UNIT 10

Electrical System

Contents

M71IJ

Learning objectives

1. To learn about the types, importance of the electrical system used in an automobile.
2. To understand the construction, working principle of various electrical systems used in an automobile.

10.0 Introduction

Electrical energy is a form of an energy. Electrical energy is used for domestic, agriculture and industrial purpose etc. Electrical energy plays an important role in an automobile. The automotive electrical system can be classified as follows.

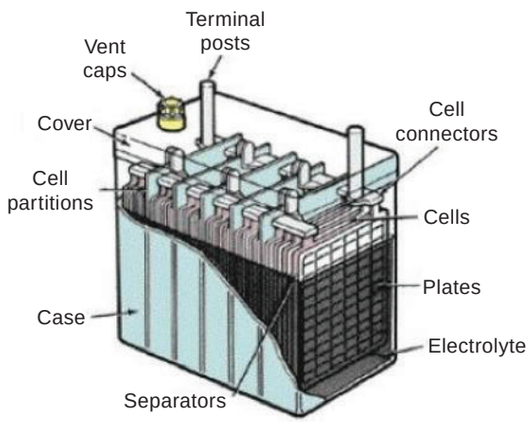
1. Starting System
2. Ignition System
3. Lighting System
4. Generation, Storage and Distribution System
5. Accessories

10.1 Battery

The battery is an important and essential component in an automotive electrical system. The electrical energy is stored in the battery and it is supplied to all the electrical subsystem when the vehicle is not operating. The battery is considered as the heart of an automotive electrical system.

A positive terminal and a negative terminal form a cell. Several cells are connected in series or in parallel is called as a battery.

A battery is used to store electrical energy as chemical energy. This chemical energy is then converted to electrical energy as and when required. The conversion of electrical energy into chemical energy by applying external electrical source is known as charging of the battery. Whereas conversion of chemical energy into electrical energy for supplying the external load is known as discharging of the battery.



10.1.1 Types of battery

1. Lead Acid Battery
2. Lithium-iron Battery
3. Nickel Cadmium Battery
4. Nickel Metal Hydride Battery
5. Sodium Sulphur Battery

Out of which, the lead-acid battery is widely used in an automobile.

10.1.2 Lead Acid Battery Construction And Working Principle

The following are the important parts of a battery

1. Container
2. Plates
3. Separator
4. Cell cover
5. Electrolyte
6. Terminal post

Container

The container is a single piece moulded part made up of hard rubber or bituminous. The container will house all the internal parts of a battery and holds the liquid electrolyte. The container is divided into six compartments for the six cells. Projections are provided on the inside at the bottom to support the plates. Bridges are used to prevent the plate from touching at the bottom.

Plates

Plates are of two types viz. 1. Positive plate and 2. Negative plate

The positive plate is made of lead peroxide. This is dark brown, hard and brittle substance. Lead oxide acts as active material. Highly porous in nature. The negative plate is made of pure lead in soft sponge condition. Spongy lead acts as active material. Grey in colour. Highly porous in nature. Grids are used to hold the plates and to conduct the electrical charge.

Separator

Separators are placed between positive plates and negative plates to insulate them between each other. This will prevent the short-circuiting between the positive and negative plates. The separators are thin sheets of non-conducting material made up of chemically treated wood, porous rubbers, or mats of glass fibre. The separators must be porous so that the electrolyte may circulate between the plates.

Cell cover

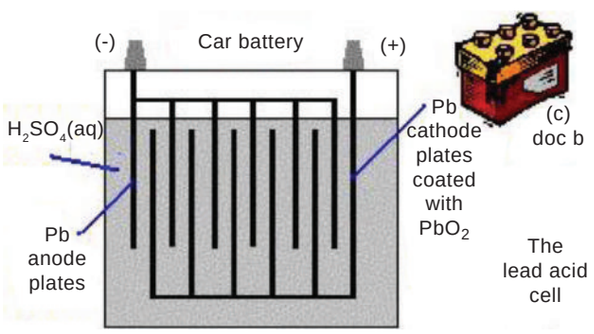
Cellcover is used to cover the complete cell. It protects the cell from the dust as well as other external impurities. Vent holes are provided to exhaust the gases generated in the cell to the atmosphere. Filler openings are available to fill up the electrolyte.

Electrolyte

In lead-acid battery dilute sulphuric acid (H_2SO_4)is used as an electrolyte. For this purpose, one part concentrated sulphuric acid is mixed with three parts of distilled water.

Terminals

Terminals are used to connect the charging circuit as well as the load. For easy identification, the diameter of the positive terminal is bigger than the negative terminal.



Working principle

During discharging (i.e., supplying a current), atoms from the spongy lead on

the negative plates combine with sulphate molecules to form lead sulphate and hydrogen. The combination of lead peroxide and hydrogen at the positive electrode produces water and lead sulphate. The water dilutes the electrolyte, making it a weaker solution, drop in cell voltage, hence specific gravity of electrolyte is reduced.

During recharging, current is made to flow into the positive electrode of each cell. This current causes the lead sulphate at the negative electrode to recombine with hydrogen ions, thus re-forming sulphuric acid in the electrolyte and Spongy lead on the negative plates. Also, the lead sulphate on the positive electrodes recombines with water to regenerate lead peroxide on the positive plates and sulphuric acid in the electrolyte. Thus cell voltage is increased and the specific gravity of electrolyte is increased.

The two way of reversible chemical reaction (charged on the left and discharged on the right) is given as

Lead Peroxide + Sulphuric Acid + Spongy Lead ⇆ Lead Sulphate + Water + Electrolyte

$PbO_2 + 2H_2SO_4 + Pb \leftrightarrows PbSO_4 + 2H_2O + PbSO_4$

10.1.3 Battery Charging

The battery is charged by the vehicle generator during vehicle running. When the engine is in off condition, the electrical device will utilise the stored electrical energy from the battery. This will quickly discharge the battery and it requires external charging to charge the battery.

Method of Charging

1. Constant Voltage Method
2. Constant Current Method
3. Quick Charging Method

1. Constant voltage method

The charging voltage is kept constant throughout the charging process. The charging current is high in the begining when the battery is in the discharge condition. The current is gradually dropping off as the battery picks up charge

2. Constant current method

The charging current is kept constant throughout the charging period. The charging may be carried out in two steps. An initial charging of approximately higher volt and a finishing rate of low volt is used to avoid excessive gassing or overheating.

3. Quick charging method

The 80% of the total charging is done with high current and later the charging current is reduced. A battery in good condition alone charged in this method.

Specific gravity	Cell Voltage	Battery Voltage	% Charge
1.28	2.12 V	12.7 V	100
1.24	2.08 V	12.5 V	70
1.20	2.04 V	12.3 V	50
1.15	1.99 V	12.0 V	20
1.12	1.96 V	11.8 V	0

A battery is called as 'dead battery' when the battery is completely discharged condition.

10.2 Ignition system

1. To supply a spark inside the cylinder, at the end of compression stroke, to ignite the compressed charge of the air-fuel mixture.
2. Convert low tension current into high tension current. (6v to 12v in to 20,000 to 30,000v)
3. To produce spark in the multi cylinder engine at the right time as per the firing order.

10.2.1 Types of ignition system

1. Battery coil Ignition system
2. Magneto Ignition system
3. Electronic Ignition system

10.2.1.1 Battery coil ignition system

The main parts of a battery coil ignition system is

1. Battery
2. Ignition Coil
3. Contact breaker points
4. Condenser
5. Distributor
6. Spark plug
7. Ignition Switch

Battery

A battery is used to provide energy for ignition. The battery is charged by the dynamo or alternator and provide electrical energy to the electrical parts in the vehicle as and when it is required.

Ignition coil

An ignition coil is made up of an iron core surrounded by two insulated coils, namely primary winding and secondary winding. Acting as a step-up transformer. It converts low tension current (12v) into high tension current of 20000 to 30000

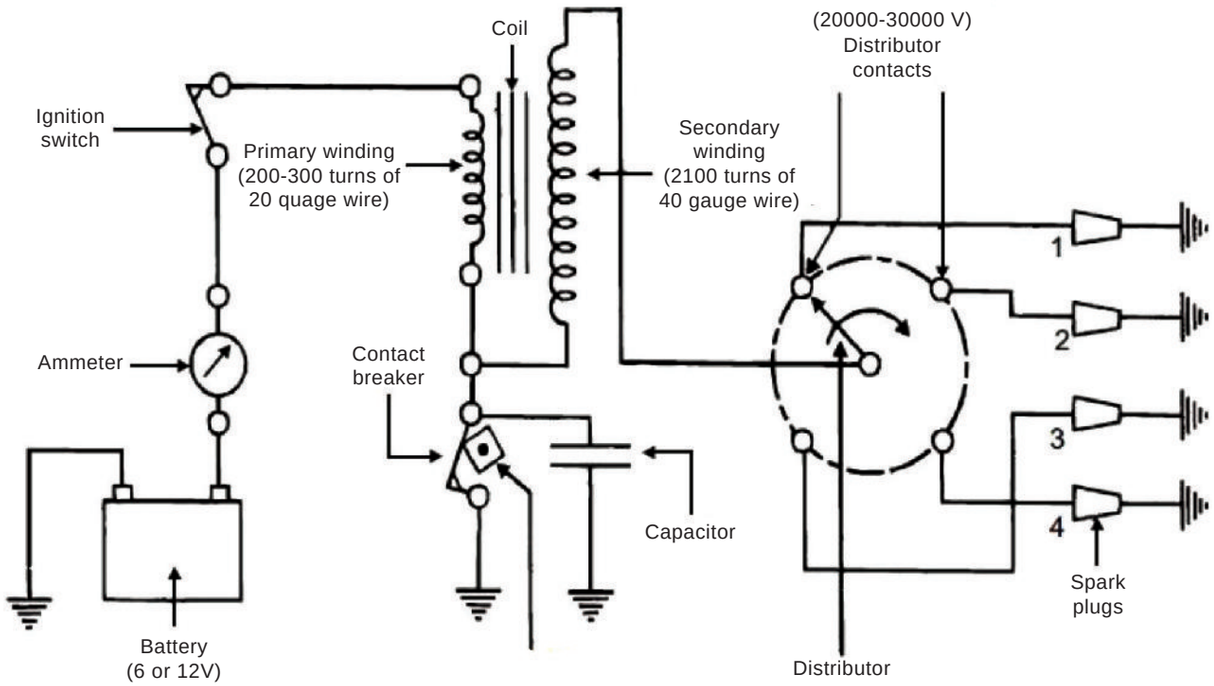


Figure 10.2.1.1 (a) Battery coil ignition system

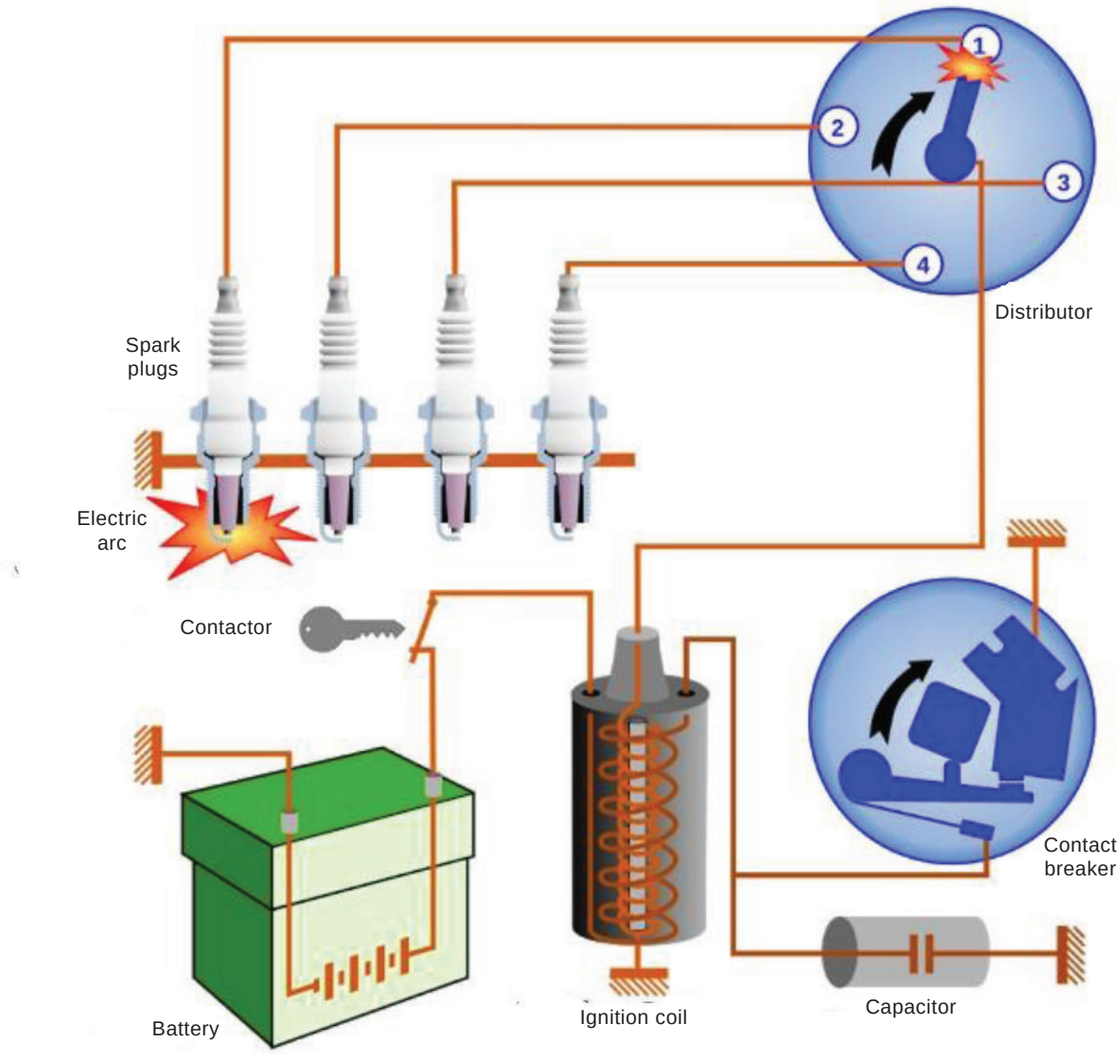


Figure 10.2.1.1 (b) Battery coil ignition system

volts. This high tension current enables to generate a spark across the electrodes of a spark plug.

Contact breaker points

The opening and closing of the primary circuit are made by contact breaker points. When the points are closed current flow in ignition coil and charge the primary circuit and when it open, discharge of primary current take place and by mutual induction, in secondary coil high tension current is induced.

Condenser

A condenser is connected in parallel to the contact breaker points to prevent arching at the contact breaker points. Also, used to increase the intensity of the spark.

Distributor

The distributor is used in multi-cylinder engine to distribute the high tension current from the ignition coil to the individual spark plug as per the firing order.

Spark plug

A spark plug has two electrodes which are separated with each other. When a high tension current is applied between these two electrodes, it produces spark to ignite the air fuel mixture in the engine cylinder.

Working Principle

When the ignition switch is turned "ON", the current flows from the battery to the primary winding, through the contact breaker. The flowing current induces a magnetic field in the primary winding. As the contact breaker opens, the current collapses resulting in high tension induction in the secondary winding. This high tension generated in the secondary winding is transferred to the distributor by a cable. The distributor distributes high tension to the spark plug located in the individual cylinder as per the firing order. A spark is generated in the spark plug to initialise the combustion of fuel and air.

10.2.1.2 (a) Rotating Armature type Magento System

Magneto ignition system is a special type of ignition system with its own electric generator to provide the required necessary energy for the vehicle. A magneto, when rotated by the engine, is capable of producing a very high tension and doesn't need a battery as a source of external energy. It is mounted on the engine and replaces all components of the coil ignition system except the spark plug. Magneto ignition system can be either rotating armature type or rotating magneto type.

Construction

Permanent magnets are stationary and acting as the North and South poles. The armature consisting of the primary and secondary windings all rotate between the poles of a stationary magnet. Primary winding will be made up of thick wire with less no. of turns (150 to 300 turns) and the secondary winding is made up of thin wire with more No. of turns (15000 to 25000 turns). Contact breaker points and condenser are connected to the primary winding and spark plug is connected to the secondary winding.

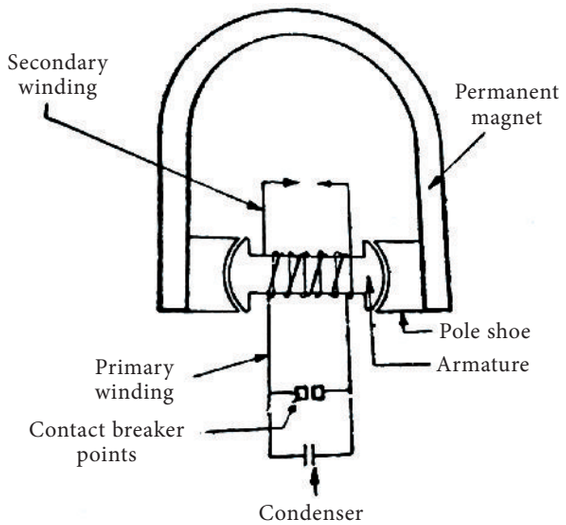


Figure 10.2.1.2 (a) Rotating armature type magnet ignition

Working

When the armature rotates, the flow of current is happening in primary winding and Contact breaker point in the closed condition. The magnetic field is induced in primary winding. When the contact breaker point open, the magnetic field in the primary winding collapses and by mutual induction principle, high tension current is induced in the secondary winding. This high tension current is applied to the spark

plug and spark is produced to ignite the air-fuel mixture in the combustion chamber.

10.2.1.2 (b) Rotating magnet type magneto ignition system

Construction

In this permanent magnet are fitted over the engine flywheel. The fixed armature will have few hundred winding (150 to 300 turns) made up of thick wire and this act as a primary winding. The secondary winding is made up of thin wire with thousands of turns (15000 to 25000 turns). Contact breaker points and condenser are connected to the primary winding and spark plug is connected in the secondary winding.

Working

When the flywheel is rotated, the permanent magnet will also rotate. This will make the flow of current to the primary winding and generates magnetic field. When the contact breaker points open, the magnetic field in the primary winding collapses and by mutual induction principle, high tension current is induced in the secondary winding. This high tension current is applied to the spark plug and spark is produced to ignite the air-fuel mixture in the combustion chamber.

10.2.1.3 Electronic ignition system

The following are the important parts of an Electronic Ignition System

1. Battery
2. Ignition Switch
3. Ignition Coil
4. Electronic Control Unit
5. Distributor
6. Spark Plug
7. Reluctor

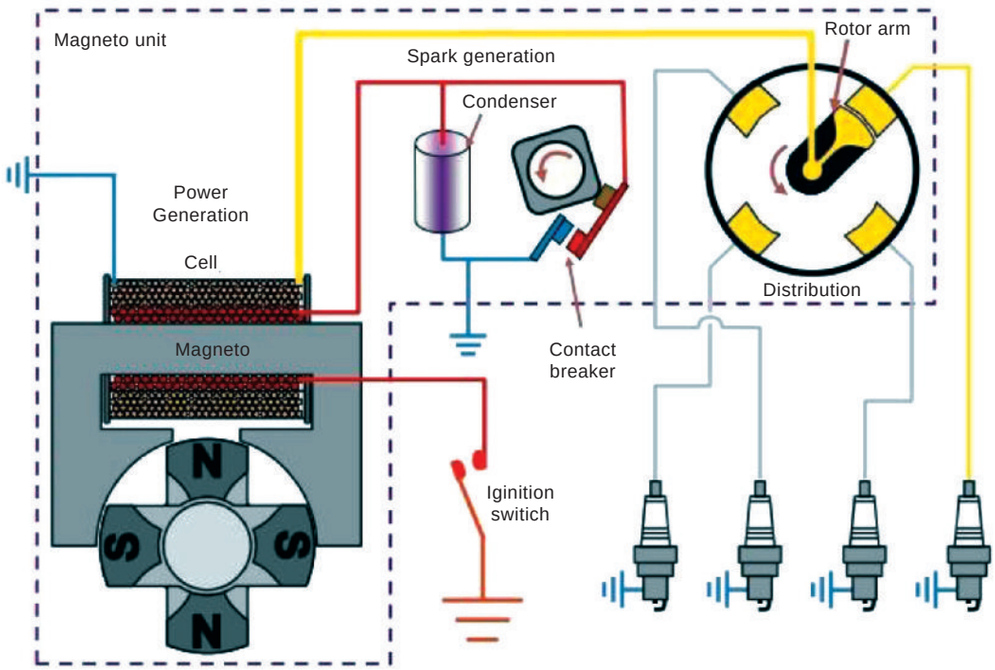


Figure 10.2.1.2 (a) Rotating armature type magento system

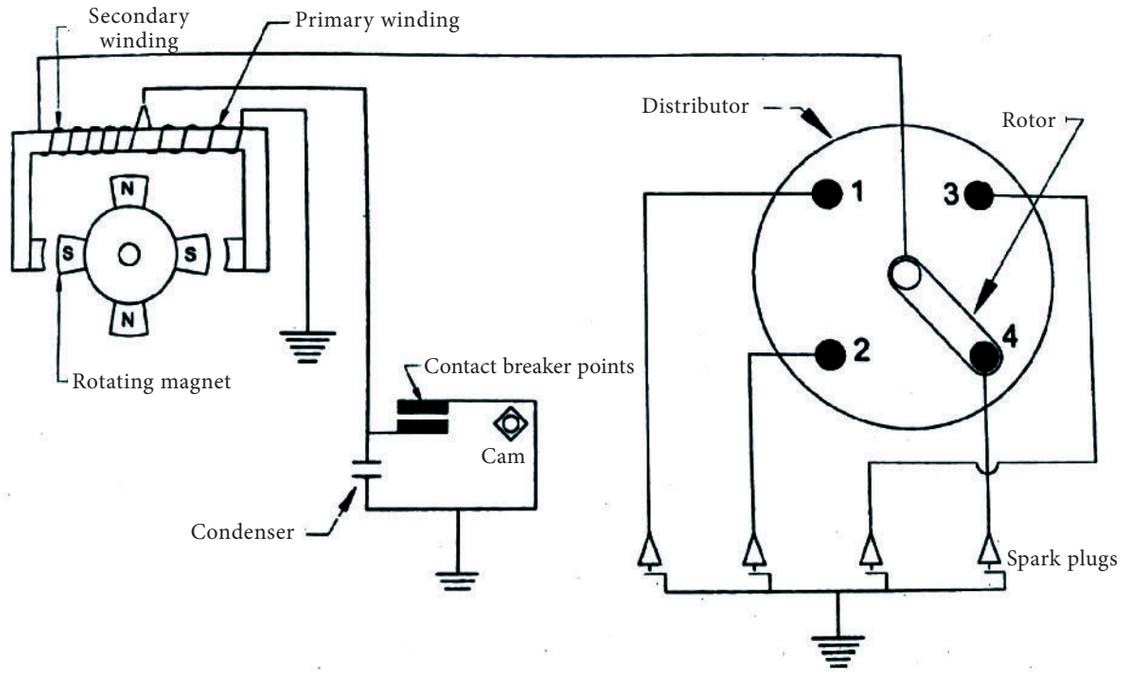


Figure 10.2.1.2 (b) Rotating magnet type magneto ignition system

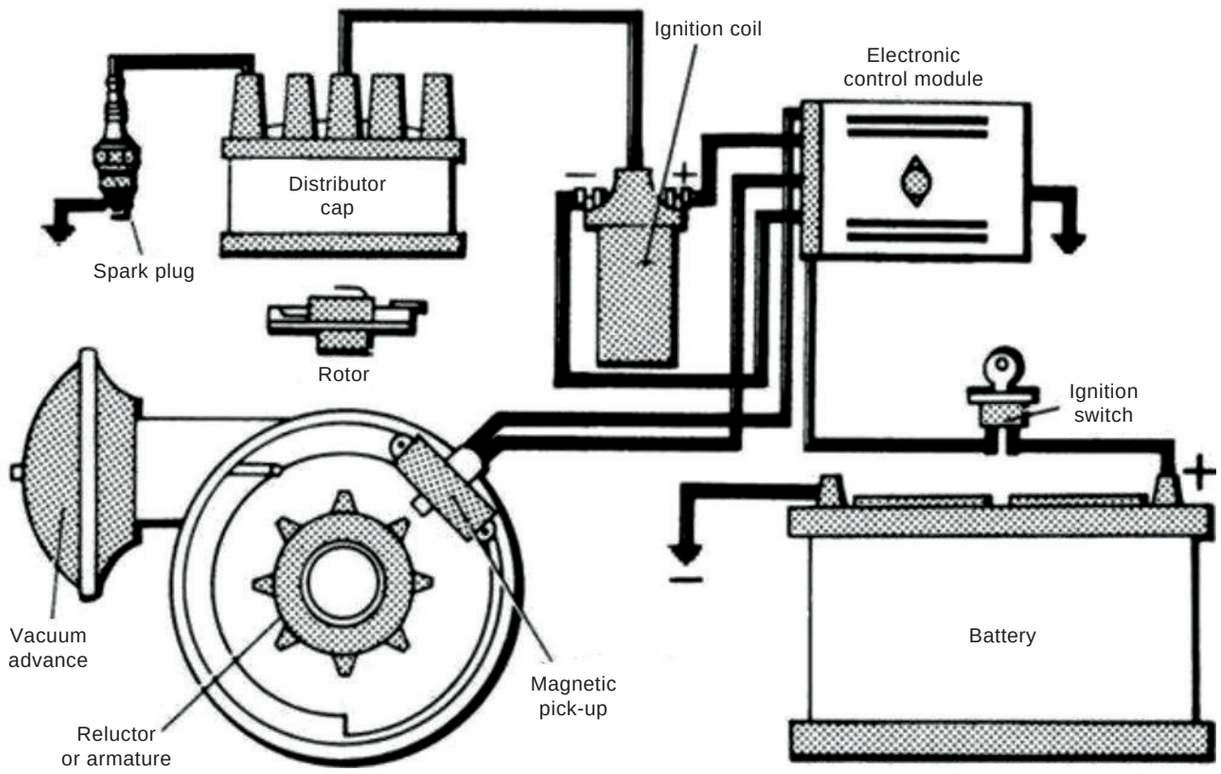


Figure 10.2.1.3 (c) Electronic ignition system

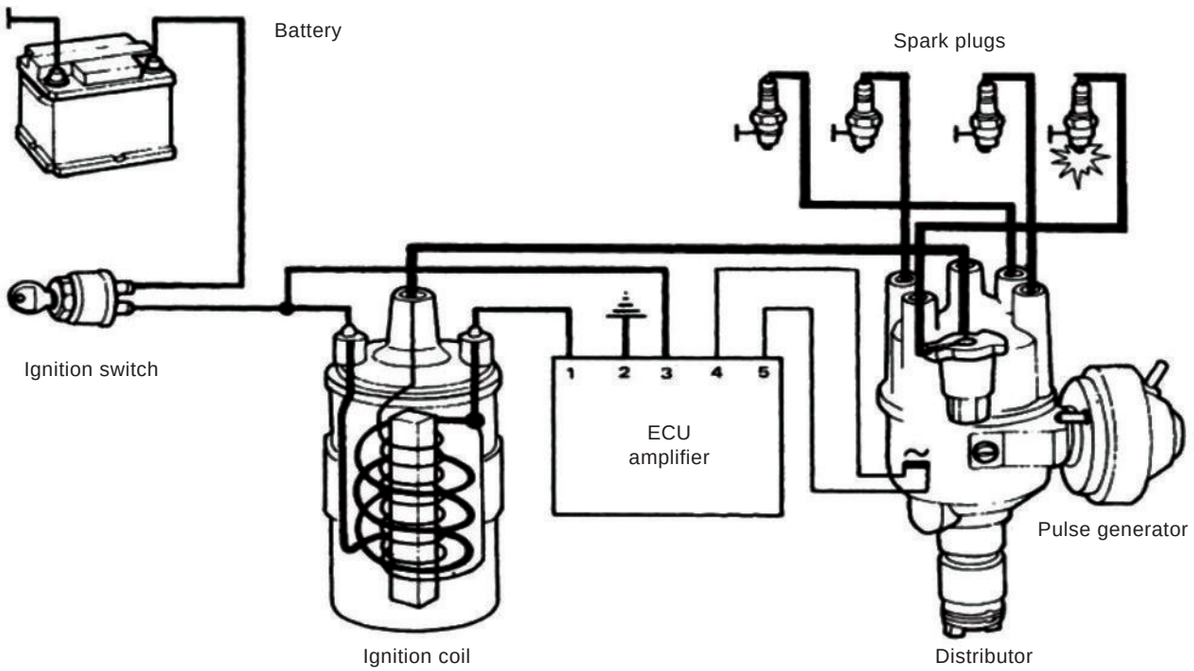


Figure 10.2.1.3 (b) Electronic ignition system

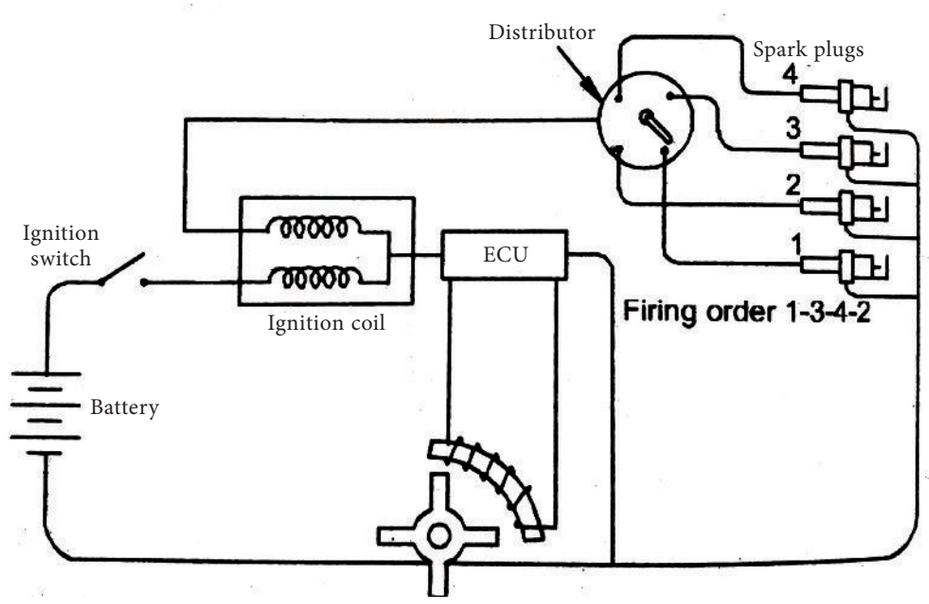


Figure 10.2.1.3 (c) Electronic ignition system

Working

Permanent magnet and pick up coil are placed in the distributor. The magnetic flux from the magnet will pass through the reluctor. Hence, electricity is generated. The current will flow through the electronic control unit. ECU has the diode and the transistor and it controls the flow of current to the primary circuit. When ECU closes the primary circuit, the primary winding charges. When ECU opens the primary circuit, the charge in the primary winding collapses and by mutual induction, high tension current

is induced in the secondary winding. This high tension current will reach the respective spark plug as per the firing order through a distributor. Thus, the spark is produced and the air-fuel ,mixture is ignited.

Advantages

1. No moving parts
2. Ignition timing is controlled by ECU, hence no need for an advance mechanism
3. Long life for spark plug
4. Spark intensity is higher
5. Contact breaker points, condenser are eliminated

10.3 Ignition coil

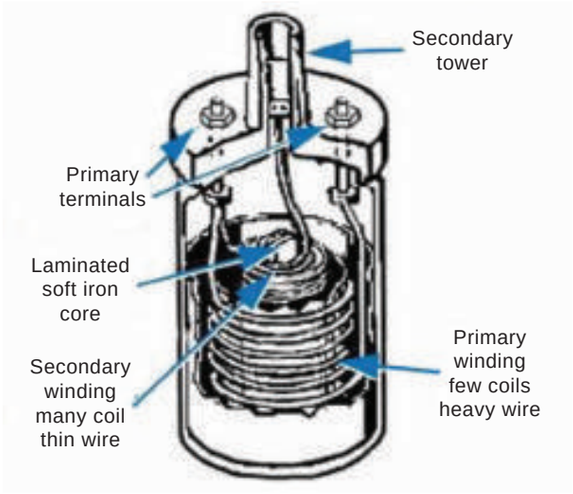


Figure 10.3 (a) Ignition coil

The ignition coil is used to convert 12 V D.C. from the battery to 20,000V to 30,000V A.C. It works on the principle of Faraday's law of electromagnetic induction. It is also called as Step up transformer. The primary coil is made up of thick wires with 150 to 300 turns. The secondary coil is made up of thin wires with 20000 to 25000 turns.

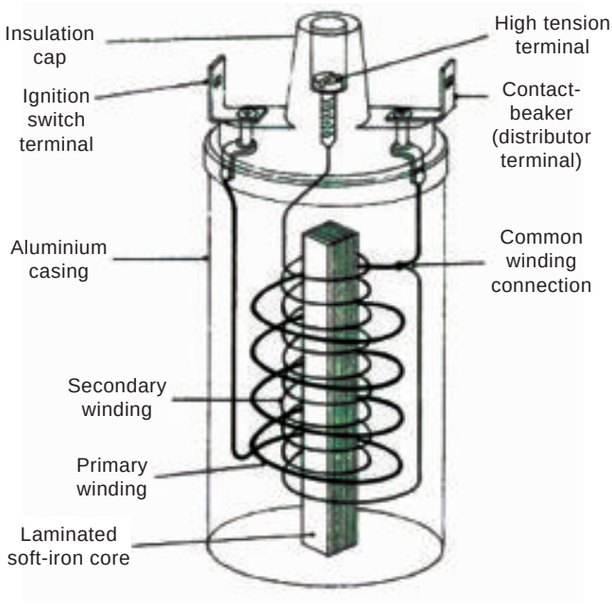


Figure 10.3 (b) Ignition coil

Types of Ignition coil

1. Can type (or) Metal glad type
2. Core type

10.4 Spark plug

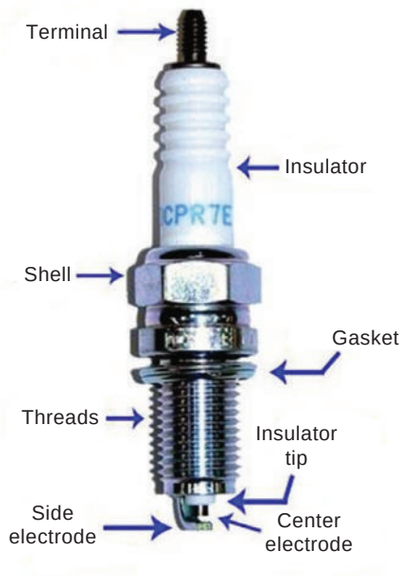


Figure 10.4 (a) Spark plug

In petrol engines, at the end of compression stroke, the spark plug is used to

introduce spark to ignite the air-fuel mixture. Spark plug consists of a central electrode, a ground electrode, an insulator. There is a small gap (0.5mm to 0.7mm) is available between the central electrode and ground electrode. When the high tension current from the ignition coil through a distributor is applied between these electrodes, spark is produced. This spark will ignite the air fuel mixture.

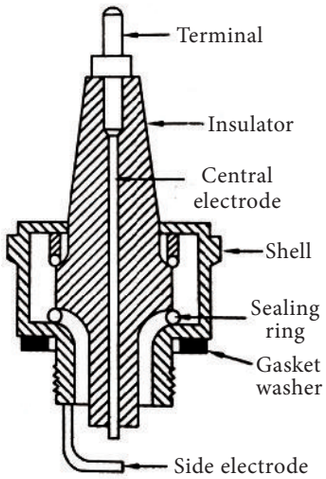


Figure 10.4 (b) Spark plug

10.4.1 Types of spark plug

1. Hot spark plug
2. Cold spark plug

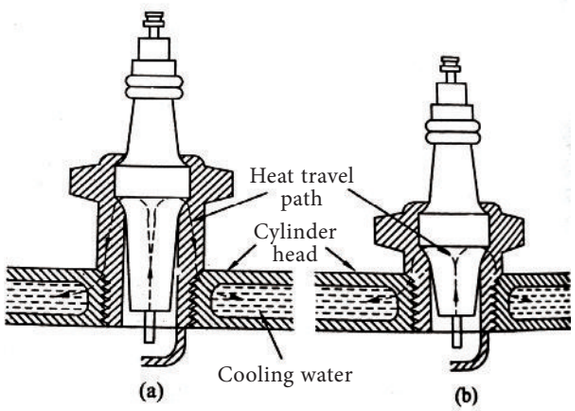


Figure 10.4.1 (a) Types of spark plug

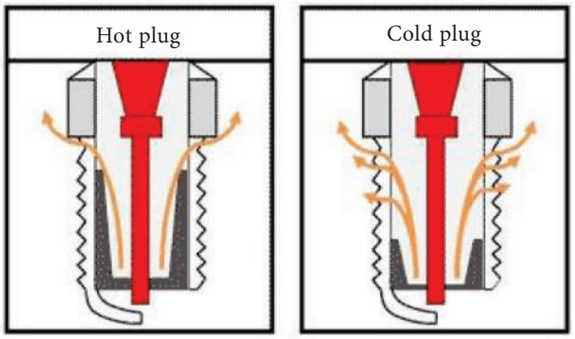


Figure 10.4.1 (b) Types of spark plug

Hot spark plug

In this type of spark plug, the length of the insulator is long and heat travel path is long. This spark plug is widely used in low-speed engine and engine operating in the cold climatic area.

Cold spark plug

In this, the length of the insulator is short and heat travel part is short. These spark plugs are widely used in high-speed engines and heavy loaded engines.

10.4.2 Ignition switch and key

The Ignition switch is used to connect the battery to the required circuits via a key. It will have three terminal viz., The battery (B), Ignition (Ig) and Starter (St). The terminal B is always connected to the battery. Ignition system, fuel system, lighting and other electrical accessories are connected in the Ignition terminal via a fuse. The solenoid switch of the starter motor is connected in Starter (St) terminal.

When the ignition switch is positioned in Ignition (Ig), then the electricity from the

battery will flow to all the electrical system (except starting system) of the vehicle. When the ignition switch is positioned in Starter (St), then the current will flow to the starter motor through the solenoid and thus the engine is started.

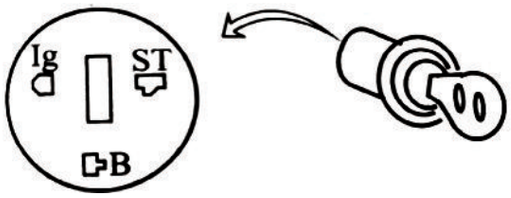


Figure 10.4.2 Ignition Switch

10.5 Difference between battery coil ignition system and magneto ignition system

	Battery coil ignition system	Magneto ignition system
1.	Electrical energy is supplied by the battery	Electrical energy is generated by the Magento
2.	Easy to start the engine	Little difficult to start the engine
3.	Difficult to start the engine, when the battery is low	The battery is not required; hence this problem will not arise
4.	Wiring circuit is complex	Wiring circuit is simple
5.	Spark intensity is good even at low engine speed.	Spark intensity is poor during low engine speed.
6.	More space is required	Less space is required
7.	Difficult in maintenance	Easy maintenance
8.	Does not work, if the battery fails	No need for battery
9.	Used in Cars, buses and trucks	Used in Moped, Scooter, Motor bikes.

10.6 Distributor

The Distributor does two functions. First, it has a set of contact breaker points, that works as a switch. When the CB points close, current flows through the coil. When the CB point open, current flow stops and coil produces a high tension current. A condenser is connected in parallel to the CB points. The condenser aids in the collapse of the magnetic field and help to reduce arching occurs between the CB points.

Second, the distributor is used to distribute the high tension current from the ignition coil to the spark plugs in the correct firing order. A coil wire delivers the high tension from the coil to the centre terminal of the distributor cap. Inside the cap, a rotor is on top of the distributor shaft. The distributor shaft is driven from the engine camshaft by a pair of spiral gears. When the rotor turns, the centre terminal of the distributor cap is connected by spark plug wires to the spark plugs. The spark plug wires carry the high tension current to the spark plug in the cylinder that is ready to fire.

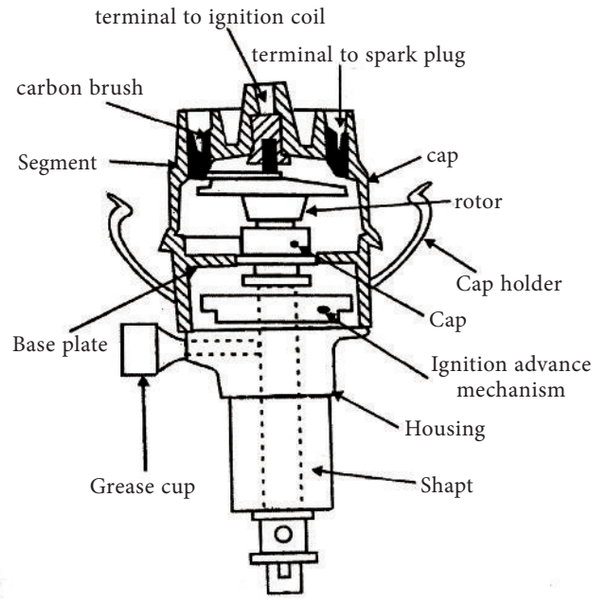


Figure 10.6 (a) Distributor

Figure 10.6 (b) Distributor

10.7 Ignition advance Mechanism

In an engine, the spark is timed just before the piston reaches TDC on the compression stroke. This will ensure the peak combustion pressure is obtained just after the TDC. If the pressure rise is before the TDC, then it will result in a weak power stroke. If the pressure rise is after the TDC, then the piston is moving down on the power stroke before combustion pressure reaches its maximum. When there is a change in the load and speed of the engine, then the ignition timing has to be adjusted accordingly to ensure maximum pressure just as the piston moves through the TDC and this is called as ignition advance.

10.7.1 Types of ignition advance

1. Vacuum advance mechanism
2. Manual method
3. Centrifugal advance mechanism
4. Combined centrifugal and vacuum advance

10.7.1.1 Vacuum advance mechanism

When the throttle valve is partly open, a partial vacuum develops in the intake manifold. The less air-fuel mixture gets inside the engine cylinder and hence fuel burns slower. The spark must be advanced at part throttle to give the mixture more time to burn.

The vacuum advance mechanism advances spark timing by shifting the position of the base plate. The vacuum advance unit has a diaphragm linked to the base plate. A vacuum passage connects the diaphragm to a port just above the closed throttle valve. When the throttle valve moves past the vacuum port, the intake manifold vacuum pulls on the diaphragm. This rotates the base plate so that the contact points open and close earlier.

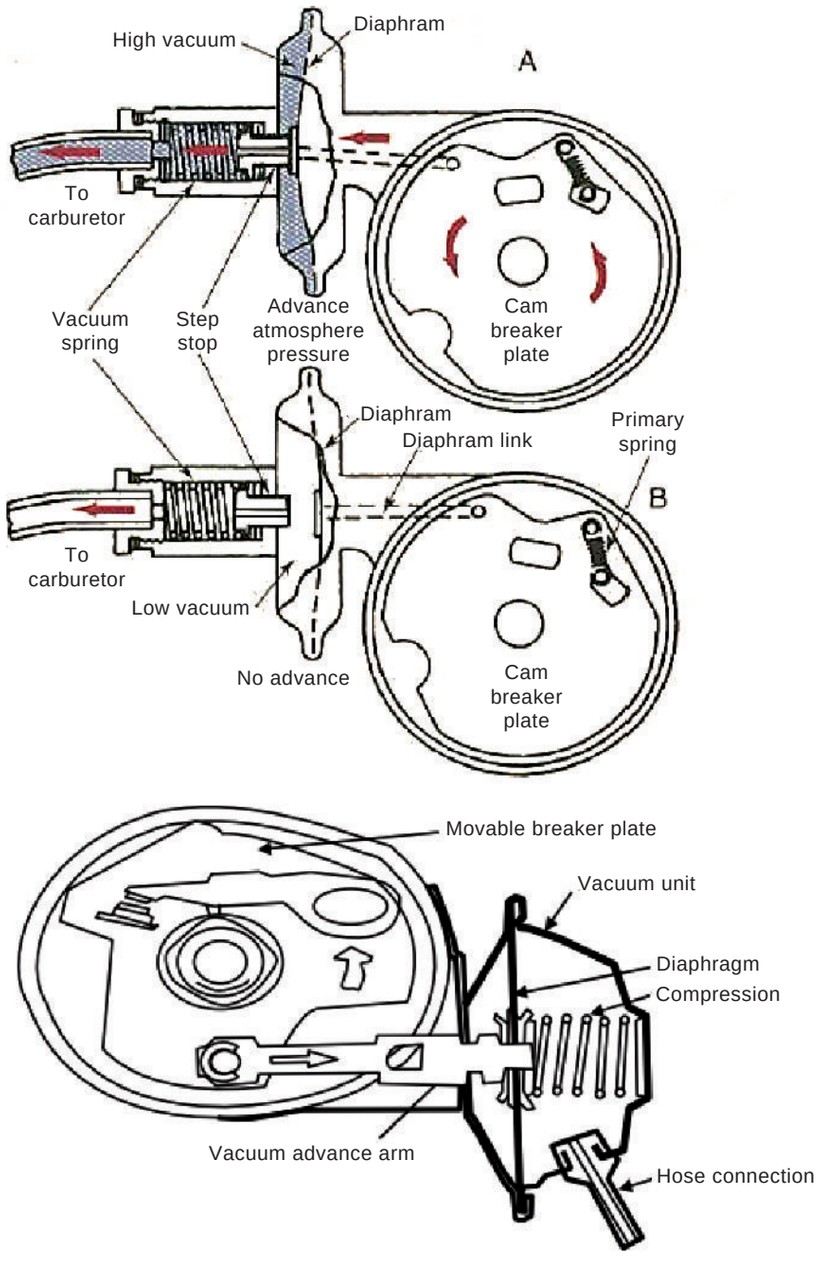


Figure 10.7 (a) Vacuum advance system

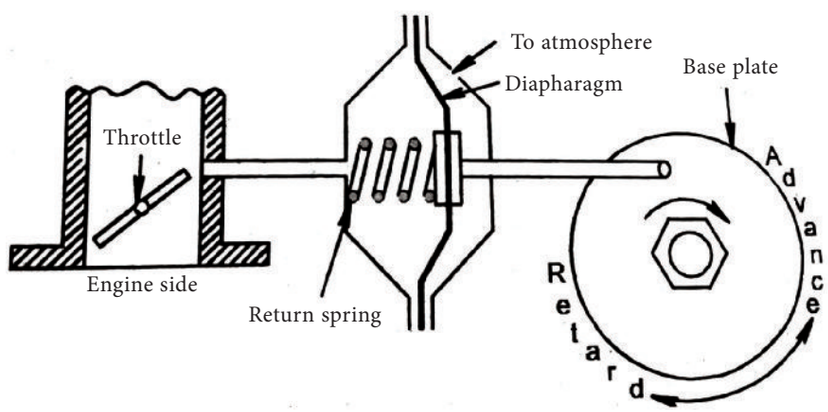
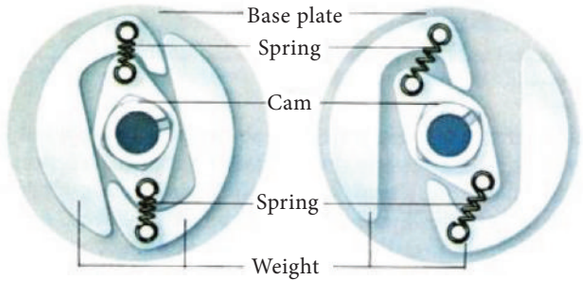


Figure 10.7 (b) Vacuum advance system



In 2017, Rolls-Royce unveiled a one-off custom build called the Sweptail. At a reported price of nearly $13 million, it is believed to be the most expensive new car ever.

10.8 Engine starting system

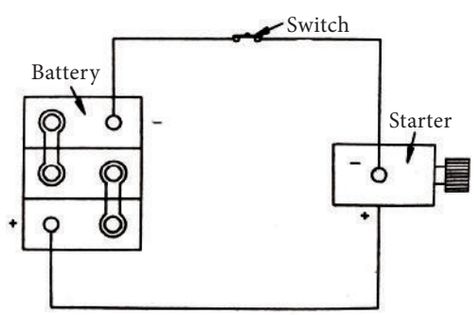


Figure 10.8 Engine starting circuit

The system which is used to start the engine is called as Starting system. In olden days, a handle is inserted and rotated in the crankshaft and thus the engine was started. Now, to crank the engine D.C. motors are used. The electrical energy from the battery is converted into mechanical energy by the D.C. Motor. The D.C. motor pinion is coupled with the ring gear in the flywheel and thus the engine is started.

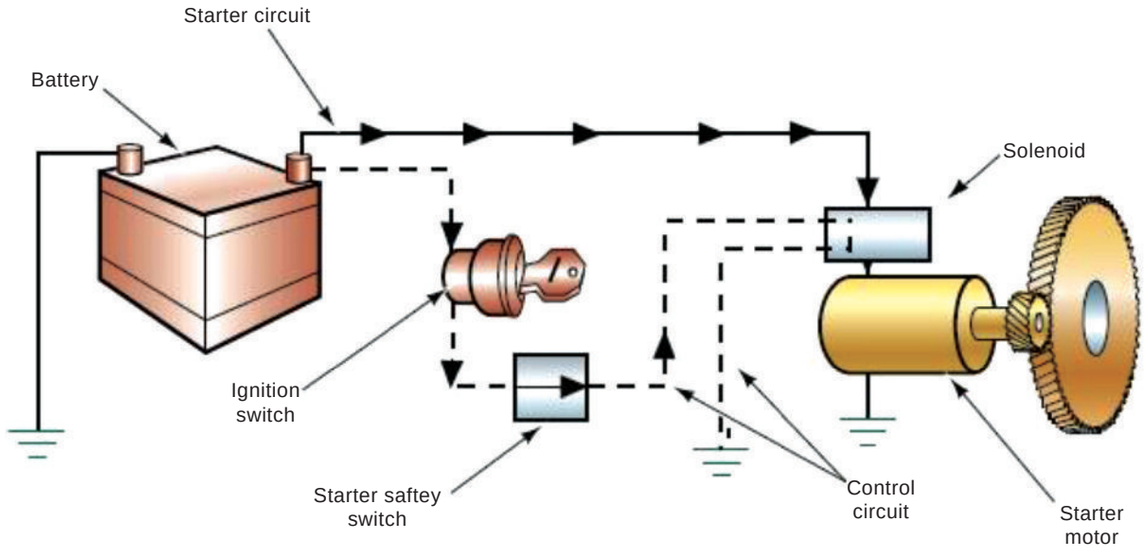


Figure 10.8 Engine starting system

10.8.1 Starter motor drive mechanism

The ratio between the starting motor pinion gear and the ring gear in engine flywheel is varied from 1:10 to 1:15. For example, if the ratio 1:15 means, the flywheel will rotate 1 revolution when the motor pinion rotates 15 revolutions. Once, the engine is cranked, then the speed of the engine will increase. If the starter motor is continuously engaged, then the engine will drive the motor and the speed of the motor will be 15 times higher than the engine speed. This will lead to failure of the starting motor. To prevent this, pinion gear should be disengaged from the flywheel ring gear once the engine is started and the mechanism used for disengagement is called as starter motor drive mechanism.

Types of starter motor drive mechanism

1. Bendix drive
2. Over running clutch type
3. Folo – thru system
4. Rubber compression system
5. Sliding armature system
6. Parallel type system
7. Friction clutch system

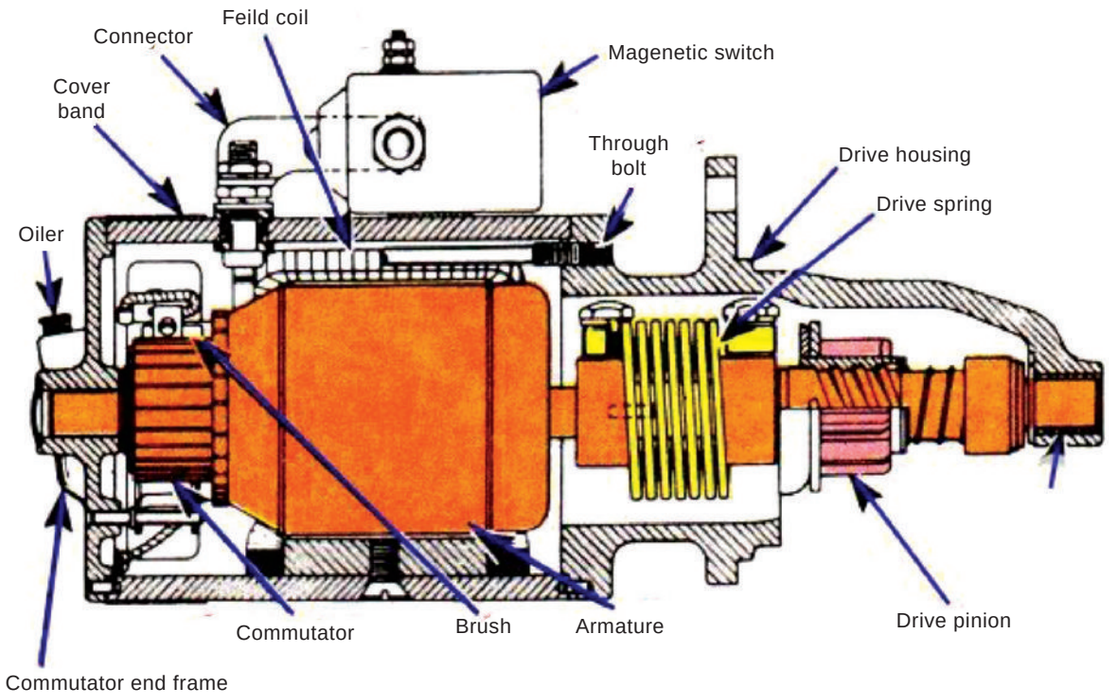
10.8.1.1 Bendix drive starting system

Construction

There is a threaded sleeve in an armature shaft. The sleeve will move on the shaft back and forth. Armature shaft is directly connected to the drivehead. Coil spring is mounted over the sleeve. Pinion will be over the sleeve. There is an unbalanced weight on the pinion.

Working

When the starter switch is “ON”, armature and sleeve assembly rotate. While rotating, the pinion moves over the sleeve due to inertia as pinion is loosely mounted over the sleeve. The pinion is engaged with the flywheel ring gear and start the engine. As the engine speed increases, the pinion retracts and go away from the engine flywheel.



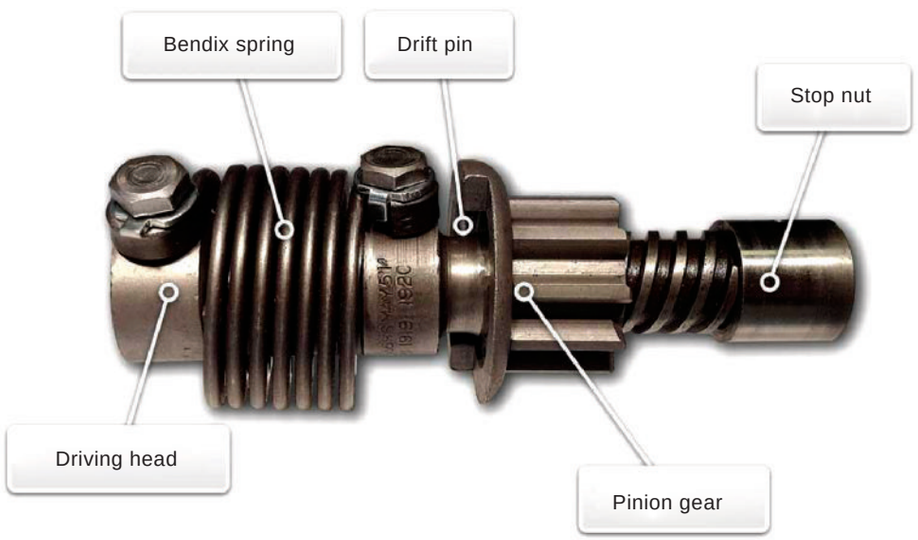
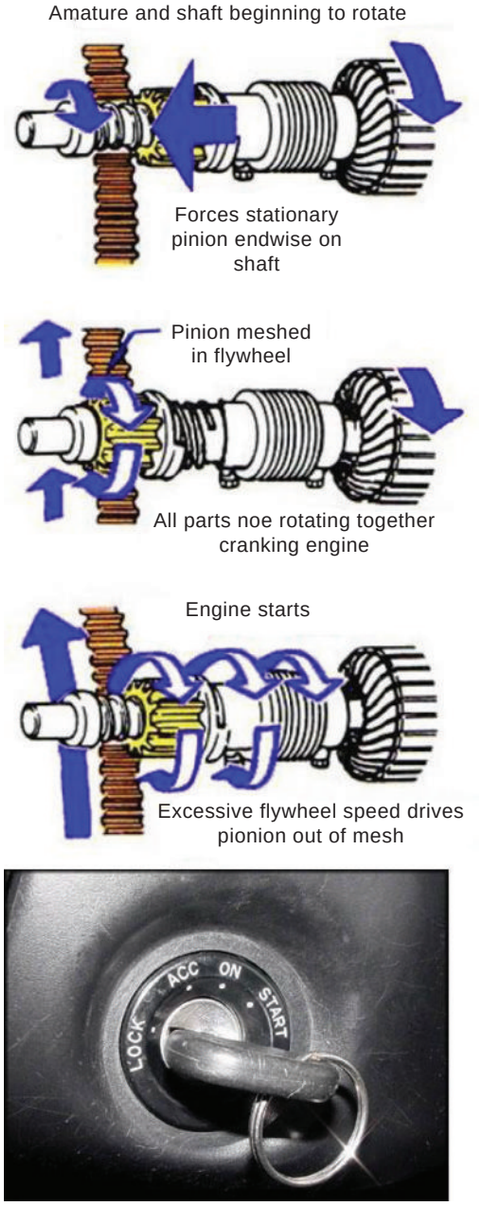


Figure 10.8.1.1 (a) Bendix drive starting system

10.8.2 Starting switch

The switch is a device which is used to open and close the electric circuit. A starting switch is used between the starter motor and the battery. In this, plunger, contact disc, pull-in – windings, terminals and connection wires are there. When the switch is on, the current passes from the battery to the pull-in – windings and it get magnetised. It pulls the contact disc and closes the circuit between the battery and the starter motor. When the switch is off, the pull-in – windings get demagnetise and the spring makes the circuit open between the battery and the starter motor. It is also called as 'Solenoid Switch'.



10.8.3 Maintenance of starter motor

1. Starting motor should not be operated continuously for more than 30 seconds.
2. Once the engine is turned on, the startingswitch should be released.
3. Periodic greasing should be made.
4. Ensure the proper tightness of cable
5. Replace the faulty bearing immediately
6. Don't crank the engine frequently, if the engine fails to start

10.9 Charging system

The mechanical energy of the engine is converted into electrical energy by means of a Generator. This electrical energy is stored in the battery. The generator is driven by the engine crankshaft. To control the current flow, regulators are used. An ammeter is used to measure the current. The generator is also called a dynamo.

10.9.1 Construction and working of generator (or) Dynamo

Based on the Faraday's laws of electromagnetic induction, the device

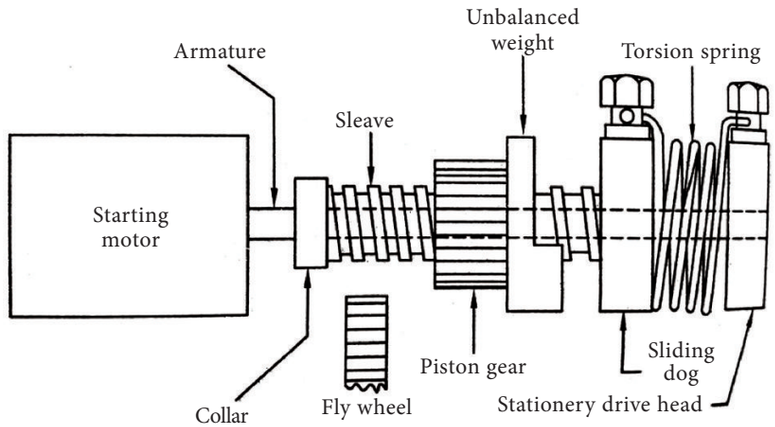
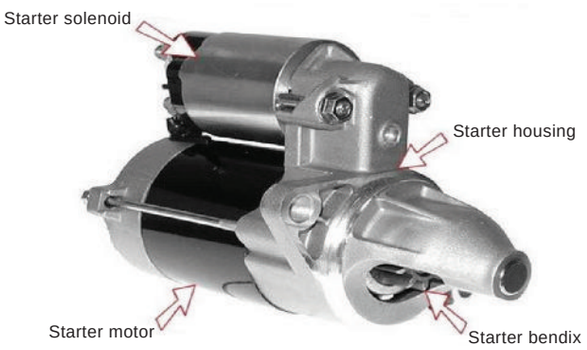


Figure 10.8.1.1 (b) Bendix drive starting system



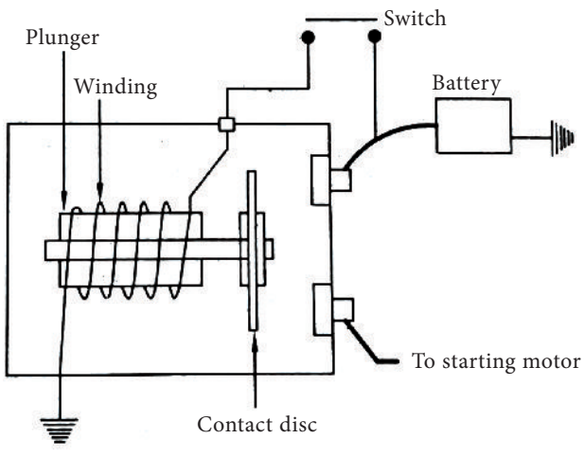


Figure 10.8.2 Starting Switch

which is used to convert mechanical energy from engine in to electrical energy is called as Generator (or) Dynamo.

Important parts

1. Frame
2. Armature
3. Commutator

Z1GSM

DO YOU KNOW?

- Most car companies themselves are named after their founders like Ford, Rolls-Royce, Austin, Ferrari, Lamborghini, Porsche, Renault, Citroen, Honda, Toyota (Toyoda), DeLorean etc.

- Car Radios Were Once Considered Dangerous.
- The first car radio was invented by Paul Gavin in 1929. It could be installed in most cars, and cost just over $100. In 1930, laws to ban the use of car radios while driving were proposed in Massachusetts and St. Louis because many feared them to be a dangerous distraction to drivers.

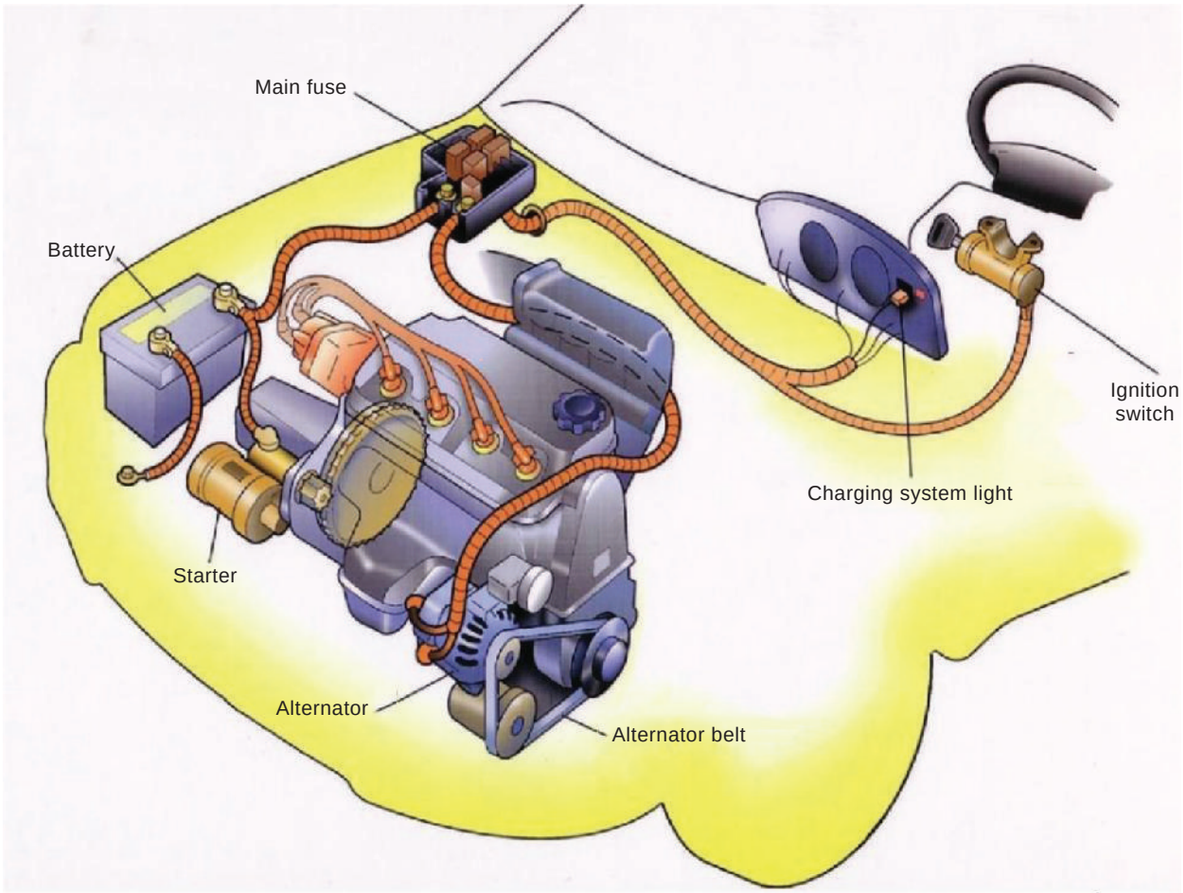


Figure 10.9 (a) Charging system

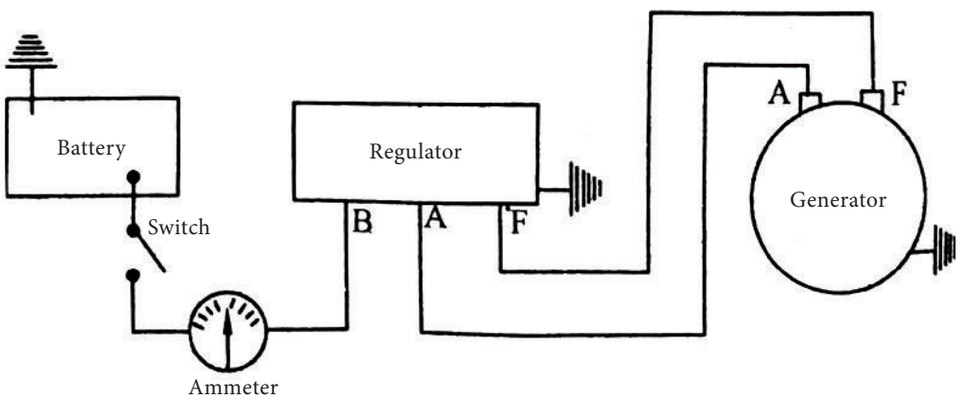


Figure 10.9 (b) Charging system

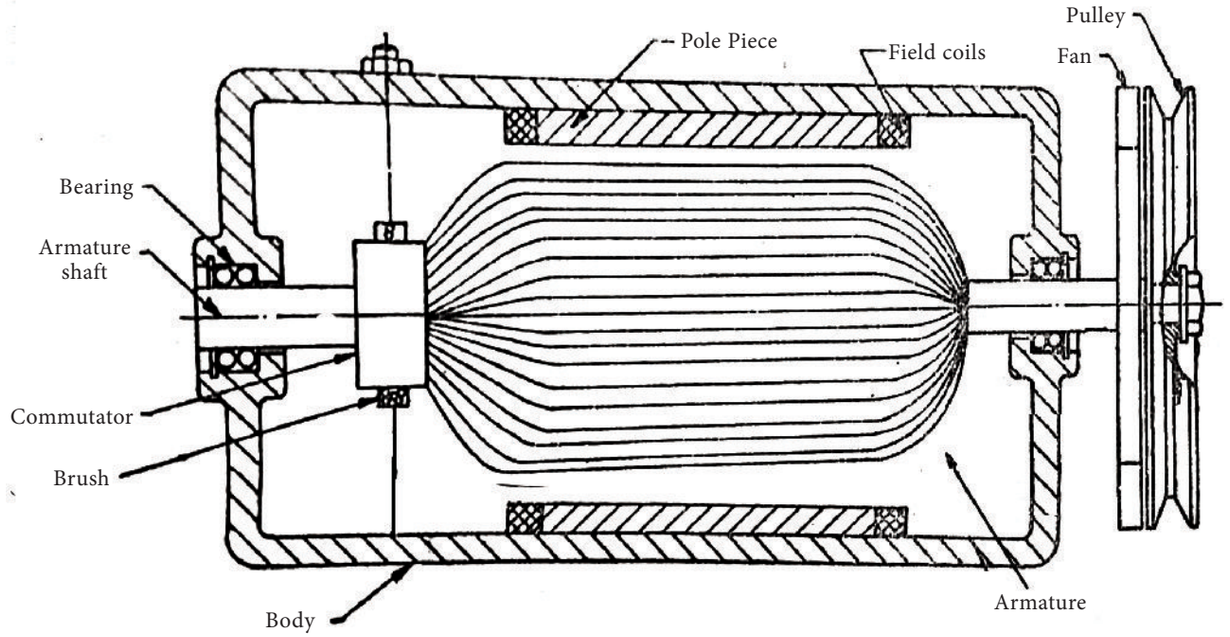


Figure 10.9.1 Dynamo (or) D.C. Generator

4. Brush
5. Pole shoe
6. Field coil

The engine crankshaft pulley drives the dynamo through a V – belt drive at two to three times crankshaft speed. Field coils are placed on each pole and are connected in series. Field coils produce an electromagnetic field and the armature conductors are rotated into the field. The armature cuts the magnetic fields and an emf is generated in the armature conductors. The commutator is to collect the current generated in armature conductors and DC is sent out through the carbon brushes.

10.9.2 Cut out relay

When the generator is operating, the cutout relay closes the circuit, permitting the battery to get charged. When the generator stops, it opens the circuit, thereby preventing the battery from discharging back through the generator.

It has two windings, namely shunt and series. It has an armature carrying the contact points. The armature is hinged and is kept away from the windings by a spring when the generator is not running.

Once the generator starts, a tension is imposed on two windings of the cutout relay. It produces the magnetic field which attracts the armature. As soon as the tension produced by the generator is of sufficient value to force the charge into the battery, the magnetism is strong enough to pull the armature down overcoming the spring tension. This makes the contact point closes and thereby completing the circuit between the generator and the battery. Thus, the battery gets charged.

When generator stops, the armature loses the magnetism and the spring tension on the armature pulls the contact point away, thereby opening the circuit between the battery and the generator.

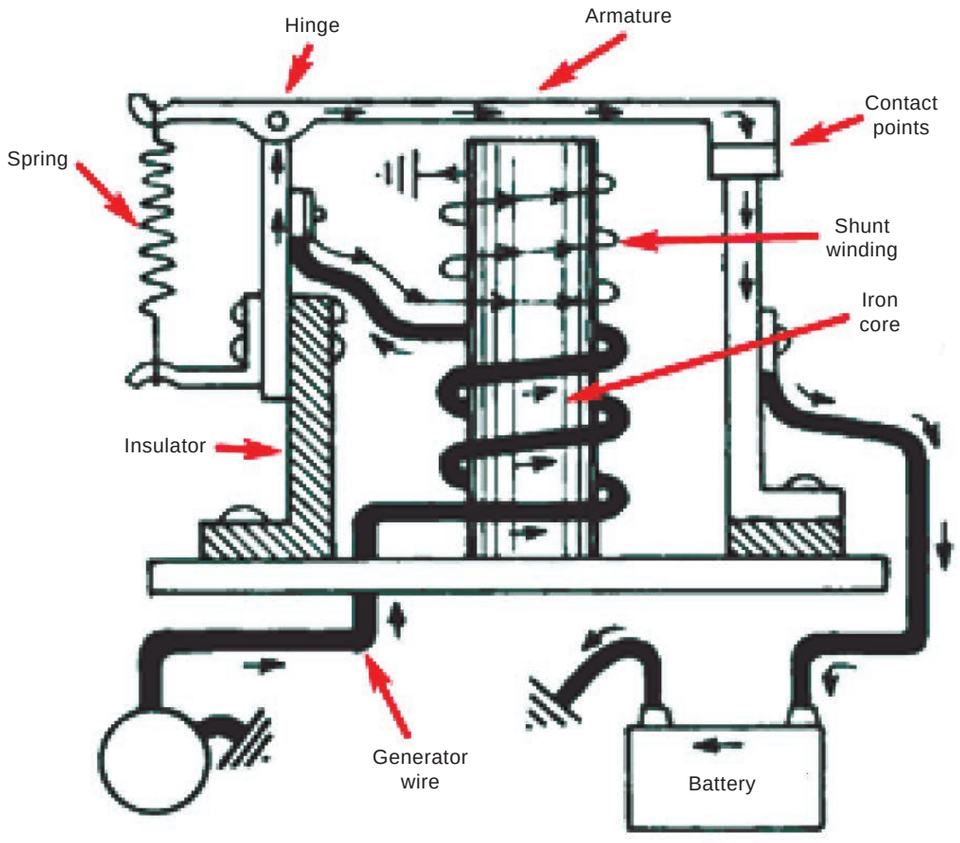


Figure 10.9.2 (a) Cut out relay

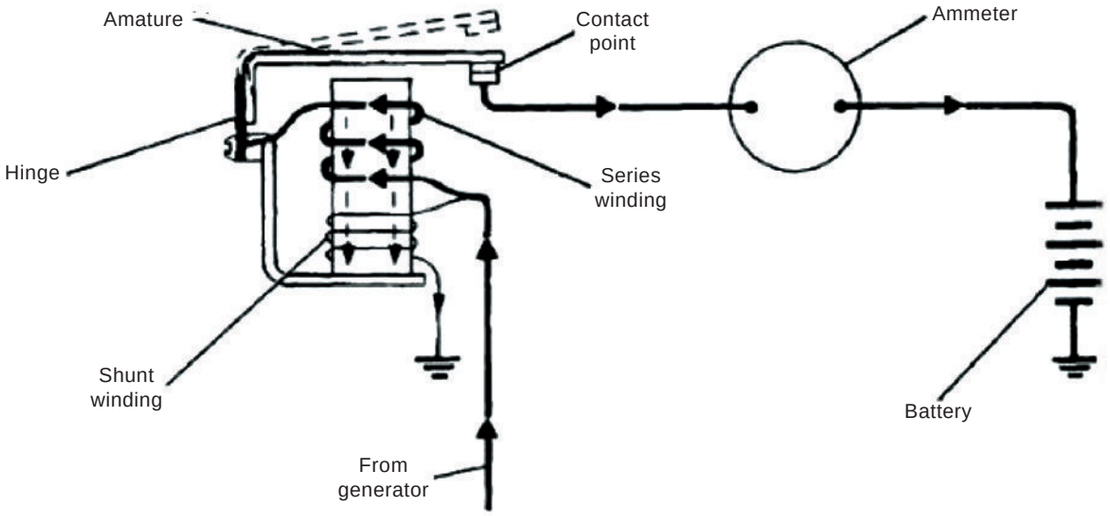
10.9.3 Alternator

The alternator converts mechanical energy from the engine into electrical energy. It is also called A.C. Generator. With the help of rectifiers formed by diodes, the Alternating Current (AC) is converted into Direct Current (DC) and stored in vehicle battery.

The rotor shaft usually consists of pole pieces with a field coil or winding between them. When the current flows through the winding, it becomes an electromagnet. Current flows in and out of the winding through two brushes riding on slip rings. Each slip rings connects to one end of the winding. The current produces a magnetic field which rotates as the rotor turned by engine crankshaft through a belt. The strength of the magnetic fields varies with the amount of the current flowing. The stationary loops or conductors are assembled into a laminated iron frame. The assembly is stator. As the rotating magnetic field cuts through the windings, an alternating current is induced in the stator. As the magnetic poles are changing for every half revolution, stator induces an alternating current for every revolution of the rotor.

Advantages

- Light in weight
- A high output is obtained even at low engine speed.
- The cutout relay is not needed.
- Long life.
- Highly reliable.



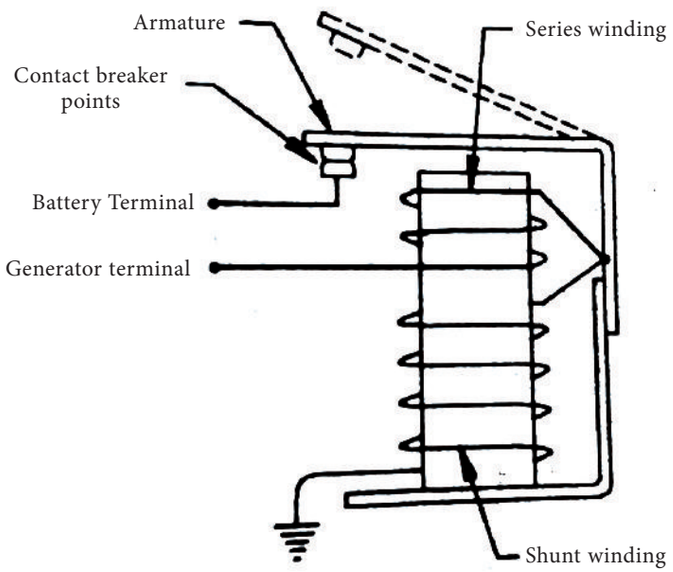


Figure 10.9.2 (b) Cut out Relay

Figure 10.9.3 Alternator

10.10 Lighting system

The automobile uses lighting system to provide illumination especially during night or light needed to safely operate the vehicle. The various lights provide vision and information to the driver, convenience for passengers, signals and warnings to other driver and pedestrians. Light means illumination.

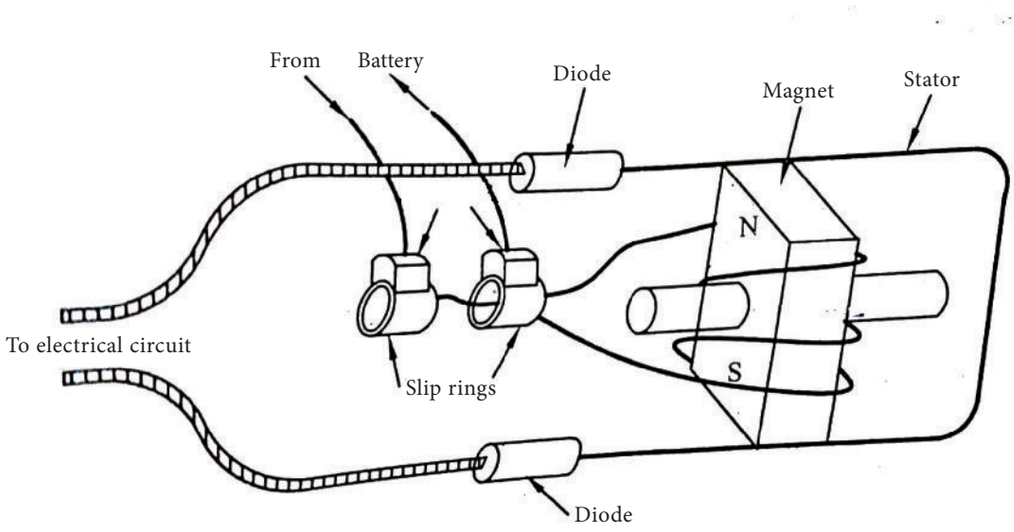
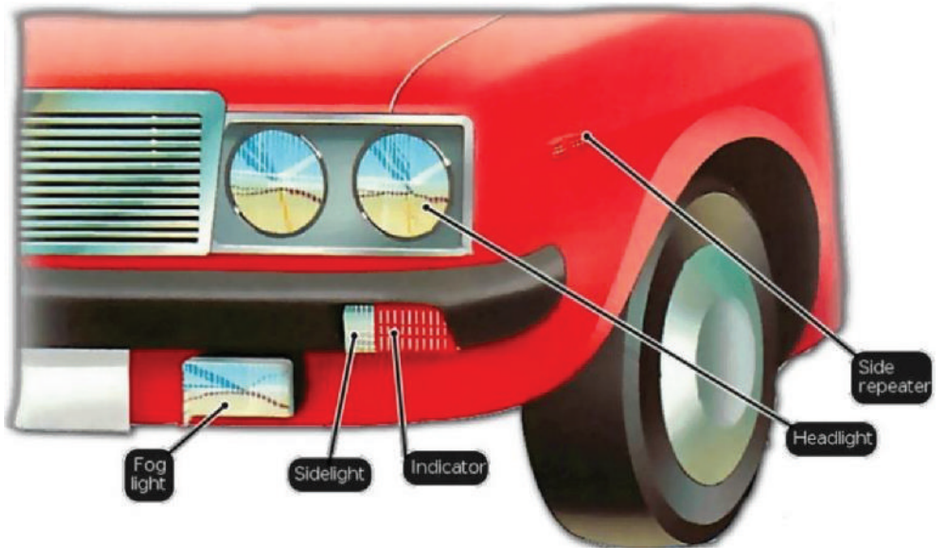


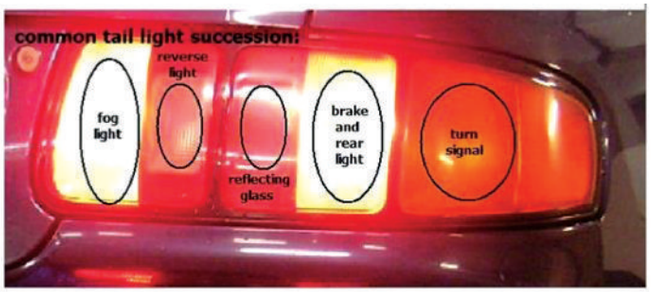
Figure10.9.3 Alternator

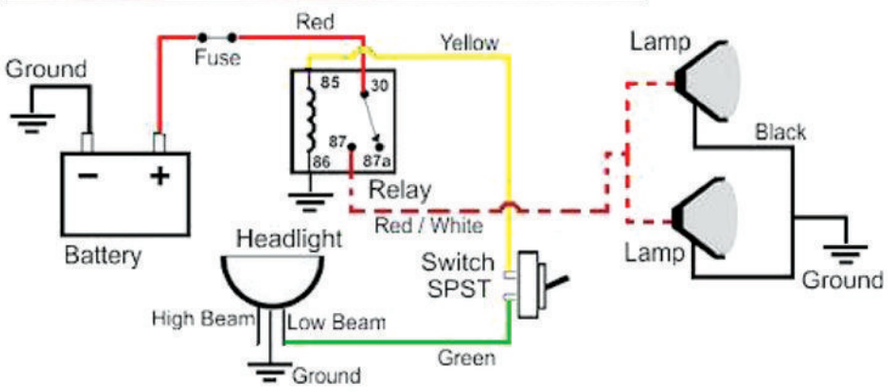
10.10.1 Important lights in a lighting system and its purpose

Sl. No.	Lights	Purpose
1	Head Lamps	To illuminate the road ahead at a reasonable distance with sufficient intensity during the night.
2	Tail Lamps	To show red at the rear of the vehicle. This gives an indication to the driver of the following vehicle.
3	Parking Lamps	To mark the front of a parked vehicle at night.
4	Fog Lamps	To illuminate the road ahead using yellow light during mist, winter season, hill station etc
5	Stop Lamps (or) Brake lamps	To indicate the application of brake to the following vehicle driver in order to slow down or stop the vehicle.
6	Direction indicating lamps	To indicate an intended change in direction by flashing light on the side towards which the turn will be made. The lamps are available in front and rear of the vehicle.
7	Panel Lamps	To illuminate the dashboard in order to see the readings indicating in various meters.
8	Interior Lamps	To illuminate the interior part/passenger compartment of the vehicle.
9	Reverse lamps	To illuminate the back of the vehicle and to indicate the reversing of the vehicle
10	Number Plate Lamps	To illuminate the number plate of the vehicle

10.10.2 Vehicle lighting circuit







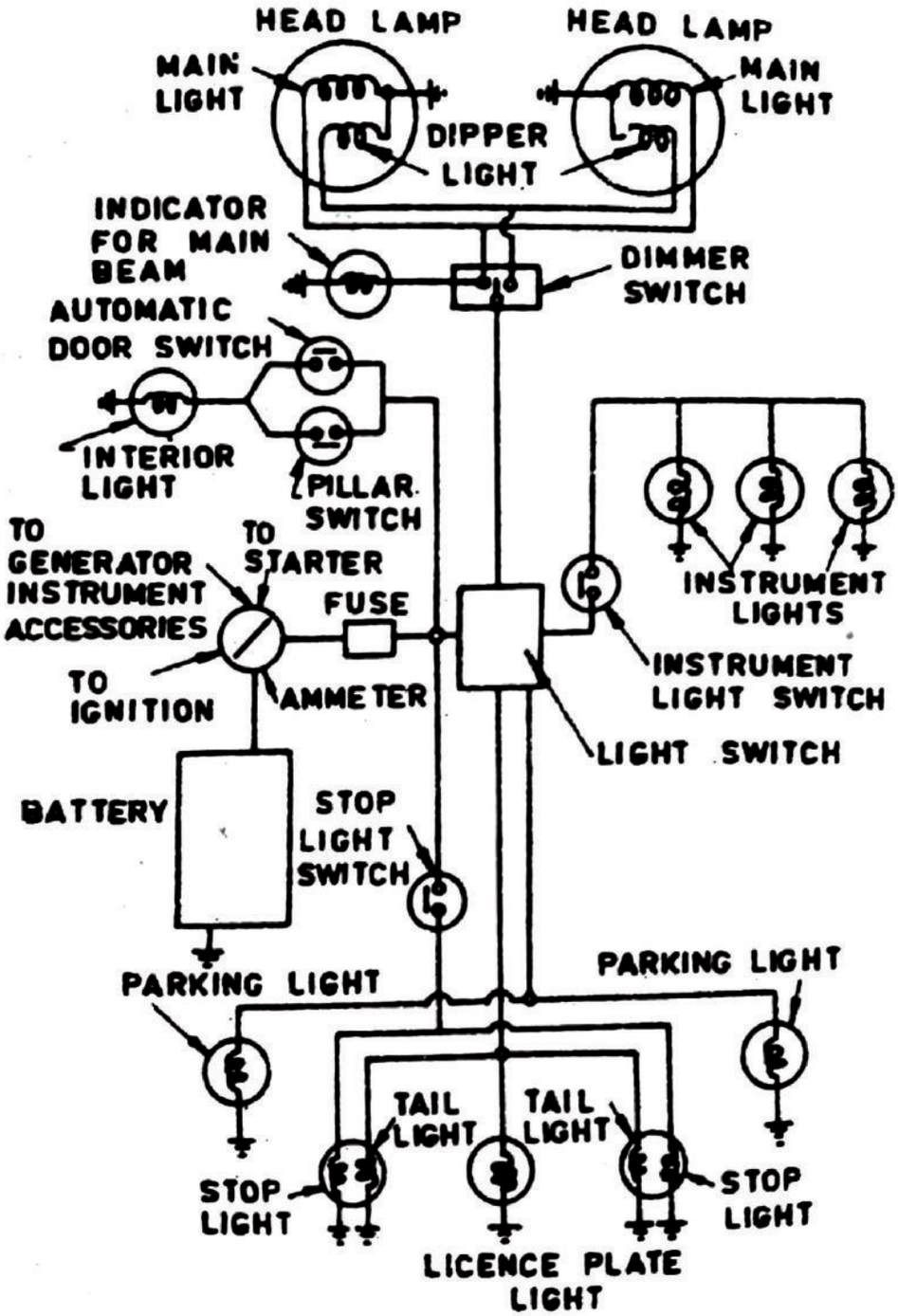


Figure 10.10.2 Lighting system

10.10.3 Direction indicating lamps

Lamps are provided at each front and rear corner of a vehicle. This allows the driver to signal an intention to turn left or right to the opposing vehicle as well as following vehicle. A lever operated turn switch is mounted in the steering column. The turn signal lever is moved up for a right turn and down for a left turn. A flasher unit is used to open and close the lighting circuit about 70 – 80

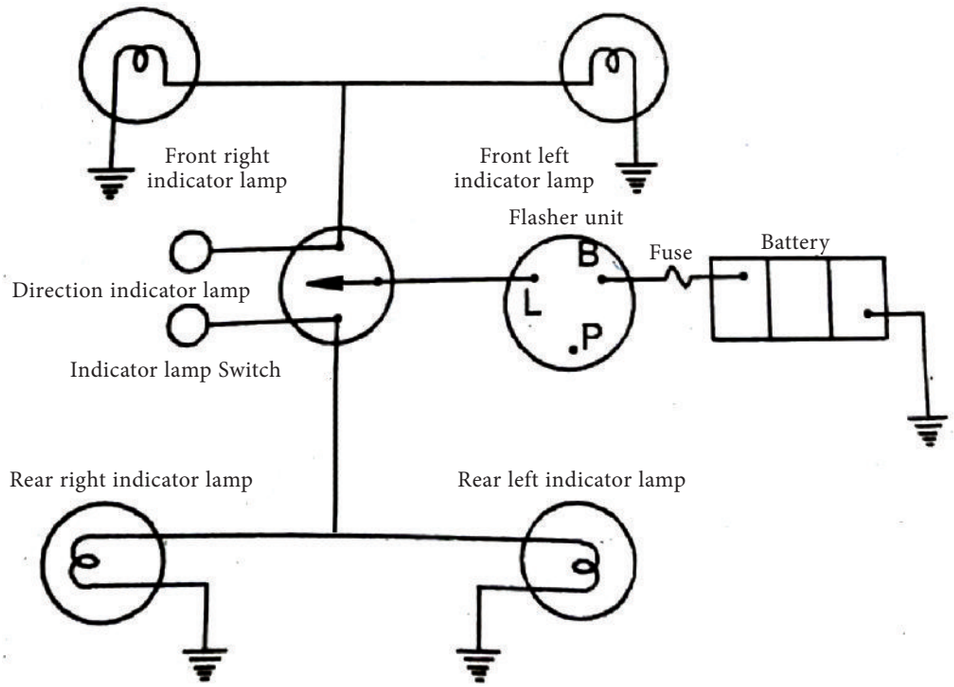


Figure 10.10.3 Directional signal circuit

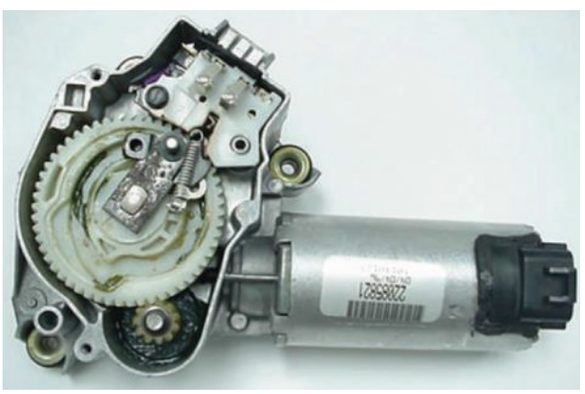
times per minute to make more able to the other driver. After completing the turn, the return movement of the steering wheel automatically cancels the turn signal and the lever moves back to its neutral position, opening the circuit.

10.11 Wind Screen Wiper

Windshield wipers clean the windshield so that the driver can see clearly while driving on rain or snow or dirt on the windshield. The wipers are operated by an electric motor.

The electric motor drives the worm. Worm drive the worm wheel. The drive to the blades is transmitted via a shaft and rotary link assembly. It is incorporated with a special limit switch to ensure consistent parking of the wiper arms and blades in the correct position. The windshield wiper switch has atleast two or three speeds. Many cars have intermittent windshield wipers. These include an adjustable time delay between blade movements. The wiper blades will move across and back, pause and then repeat the action.

A windshield washer is part of the windshield wiper system. When the driver presses a button, liquid windshield washer fluid squirts on the windshield. This allows the blades to clean more effectively.



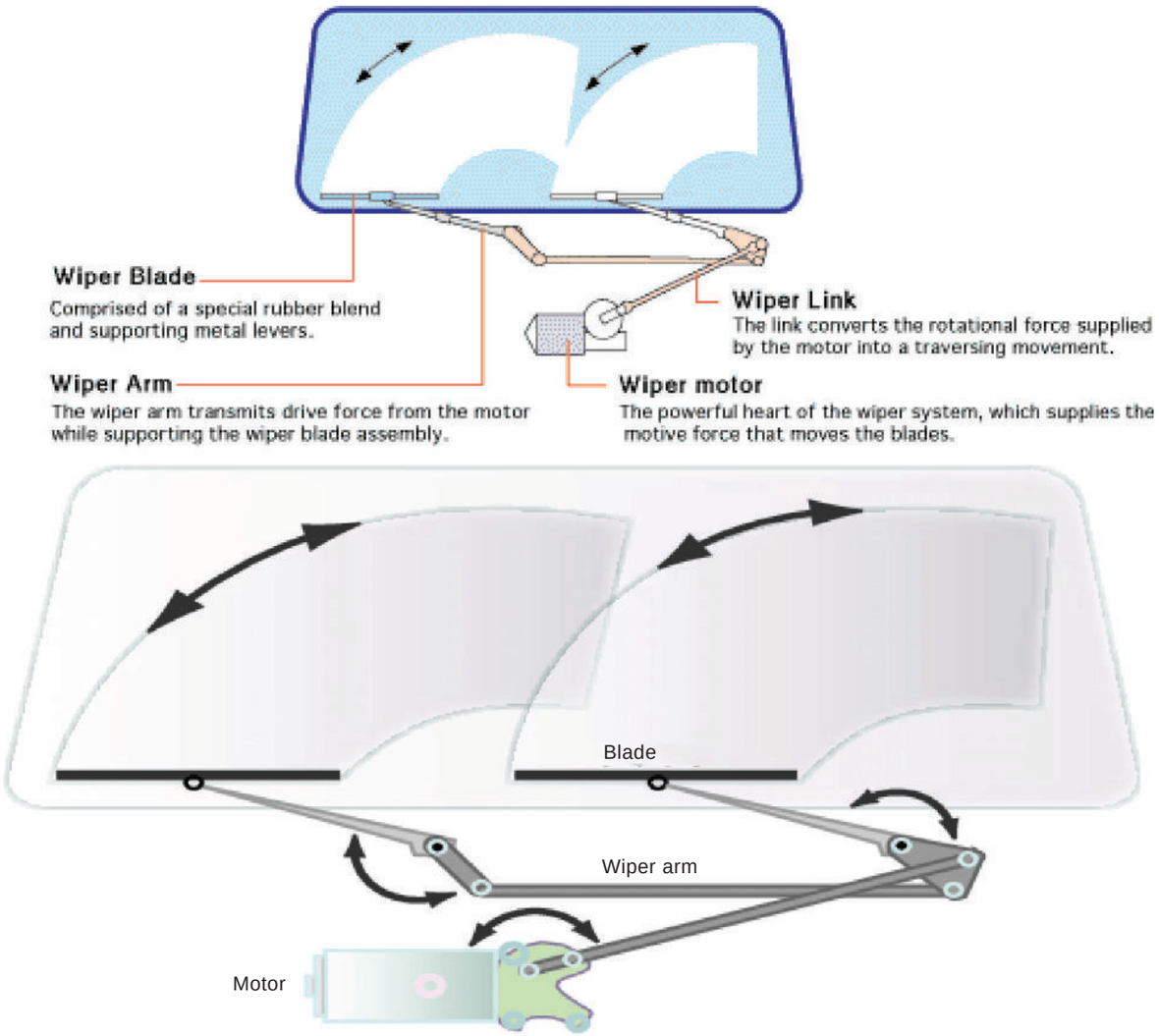
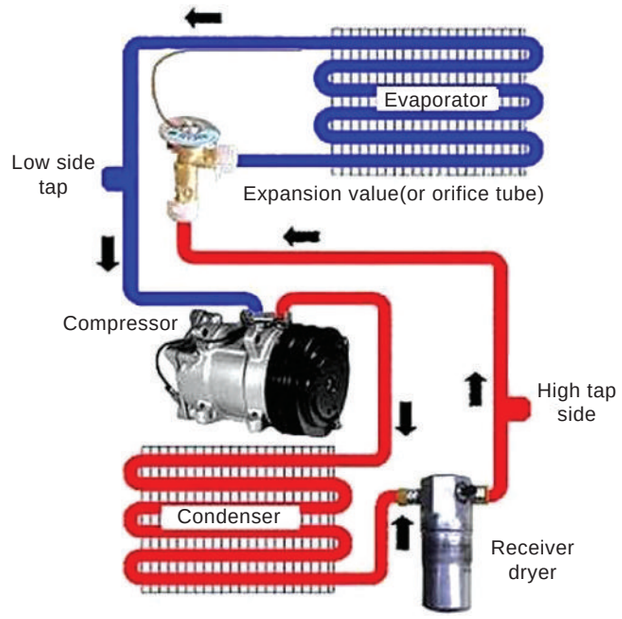


Figure 10.11 Wind screen wiper

10.12 Air conditioning system

The passenger is like to travel with comfort. During the winter season, passenger prefers mild heating and during the summer season, passenger prefers cooling. To achieve this, the system which is to provide both the conditions is called an airconditioning system.

10.12.1 Construction and working principle of vehicle air conditioning system



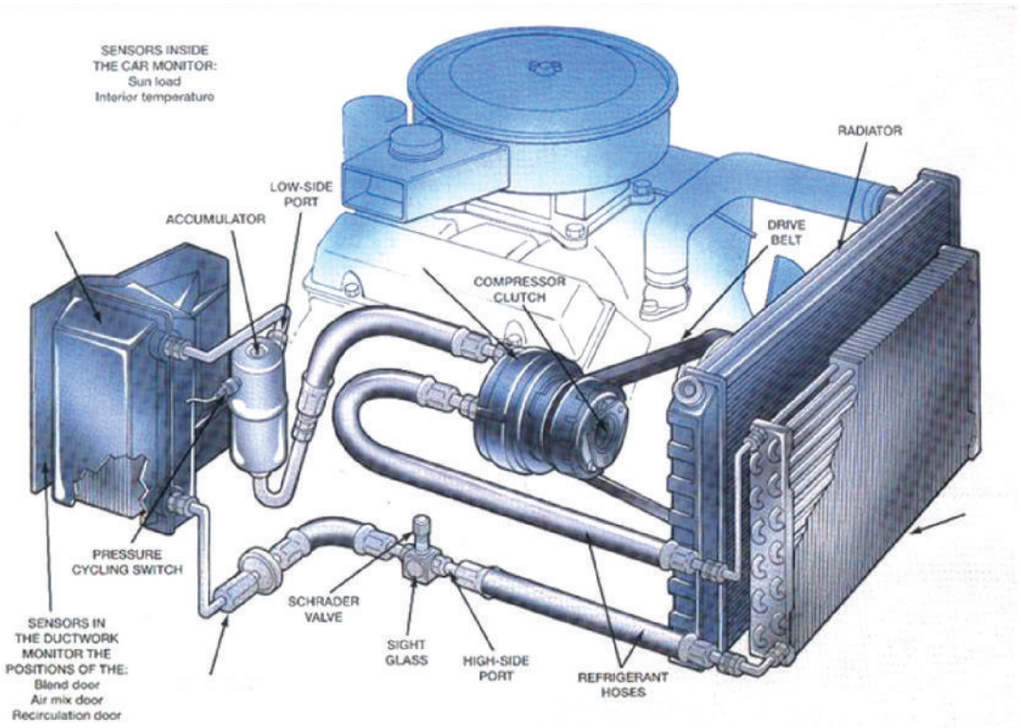


Figure 10.12.1 (a) Air conditioning System

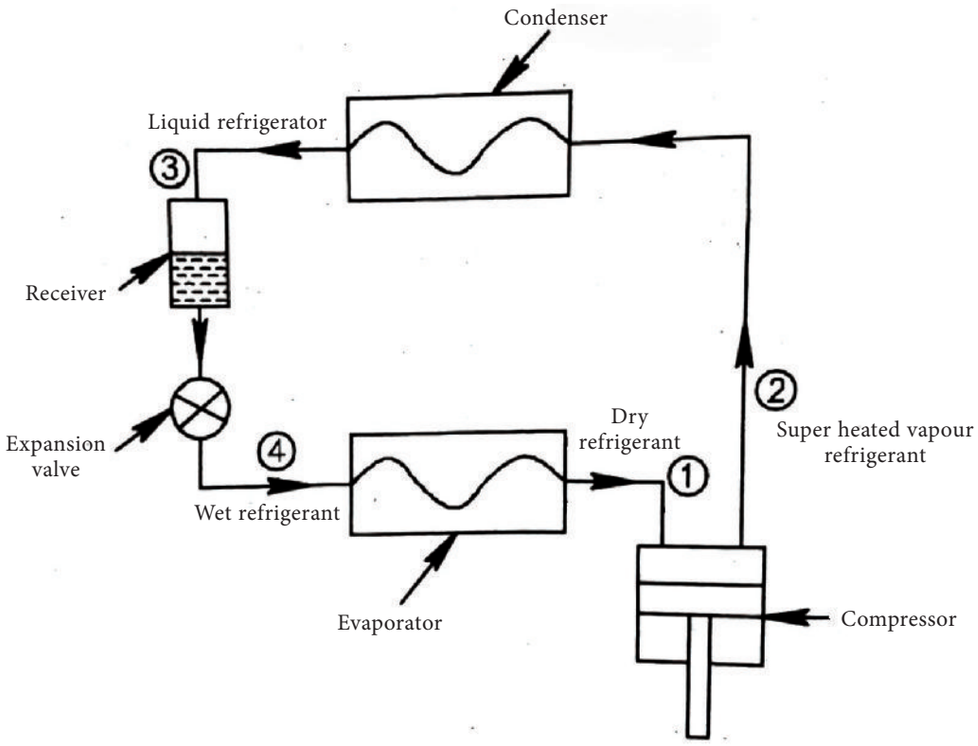


Figure 10.12.1 (b) Simple steam air conditioning system

Important parts of a vehicle airconditioning system

1. Compressor
2. Condenser
3. Receiver/driver
4. Thermostatic Expansion Valve
5. Evaporator
6. Refrigerant
7. Lines and Hoses

The compressor is driven by the engine by means of belt drive. The compressor receives the low pressure, low-temperature vapour refrigerant from the evaporator. This refrigerant is compressed to high pressure, high-temperature vapour refrigerant by the compressor. This refrigerant is sent into the condenser where it is condensed into liquid refrigerant by a constant temperature process.

This liquid refrigerant is expanded in the expansion valve where it is converted into the low-pressure low-temperature liquid refrigerant. This refrigerant is sent into the evaporator, where it receives the heat energy from the passenger compartment and converted into vapour refrigerant, there by cooling effect is obtained. This vapour refrigerant is again sent into the compressor and the cycle is continued. This airconditioning system controls the temperature, humidity, ventilation and dust level simultaneously.

10.13 Troubleshooting, causes and remedies in the ignition system

1. Engine Misfiring

Sl.No.	Cause	Remedy
1.	Spark plug faulty	Clean, regap or replace the spark plug
2.	Loose electrical wiring	Tighten, clean the wires
3.	Late ignition timing	Correct ignition timing
4.	Wear and tear of contact breaker point	Replace
5.	Faulty ignition coil	Replace

2. Engine does not start

Sl.No.	Cause	Remedy
1.	Cable lose, corroded, open terminal	Tight, repair as needed
2.	Defective ignition switch	Replace
3.	Faulty condenser	Rectify
4.	Defective contact breaker points	Rectify
5.	Low voltage in the battery	Charge the battery

10.14 Troubleshooting, causes and remedies in Starter Motor

1. Starter motor does not start

Sl.No.	Cause	Remedy
1.	Low voltage in the battery	Charge the battery
2.	Burned coil / winding	Replace
3.	Faulty starting switch	Rectify
4.	Faulty armature	Repair or replace
5.	Dust on sleeve or pinion	Clean the parts

Student Activity

1. Students are advised to submit a detailed report based on the visit to the nearest service station to study the service of various electrical components such as a battery, ignition coil, condenser, spark plug etc.
2. Students are asked to prepare and submit a detailed report with appropriate sketches on the starting system, charging system and lighting system based on the visit to the nearest service station.

Glossary

1.	Battery	–	மின்கலம்
2.	Primary Winding	–	பிரதம மின் சுற்று அல்லது முதல் நிலை மின் சுற்று
3.	Secondary Winding	–	துணை மின் சுற்று அல்லது இரண்டாம் நிலை மின் சுற்று
4.	Circuit	–	மின் சுற்று
5.	Electrolyte	–	மின்னாற் பகுபொருள்
6.	Electrical Energy	–	மின் ஆற்றல்
7.	Mechanical Energy	–	இயக்க ஆற்றல்
8.	Ignition or Induction Coil	–	தூண்டு சுருள்
9.	Magnetic Field	–	காந்த புலம்
10.	Condensor	–	மின் தேக்கி
11.	Distributor	–	பகிர்வி
12.	Spark Plug	–	மின் பொறிக்கட்டை
13.	Illumination	–	வெளிச்சம்
14.	Generator	–	மின்னாக்கி
15.	Contact Breaker Points	–	தடை செய்யும் முனைகள்

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Evaluation

KT4C5

PART - A

One mark questions

Choose the correct answer

1. _____ is called as the heart of an automotive electrical system.
   a. Battery
   b. Dynamo
   c. Spark plug
   d. Contact breaker points

2. A positive terminal and a negative terminal forms a _____
   a. Rotor
   b. Cell
   c. Battery
   d. Coil

3. The number of types of an ignition coil _____
   a. 2
   b. 3
   c. 4
   d. 5

4. The gap between the central electrode and ground electrode of a spark plug is
   a. 5 mm to 10 mm
   b. 10 mm to 20 mm
   c. 30mm to 50 mm
   d. 0.5mm to 0.7mm

5. In the starting system, the starter motor is engaged with flywheel through _____
   a. Valve
   b. Armature

c. Pinion
d. Coil

6. Which of the following is used to convert mechanical energy into electrical energy?
   a. Motor
   b. Generator
   c. Regulator
   d. Camshaft

7. The illumination is related to _____
   a. Light
   b. Sound
   c. Motion
   d. Temperature

8. The number of types of the ignition system is _____
   a. 2
   b. 3
   c. 4
   d. 5

9. The ratio of acid and water in an electrolyte solution is _____
   a. 1:3
   b. 3:1
   c. 4:1
   d. 1:4

10. The ignition coil is also called as _____
    a. Step up transformer
    b. Battery
    c. Spark plug
    d. Rotor

PART - B

Three marks questions

1. List out the various electrical system in an automobile?
2. State the use of condenser in an ignition system?
3. List out the advantages of an electronic ignition system.
4. Why spark plug is used?
5. List out the various types of starter motor drive mechanism.
6. What do you mean by ignition advance?
7. Write short notes on air conditioning?
8. Identify the reason for more noise in a generator?

PART - C

Five marks questions

1. Draw neatly and indicate the various parts of a battery.
2. State the difference between coil ignition system and Magento ignition system?

3. Highlight the maintenance requirements of a starter motor.
4. Draw the headlamp circuit used in an automobile and indicate the parts.
5. With the aid of a neat sketch, explain the construction of an ignition switch.
6. Draw the layout of a vehicle air conditioning system and indicate the parts.

PART - D

Ten marks question

1. Explain the construction and working principle of a battery coil ignition system with a neat sketch.
2. Describe the construction and working principle of an electronic ignition system with a neat sketch.
3. Illustrate the working principle of Bendix drive mechanism with neat sketch.
4. With the aid of a neat sketch, explain the construction and working principle of an alternator.
5. Explain the various lights and its purposes that are used in an automobile.