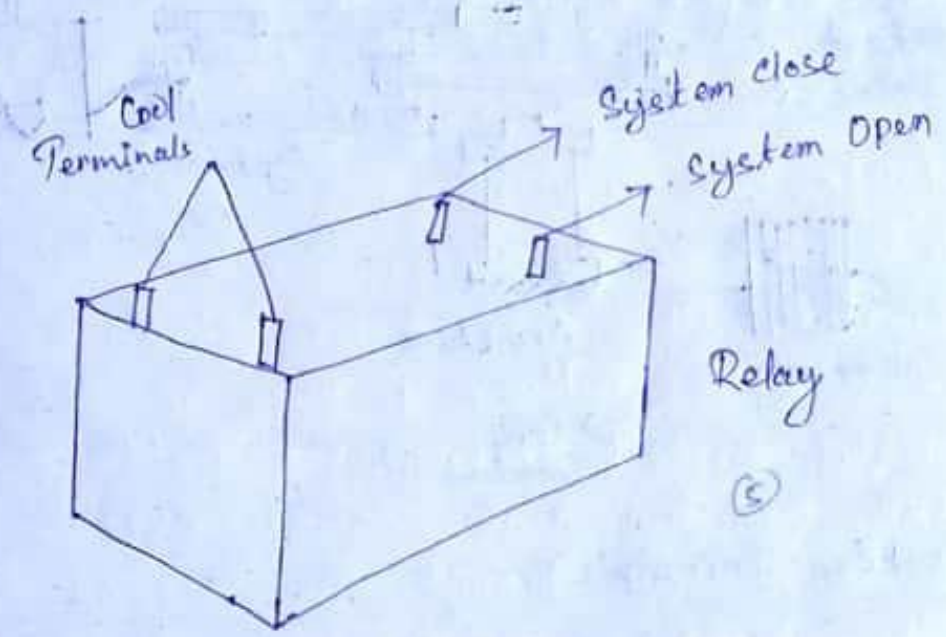

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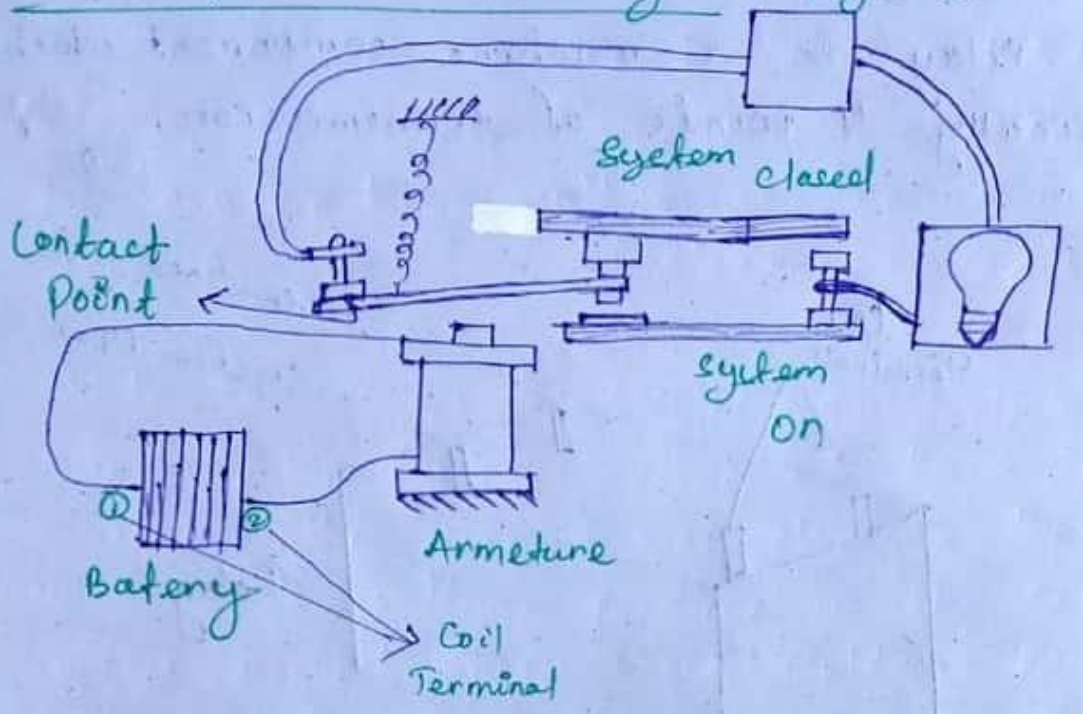
Construction :-

The cut out Relay consist of a battery and both the terminal of the battery are attached to the armeture. The armeture 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 & Relay :- Regulator



Working Principle :-

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

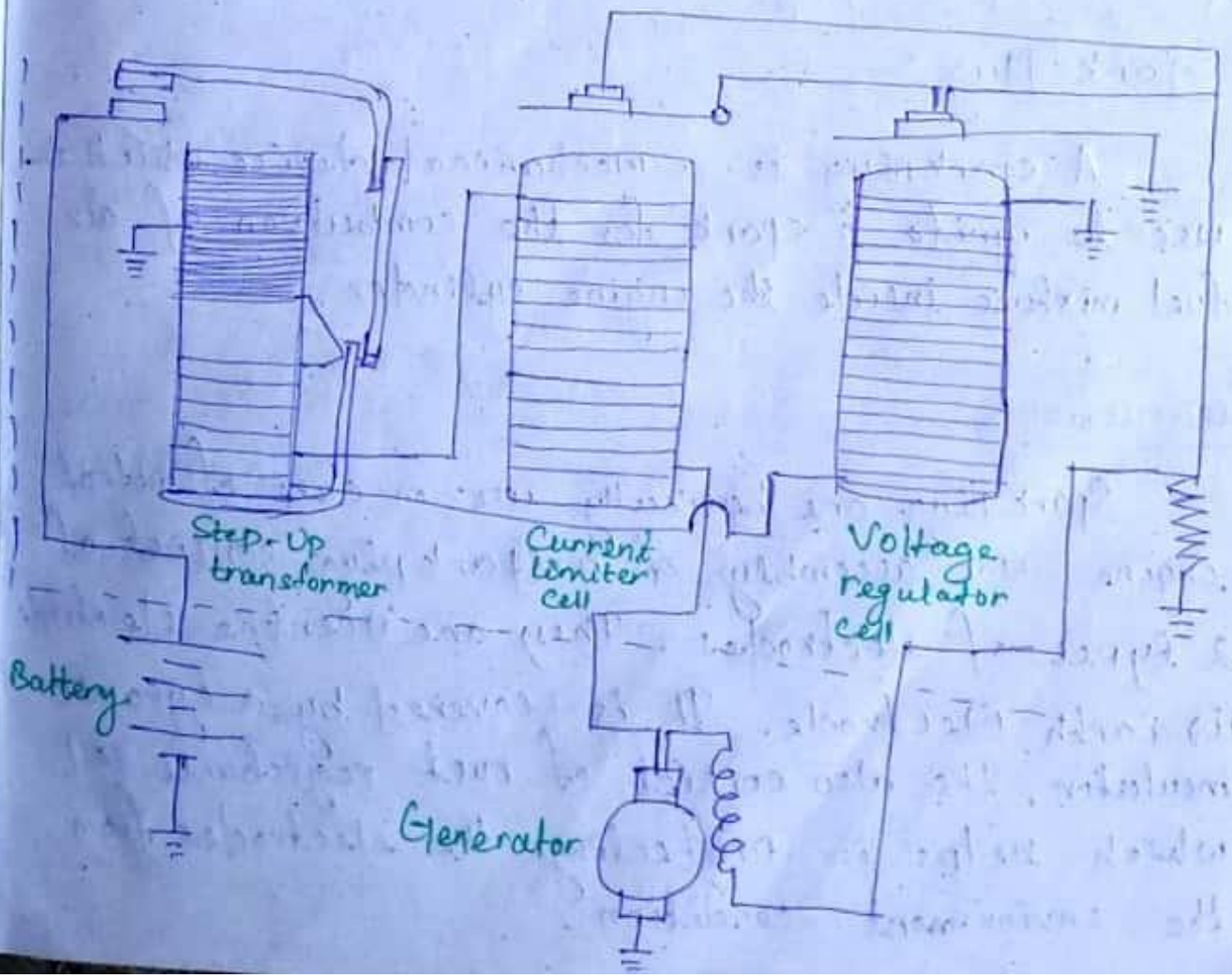
When the both terminals of the battery is connected with armeture then magnetic field is produced and the Armeture charges the contact points towards itself. Now the contact point will be attached to the system open way and the circuit is finally completed. In this way the current is supplied to the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

Voltage Current Regulator Circuit:—

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 ~~machine~~ 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 controling of high tension current flowing in the ckt.



Working Principle :-

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

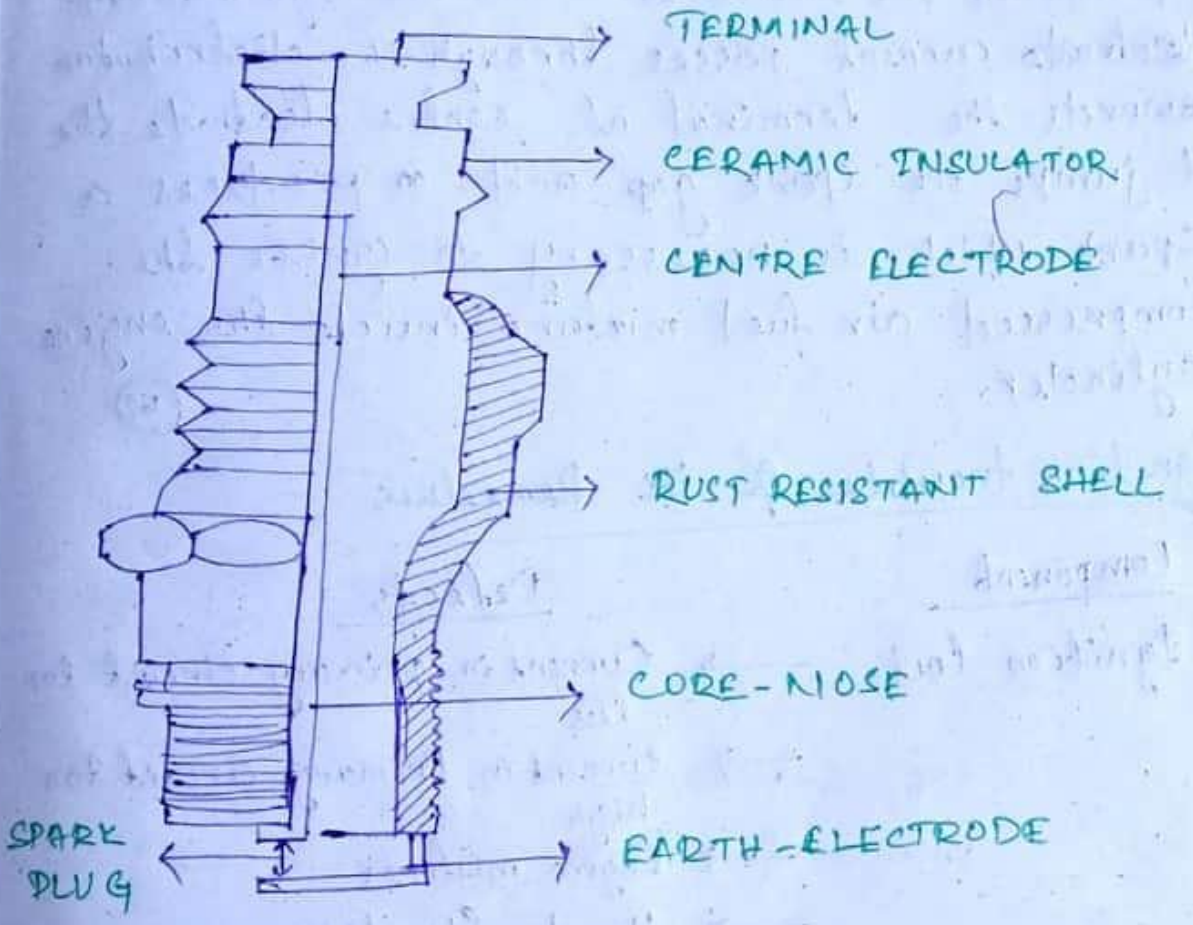
In some cases this high magnitude of voltage is responsible for generation of high tension current. This current may damage the distibutor ckt, so the voltage produce in the secondary coil is passed through a voltage regulator cell and the high tension current is also made to run through the current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

Spark Plug :-

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

Construction :-

Sparkplug are basically use in case of petrol engine. The assembly of a sparkplug consist of 2 types of electrodes. They are i) centre electrod ii) Earth Electrode. It is covered by a cyramic insulator. Its also consist of rust regisbande cell which helps in protecting the electrodes from the enviornment condition.



Working Principle :—

The function of the sparkplug is to produce an electric spark to ignite the compressed air fuel mixture inside the engine cylinder. It produces spark at the correct moment 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 takes 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.

compressed air fuel mixture inside the engine cylinder.

Ignition troubles & its Remedies :-

Component	Defects	Remedies
1) Ignition Coil	→ Current in primary circuit too less	→ Test & replace the defective coil
	→ Current in Primary circuit too high	→ Test & replace the defective coil
	→ Engine misfires	→ Test & replace the defective coil
	→ Hard Starting	→ Replace the defective cables.
2) Contact Breaker	→ Burns rapidly	→ Replace defective Condenser
	→ Burnt & dirty points	→ Clean the points & Replace the resistance
3) Distributor Assembly	→ Engine do not start in wet weather	→ Wipe off the moisture inside distributor Cap
	→ Wearing of blocks	→ Lubrication the blocks or replace.
4) Condenser	→ Breaker Points burns rapidly	→ Toghten the loose condenser lead
	→ Difficult engine starting	→ Replace the low Capacity Condenser
5) Ignition switch	→ Low current in primary ckt	→ Replace the switch
6) Spark Plug	→ Over heating	→ Use correct plug & Adjusted Carburetor
	→ Misfiring	→ Adjust the gap or replace the plug.
	→ Electrodes Erosion	→ Use proper fuel

Components	Defects	Remedies
1) Magneto	→ Noose	→ Repair & tighten Screws, loose plates etc