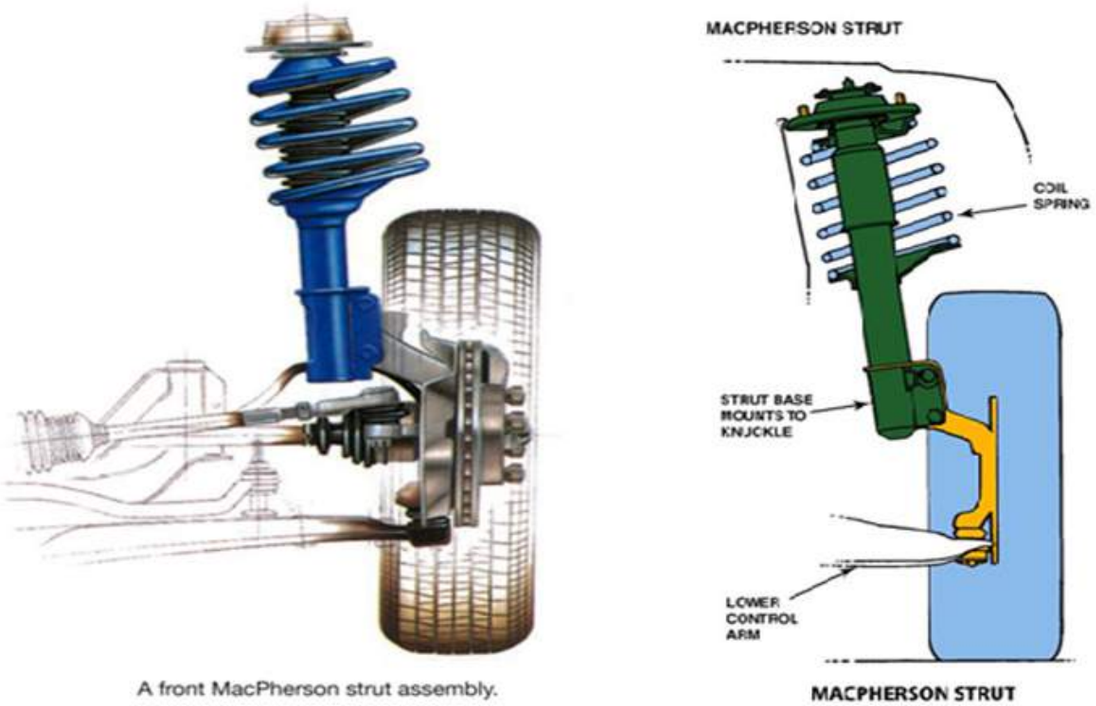

Figure 7.3.2.4 MacPherson Strut types

7.3.2.5 Swing half axle types

The simple construction is shown in the figure 7.3.2.5. Wheels are firmly fixed on one end of the half axle and the other end of the half axle is fixed to the center point of the chassis frame. Coil spring and shock absorber are mounted as shown in the figure. When the wheel passes the bumps and pits, axle get oscillates. As the vehicle moves on the irregular roads, coil spring and shock absorber are stretched or compressed simultaneously to take the road disturbances.

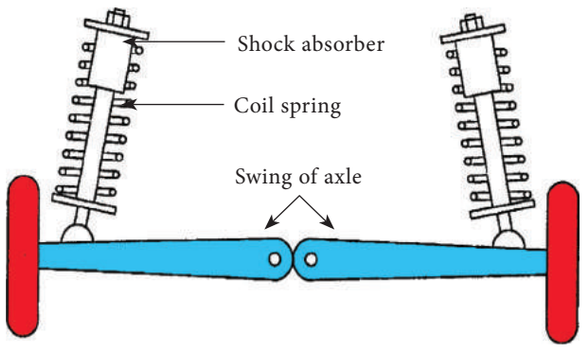

Figure 7.3.2.5 Swing half axle types

7.3.2.6 Rear axle independent suspension system

Rear axle independent suspension system construction is given in the figure 7.3.2.6. In most of the vehicles, the drive from the engine is given to the rear wheels. Hence it is difficult to design, construct and installing an independent suspension system in rear wheel drive vehicles. The differential unit is firmly fixed on the chassis cross frame member. Two

universal joints (A & B) are there in between differential unit and wheel, movable coupling (C) allows to move up and down motion of the wheel. A shock absorber is incorporated to the system. With the help of these components, the system absorb the road disturbance when the vehicle passes over the bumps and pits.

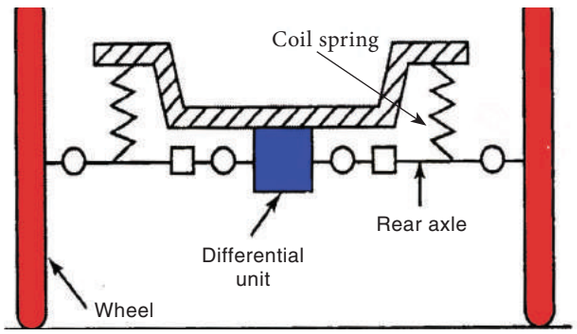

Figure 7.3.2.6 Rear axle independent suspension system

7.3.3 Air suspension system

These types of suspension systems are commonly used in a long-distance vehicle like buses. Due to the benefits of the air suspension system, nowadays this system is widely used in many vehicles.

Schematic representation of this type of air suspension system is shown in the figure 7.3.3(1&2). It consists of four air springs which may be a bellow type or piston type. Air compressor is used to pressurize the purified air (through filter) from the atmosphere and stored in the accumulator at a pressure maintained between 5.6 to 7 kg/cm^2. To release the excess air and to maintain the pressure inside the accumulator, a safety relief valve is used. The high pressure compressed air enters into the air spring through leveling valve and lift control valve. The lift control valve was operated by a manual lever which is located in the panel board.

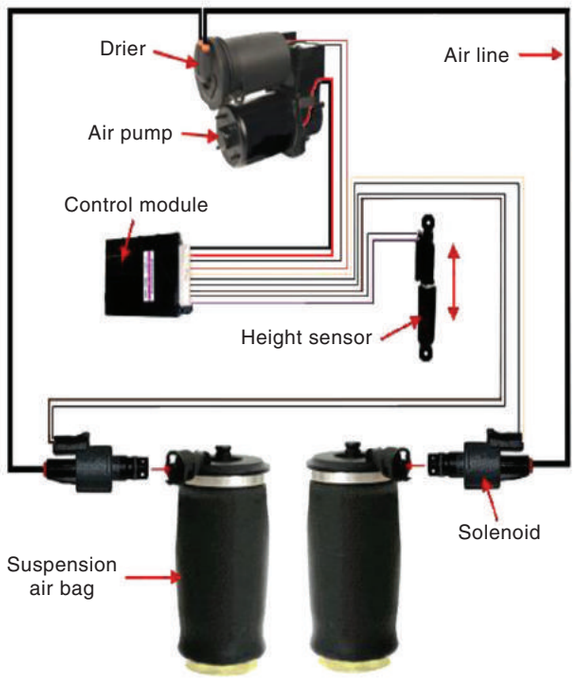

Figure 7.3.3 (1) Air suspension system

Advantages

1. It reduces noise, vibration, and harshness due to which passenger and driver attain better ride comfort. It reduces the journey tiredness of the driver and the passenger.
2. Change of spring deflection is quite low when compared with a conventional suspension system for both loading and unloading condition. This helps to reduce the load transfer on the vehicle.
3. Headlamp alignment remains constant though the vehicle is travelling over irregular roads.
4. With the help of automatic controlling tools, this system will provide some space for required wheel movement.

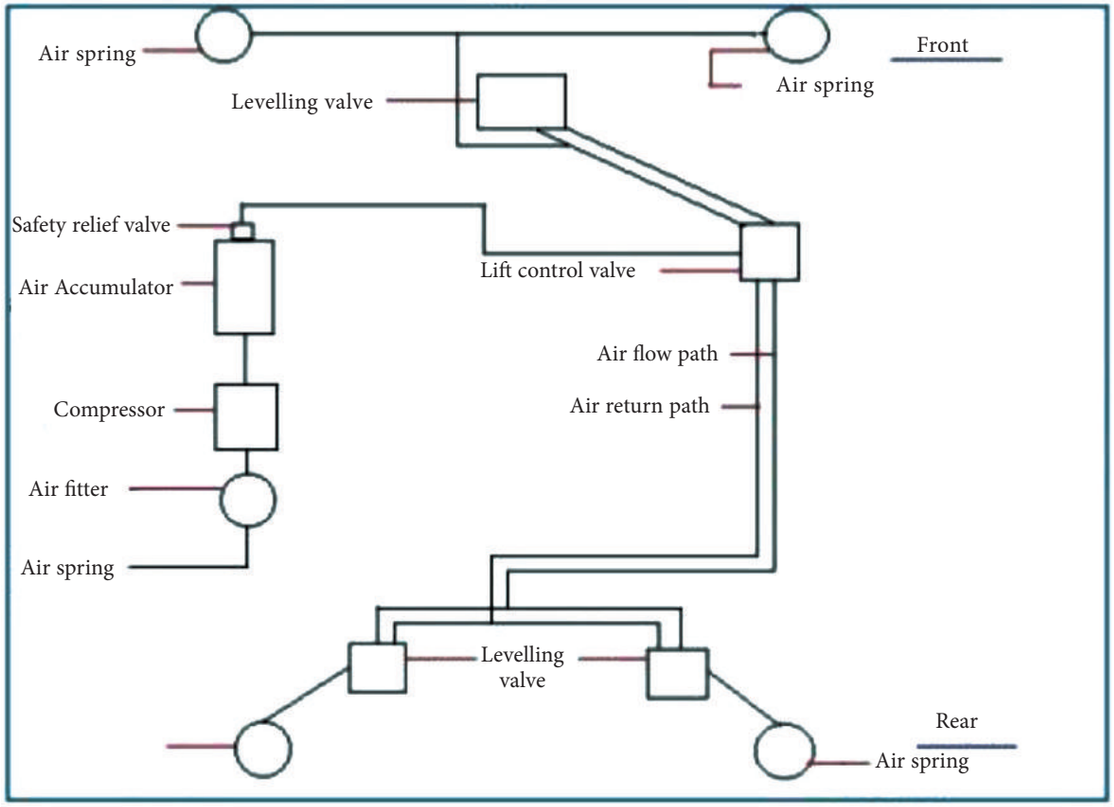

Figure 7.3.3 (2) Air suspension system

7.4 Independent suspension system advantages and disadvantages

Advantages

1. When one side of the wheel is subjected to road disturbance, then this disturbance does not transmit to the other side of the wheel.
2. During cornering, the rollover, the skid, pull on one side etc will not occur.
3. It provides good road holding property.
4. It promotes easy turning of the vehicle and have better control.
5. It ensures good ride quality.
6. It prevents the wheel from turning towards the kingpin axis.
7. In front wheel steering vehicles, it provides ambient space to locate the engine.
8. It reduces the unsprung weight.
9. It controls the effect of steering geometry hence steering is easier.

Disadvantages

1. It has more probable for tyre wear.
2. Comparatively, the cost is high.
3. Requires more maintenance and it is complex.
4. Maintenance cost is high.
5. It requires good quality shock absorber to enhance the ride comfort.
6. Construction is complex.
7. More benefits when it is mounted in the front axle than rear axle.

7.5 Shock absorber

The spring system prevents the travelers and truckloads that do not cause any shocks when climbing up the sudden disturbance on the road. However, if the spring are stiffer than expected, it will not absorb the road shock. The spring will keep on oscillate even after crossing the disturbance till the energy is completely die out. Hence, to quickly dissipate the stored energy in springs, dampers are used.

According to the working principle shock absorber are classified into three types they are,

1. Friction type
2. Hydraulic type
3. Air type

7.5.1 Friction type

When one body is allowed to slide over the other, the surface of one body offers some resistance to the movement of the other body on it. This resisting force is called friction force. In leaf spring, the interleaf friction is act as a damper. It is not widely used with other types of springs.

7.5.2 Hydraulic type

This type of damper is most widely used in the suspension system. It works based on Pascal'slaw. They are further classified into two types.

(i) Pistontype
(ii) Telescopic type

Telescopic type

It works on the basic principle of Pascal's law. Damping is obtained as high-velocity fluid passing through a tiny hole. This system is also called telescopic shock absorber and because of use of hydraulic, it is also called as hydraulic damper.

Construction

Figure 7.5.2.2 shows the construction details of this shock absorber. The head is fixed inside the cylinder. The piston and two way valve located on the top portion of the Cylinder is assembled with piston rod for up and down motion. The other end of the piston rod has eye and it is attached to the chassis frame. On the bottom portion of the cylinder another two way valve named as foot valve is attached. In this two way valve, one valve is used for fluid inlet and other valve is used for fluid outlet. Cylinder is filled with fluid.

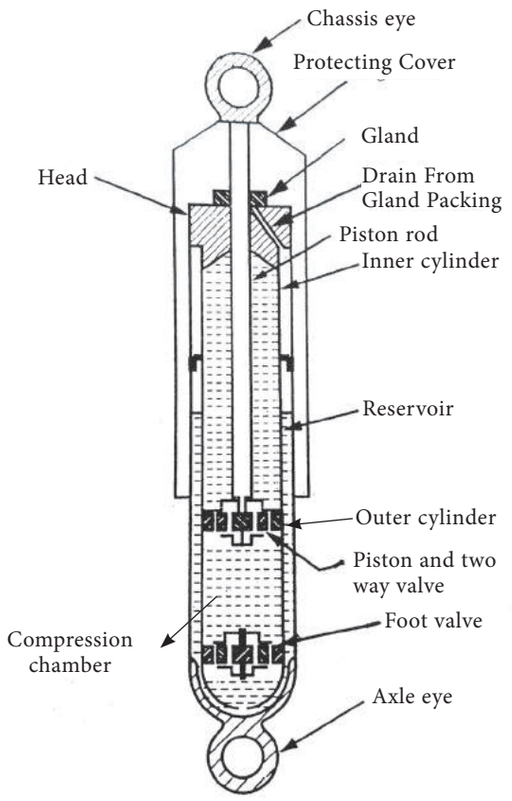

Figure 7.5.2.2 Telescopic type shock absorber

Inner portion of the cylinder is called as tube and the gap between the outer portion of the inside tube and that of the inner portion of the outside tube is used for fluid storage and it is called as reservoir. A gland is fixed at the top portion of the cylinder. When damper is in operation, Gland is used to scrap the excess oil in the piston rods to the reservoir. When suspension works, fluid from the glands has been sent it to reservoir through piston rods.

The lower portion below the piston of the inner cylinder, is called as compression chamber and the top portion above the piston is called as rebound chamber. Damping fluid is made up of with 60% transform oil blended with 40% turbine oil.

Working principle

When the vehicle passes over the road disturbance, it piston moves down and this movement of piston pressurizes the fluid at the bottom portion. Then this fluid flows into the rebound chamber from compression chamber through a valve located on the top portion of the piston and the remaining portion flows into the reservoir through foot valves.

Similarly, when the vehicle comes to normal road condition, the piston moves from downward to the upward direction, so that the fluid at the top portion of the piston is compressed. This pressurized fluid is sent inside the compression chamber through the piston valve and the remaining amount of the fluid which again fed back from the reservoir through the foot valves. Because of this upward and downward motion of the piston, the fluid becomes highly pressurized and hence the energy due to road shock has been absorbed.

7.5.3 Air type

Air suspension is nowadays the most popular on commercial vehicles. It works on the principle of air so it is called as air type shock absorber.

7.6 Troubles, Causes and remedies of the suspension system

7.6.1 Noise in the suspension system

Sl. No.	Causes	Remedies
1	Loose, worn, un lubricated spring or suspension parts	Lubricate, tighten or repair
2	Worn out bushes	Replace the bush
3	Weak / Broken / Defective spring	Replace
4	Worn out shackle pin	Replace

7.6.2 Frequent failure in leaf spring

Sl. No.	Causes	Remedies
1	Defective shock absorber	Replace
2	Vehicle heavily loaded	Avoid overload
3	Tight spring shackle	Loosen, Rectify / Replace
4	Sudden brake in high speed	Apply brake gradually

7.6.3 Uncomfortable ride in vehicle

Sl. No.	Causes	Remedies
1	Misalignment of suspension system	Align the system
2	Defective shock absorber	Rectify / replace
3	Loosened U-Bolt	Tighten
4	Seized shackle pin	Clean and lubricate / replace the damaged parts

- Hong Kong is home to the most Rolls Royce's in the world.

- Red cars are prohibited in Shanghai, China.

- 1 out of every 4 cars produced in the world come from China.

- The world's most profitable car manufacturer is Porsche.

Student Activity

1. Students are advised to submit a report based on visit to nearest Automotive workshop to study how suspension system is installed in a vehicle.
2. Students are advised to submit a report on construction and working principle of air suspension system used in modern Automobiles with line sketches.

Glossary

1.	Plastic	–	நெகிழி
2.	Leaf Spring	–	பட்டை வில் தொகுப்பு
3.	Coil Spring	–	சுருள் வில்
4.	Bellow type	–	மடிப்புரை வகை
5.	Shackle	–	அசைவுக்கரம்
6.	Cantilever	–	நெடுங்கை
7.	Torsion bar	–	முறுக்கு தண்டு
8.	Shock Absorber	–	அதிர்வு உறிஞ்சி
9.	Face Shear	–	முகப்பு வெட்டு
10.	Reinforced	–	வழுவூட்டப்பட்ட

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Evaluation

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PART - A

One mark questions

Choose the correct answer

1. In leaf spring, one end of the spring is fixed and the other end of the spring is attached to _____
   a) U - bolt
   b) I - bolt
   c) Shackle
   d) Axle shaft

2. The up and down motion of the vehicle is called as _____
   a) Damping
   b) Bouncing
   c) Pitching
   d) Rolling

3. Energy stored in the coil spring during
   a) Compression
   b) Straightening
   c) Expansion
   d) Bending

4. Hydraulic damper is working based on the principle of
   a) Newton Law
   b) Principle of Lever
   c) Principle of friction
   d) Pascal Law

5. In which type of vehicle, helper springs are used?
   a) Light vehicles
   b) Heavy vehicles
   c) Two wheeler
   d) Three wheeler

PART - B

Three mark questions

1. State the requirements of a suspension system?
2. Classify the types of leaf spring?
3. Write short notes on helper spring.

4. What will happen if suspension system fails?
5. State the advantage of rubber Springs?
6. Classify the types of suspension system
7. State the types of air spring?
8. List out the types of shock absorber.
9. How leaf spring is mounted on a vehicle?
10. State the function of suspension system?

PART - C

Five mark questions

1. With the aid of neat sketch, explain torsion bar.
2. Draw any one type of leaf spring and indicate its parts.
3. State the advantage of air suspension.
4. Highlight the advantage and disadvantage of a coil spring.

PART - D

Ten mark questions

1. State the advantage and disadvantage of independent suspension system?
2. With the aid of simple sketch, explain the construction and working principle of shock absorber.
3. Explain with neat sketch, the principle of wishbone type suspension system.
4. With the aid of line diagram, explain the construction and working principle of air suspension system.

UNIT 8

Steering System

Contents

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Learning objectives

1. To make the students to understand on need and types of steering system.
2. To make the students to understand upon various components, construction and working principle of a steering system.

8.0 Introduction

The most conventional steering arrangement is to turn the front wheels using a hand-operated steering wheel which is positioned in front of the driver to allow it to deviate somewhat from a straight line. The system allows a driver to use only light forces to steer a heavy vehicle. Front axle carries the weight of the front part of the automobile as well as facilitates steering and absorbs shocks due to road surface variations. Let us see about the structure and its functioning in the following segment.

8.1 Functions of the steering system

- Steering system is helps to turn the front wheels on desired direction with the help of steering wheel.
- This system provides to vehicle steer in turning are also stabilize the vehicle on the straight road.

8.2 Parts of steering system

1. Steering Wheel
2. Steering Column
3. Steering Shaft
4. Steering Gear Box
5. Cross Shaft
6. Drop arm (or) Pitman arm
7. Drag Link (or) Pull and Push rod
8. Tie Rod or Track Rod
9. Ball Joint
10. Front Axle
11. Road Wheel

8.2.1 Steering parts and its uses

1. Steering Wheel

It is a circular wheel mounted at the centre portion with two or three rods. The steering wheel is connected with steering gear box through steering shaft. So the road wheels are turns easily when rotation of steering wheel.

2. Steering Column

It is hollow shaft in which is made up on alloy steel. The steering shaft rotates with the help of bearing. In modern vehicles, the gear change lever is provided at the steering column for the convenience of the driver.

3. Steering Shaft

It is made up of good quality steel. The upper end is fixed in steering wheel with the help of splines (or) key. The other end is connected to the steering gear box.

4. Steering Gear Box

The steering gear box serves the following purposes.

1. It provides mechanical advantages and enable the driver to steer the vehicle easily.
2. It converts the turning motion of the steering wheel into the to-and-fro motion of the link rod of the steering linkage.

5. Steering Linkages

- When the steering wheel is turned its motion is carried to the steering gear box through the steering shaft.

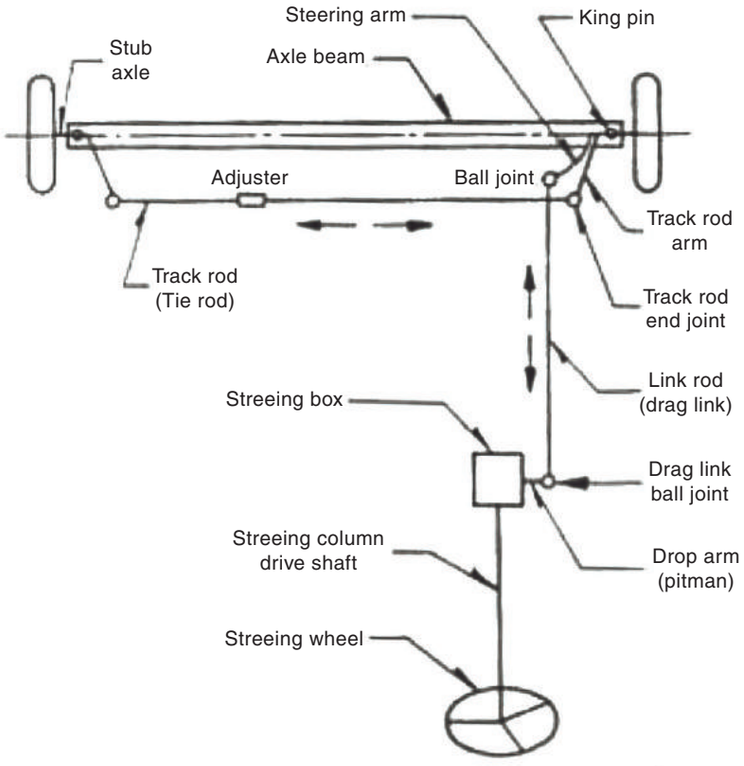

Figure 8.2.1 (a) Steering system

- This motion is converted into angular motion of the drop arm which is connected to the link rod.
- The other end of link rod is connected to the steering arm by means of ball joint. The steering arm is connected to the lower end of the stub axle. Both the steering arms are connected by a tie rod.
- When the steering wheel is to be turned to the right side or left side, the stub axle turns to the wheels either left or right side. The steering linkage as shown in figure 8.21 (a).

8.3 Steering gear box

- The case which holds the steering gear is called as steering gearbox.
- The Rotary movement of the steering wheel is converted into reciprocating motion of the steering linkage.
- The driver easily turns the stub axle either left or right side with the help of steering gear box.

8.3.1 Types of steering gear box

Based on the construction and working principle the steering gear box are classified into the following types

1. Worm and sector type
2. Worm and Roller type
3. Worm and Nut type
4. Worm and wheel type
5. Recirculating Ball type steering gearbox
6. Cam and Peg Steering Gear Box
7. Cam and Roller type
8. Rack and Pinion Steering Gear Box

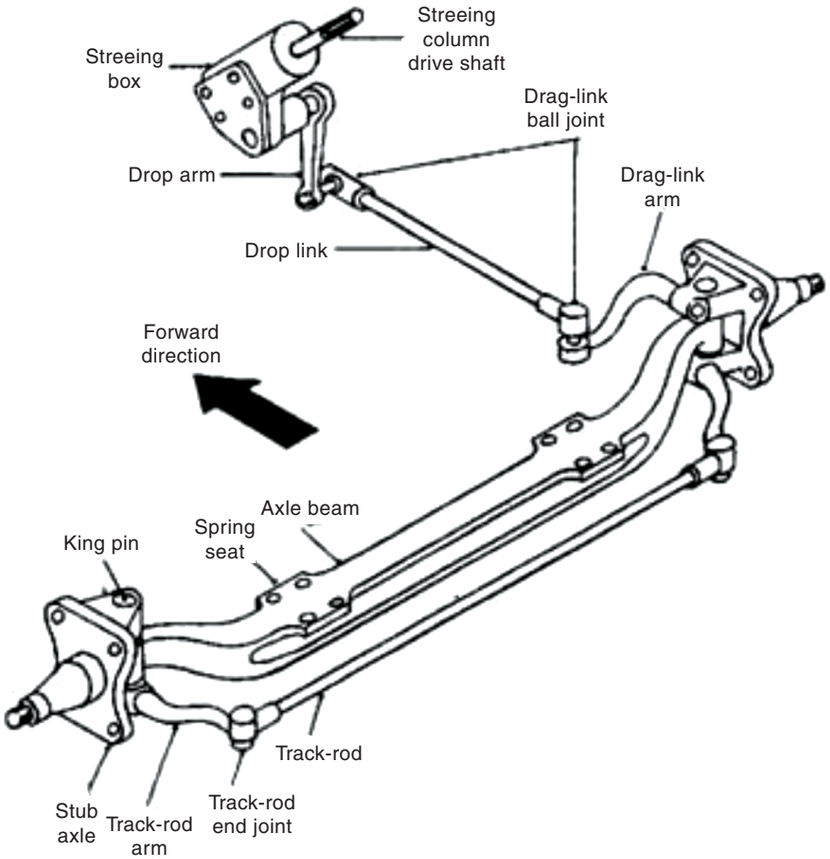

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Figure 8.2.1 (b) Steering system

8.3.1.1 Rack and pinion steering gear box

Construction

- In this type of steering gearbox, in place of cam or worm, the pinion gear is attached to the steering shaft through universal joints.
- The pinion is meshed with rake gear. The circular input motion of the pinion is converted into a linear rack output movement.
- The tie rod at each end of the rack is connected to the steering arm by means of ball joint.

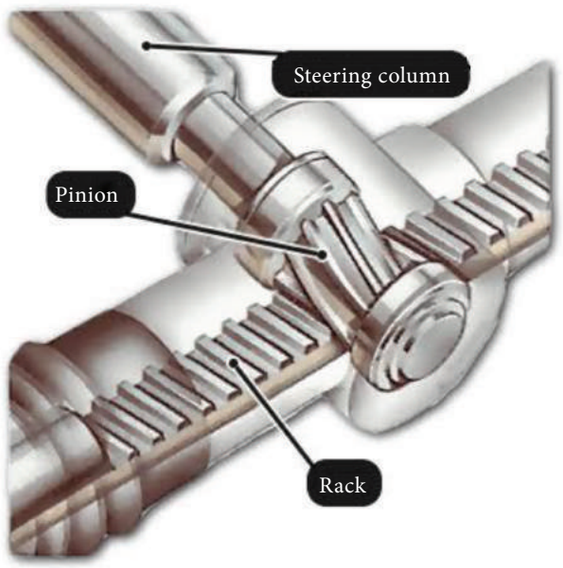


Figure 8.3.1.1 (a) Rack and pinion type steering gear box

Working Principle

- When the drive turns the steering wheel, the pinion at the end of steering wheels rotates at its own axis.
- Based on the direction of rotation of the pinion, the rack moves towards the left or right.

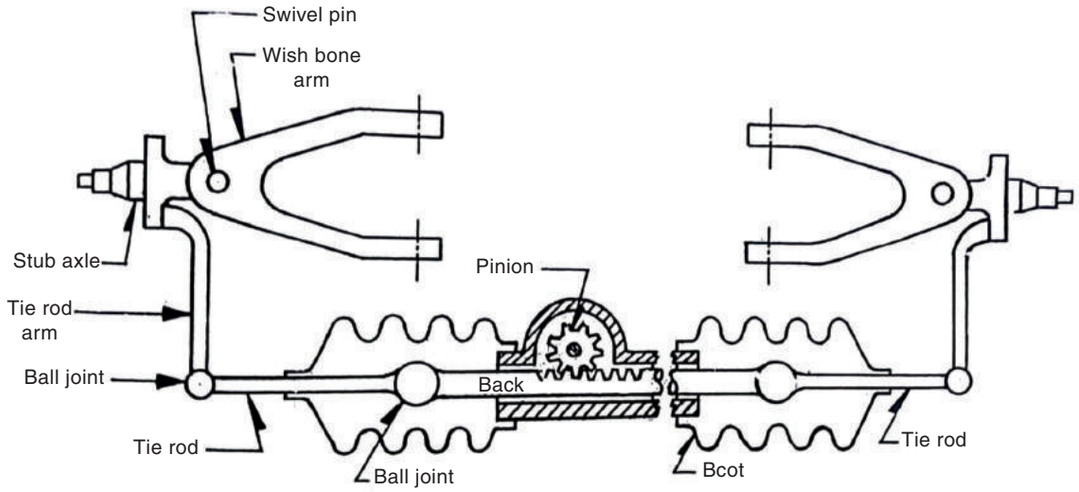


Figure 8.3.1.1 (b) Rack and pinion type steering gear box

- This rack movement, make the tie rod to push the steering arm on one side and to pull the steering arm on other side.
- This turn the stub axle at its pivot point. The wheel attached in the stub axle is also turned and thus the steering movement is achieved.

8.3.1.2 Cam and Peg Steering Gear Box

Construction

- This type of steering box, in place of worm, a cylindrical shaft, supported by two roller bearing in the housing.
- The cylindrical shaft carried a deep spiral groove, usually a variable pitch

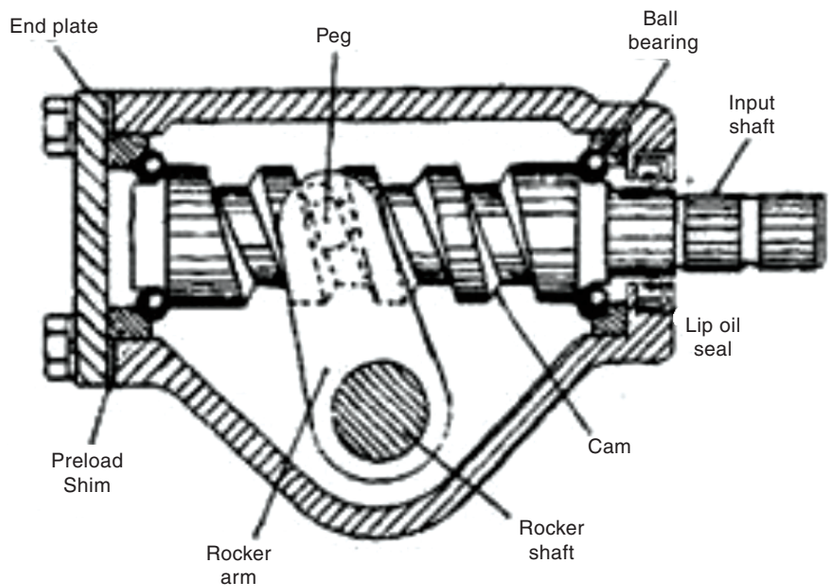


Figure 8.3.1.2 (a) Cam & peg type steering gear box

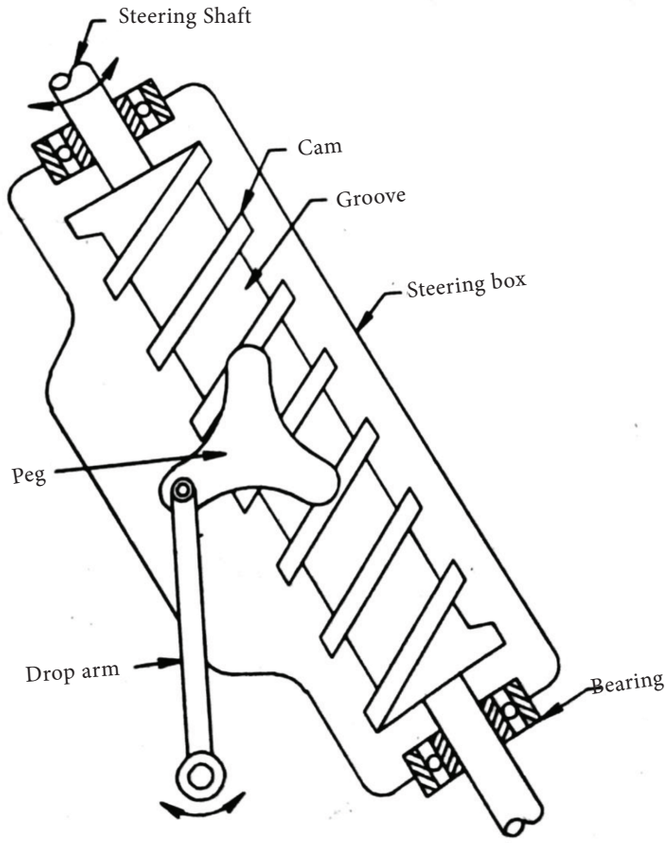


Figure 8.3.1.2 (b) Cam and peg type steering system

on its surface between its bearing and this shaft is known as a cam.

- An integral rocker arm and shaft is placed half-way along the cam. At the free end of the rocker arm a conical peg is fitted which engages the groove.

Working Principle

When the steering wheel and shaft rotate the camshaft, one side of the spiral groove screws the peg axially forward or backward, depending upon the direction of turning of the cam. This forces the rocker arm to pivot about its shaft axis and as a result a similar angular motion is transferred to the drop arm, which is attached to the shaft's outer end. Thus the road wheels are turns either left or right.

8.3.1.3 Worm and Sector Steering Gearbox

Construction

- The worm is firmly connected to the inner column of the steering shaft.
- Worm shaft is mounted on the housings with the help of two taper roller bearing makes the rotation of shaft easily.
- The sector gear is meshed with worm.
- The sector gears form a part of the rocker shaft in the steering gear box.

Working principle

- When the driver turns the steering wheel, the worm will turn and turns the sector gear. The rotary motion of

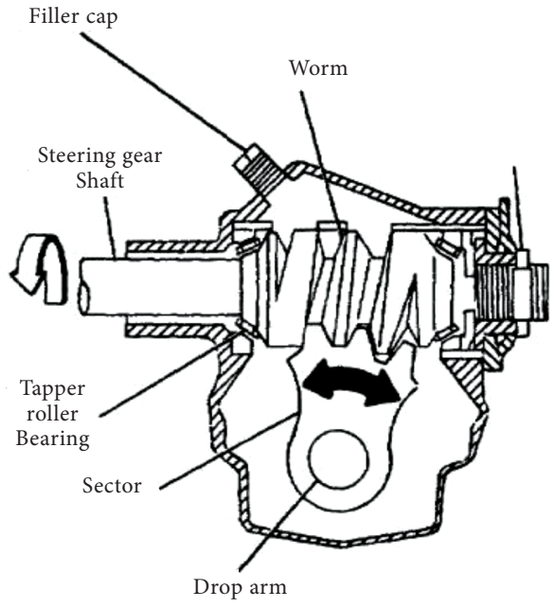


Figure 8.3.1.3 Worm and sector steering box

the steering wheel is converted into angular motion of the sector gear.

- The drop arm attached to the sector is also oscillated and through the steering linkages, the wheel is turned to the required degrees in the required direction.

8.3.1.4 Recirculating ball type steering gear box

It consists of a worm at the end of a steering rod. A nut is mounted on the worm with two sets of balls in the grooves of the worm, in between the nut and the worm. The balls reduce the friction during the movement of the nut on the worm. The nut has a number of teeth on the outside, which mesh with the teeth on a worm wheel sector, on which is further mounted the drop arm. When the steering wheel is turned, the balls in the worm roll in the grooves and cause the nut to travel along the length of the worm. The balls, which are in 2 sets, are recirculated through the guides. The movement of the nut causes the wheel sector to turn at an angle and actuate the link rod through the drop arm, resulting in the desired steering of the wheels.

8.4 Power steering

- In medium and heavy commercial vehicles, the driver has to put lot of physical effort to turn the vehicle. If the driver continuously drives the vehicle for longer duration, then the driver will be very tired.
- In order to reduce the steering effort by the driver for easy turning, an energy source that aids the driver in turning the wheels is called as power

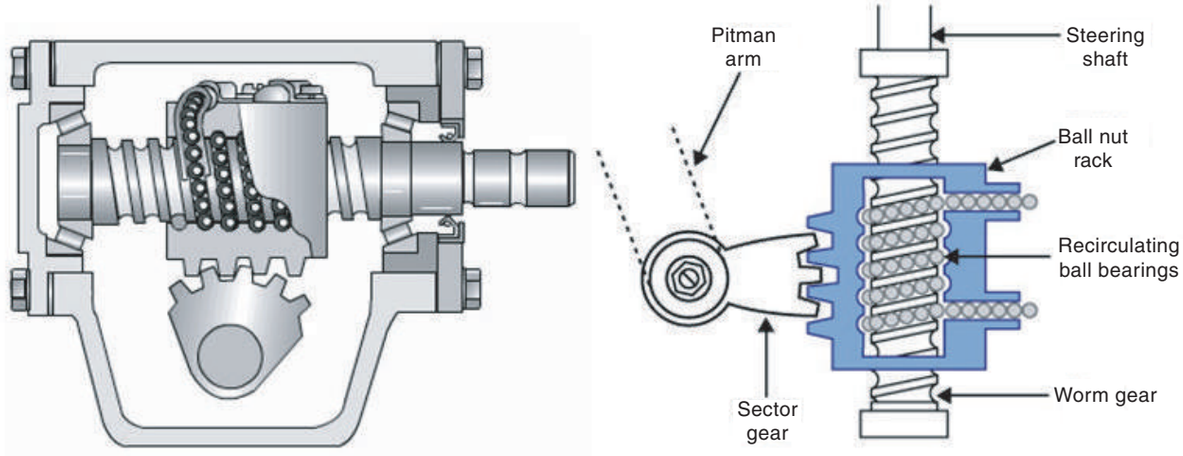
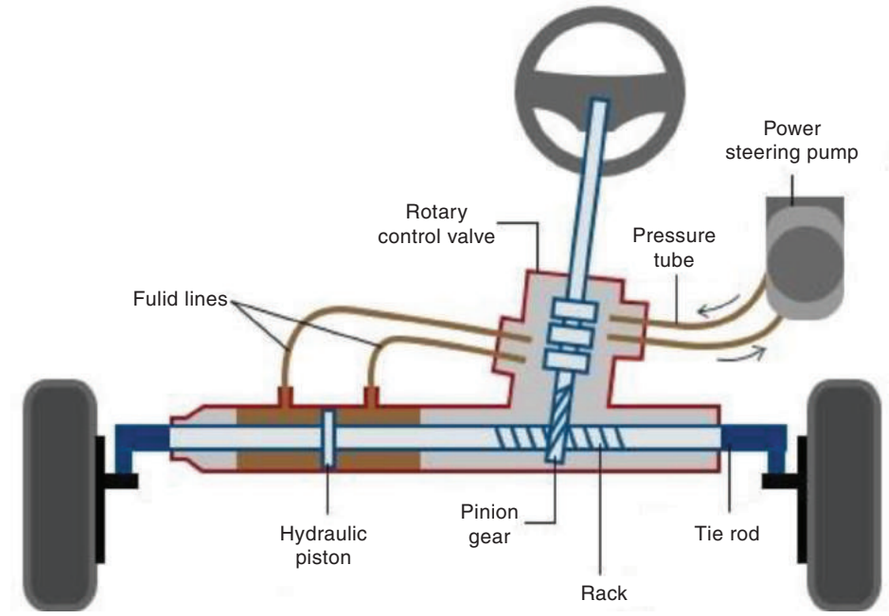


Figure 8.3.1.4 Recirculating ball type steering gear box



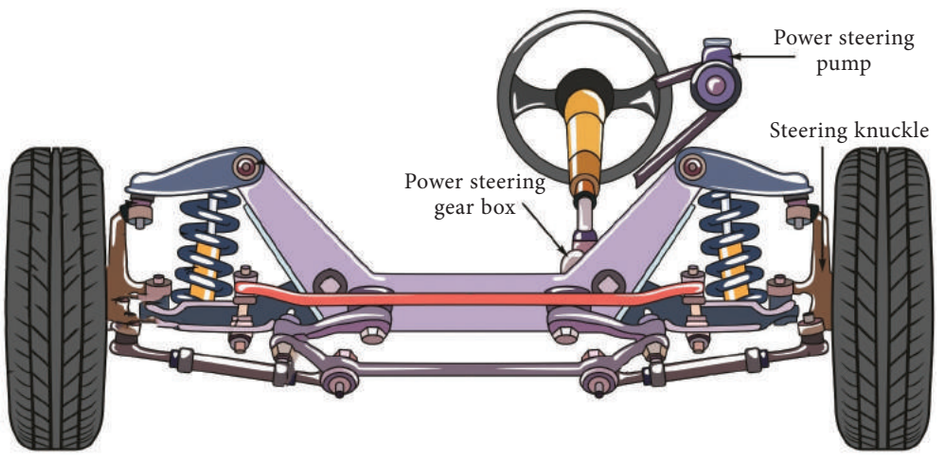


Figure 8.4 Power steering

steering system. Most automotive power steering system are hydraulic.

- A pump supplies high pressure fluid when the driver turns the steering wheel. This provides 80% of the required steering effort and the remaining 20% is by driver's physical effort.

Types of Power steering

1. Integral type
2. Linkage type

8.5 (a) Reversible Steering

- Steering gear is said to be reversible if the deflection of steered wheel due to road surface is transmitted through steering linkages and steering gears to the steering wheels.

(b) Irreversible Steering

- Steering gear is said to be irreversible if the deflection of steered wheel due to road surface is not transmitted

through steering linkages and steering gears to the steering wheels.

8.6 Steering play

- The position of the steering wheel may change with the vibrations in the wheels, result in directional instability of vehicle. To avoid this, the steering wheel should be set to be free to rotate to a small degree and this play is called as steering free play.

8.7 Steering ratio

- The ratio between rotation of steering wheel to that of the turning angle of the stub axle is called as steering gear ratio. Example 360˚ : 36˚(ie) 10 : 1.

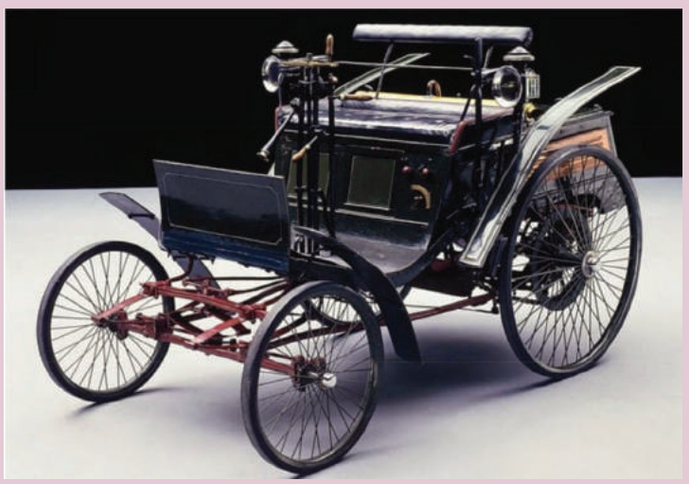
8.8 Turning radius

- Turning radius is the smallest radius takes place when the vehicle takes a turn

DO YOU KNOW?

- Roads were first made for bicyclists, not cars.

- The first cars did not have steering wheels. They were operated by a lever.



- The first windshield wipers were hand-operated.

- The first car to use a rear-view mirror was driven by inaugural Indy 500 winner Ray Harroun in 1911 to see the cars catching up behind him.

8.9 Wheel Alignment

- It refers to the angular relationship between the front wheels and parts attached to it with that of car frame. Wheel alignments ensure that all four wheels are consistent with each other and are optimized for maximum contact with the surface of the road.

8.9.1 Aim of wheel alignment

1. To turn the steered wheel easily and to ensure vehicle directional stability.
2. To reduce the tyre wear to a minimum.

8.9.2 Angles in wheel alignment

1. Caster Angle
2. Camber Angle
3. King pin inclination
4. Toe-in and Toe-out

8.9.2.1 Caster Angle

The angle between the king pin centre line (or steering axis) and the vertical axis, when viewed from the side of the vehicle, is called the Caster angle. Caster angle is about 2° to 3°. As shown in figure 8.9.2.1 (a), (b), (c).

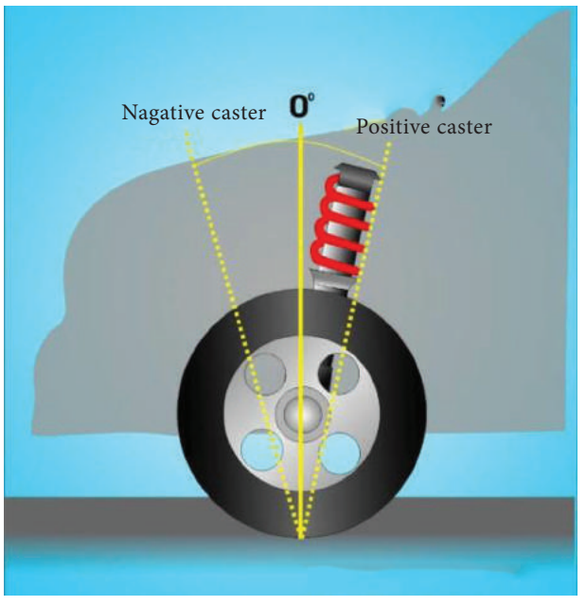


Figure 8.9.2.1 (a) Caster angle

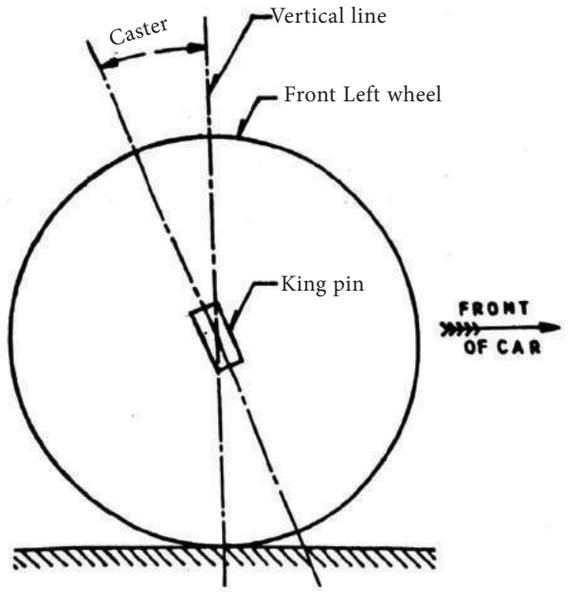


Figure 8.9.2.1 (b) Caster angle

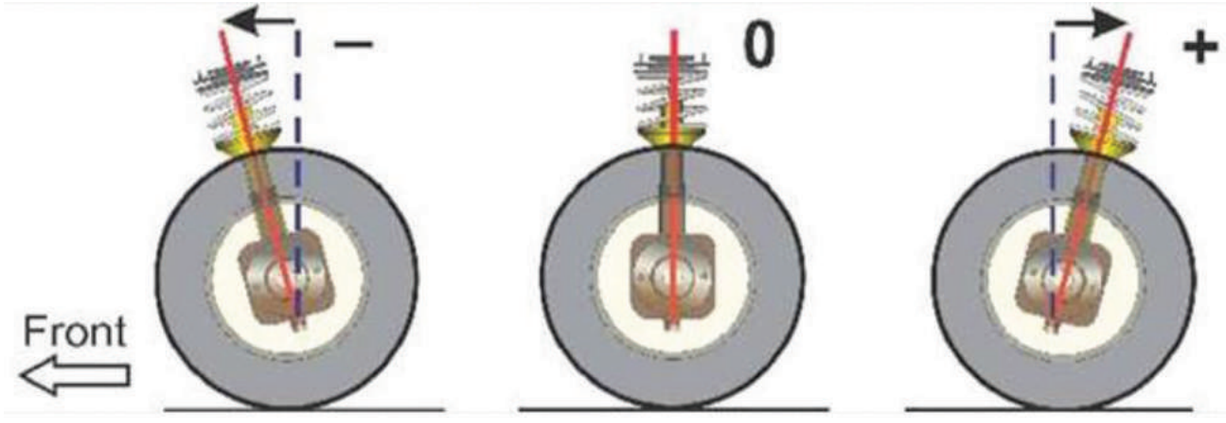


Figure 8.9.2.1 (c) Caster angle

Importance of Caster Angle

1. Positive Caster provides directional stability.
2. To prevent pulling of wheel on one side during braking
3. To reduce the tyre vibration

8.9.2.2 Camber angle

The angle between the centre line of the tyre to the vertical line when viewed from the front of the vehicle is known as Camber. It is approximately 1° to 2°. As shown in figure.

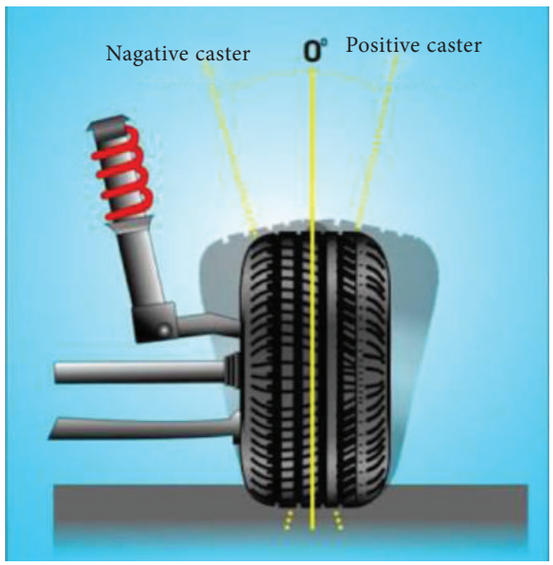


Figure 8.9.2.2 (a) Camber angle

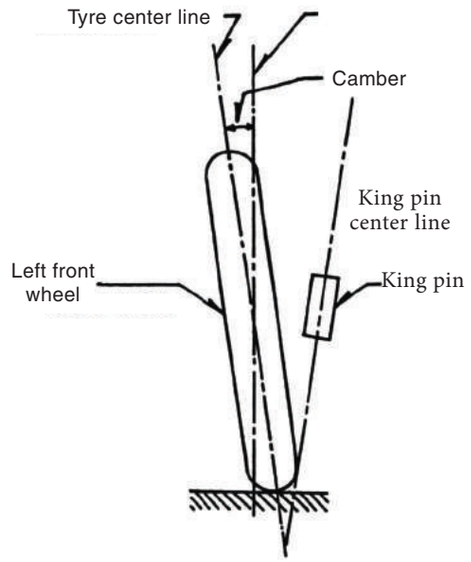


Figure 8.9.2.2 (b) Camber angle

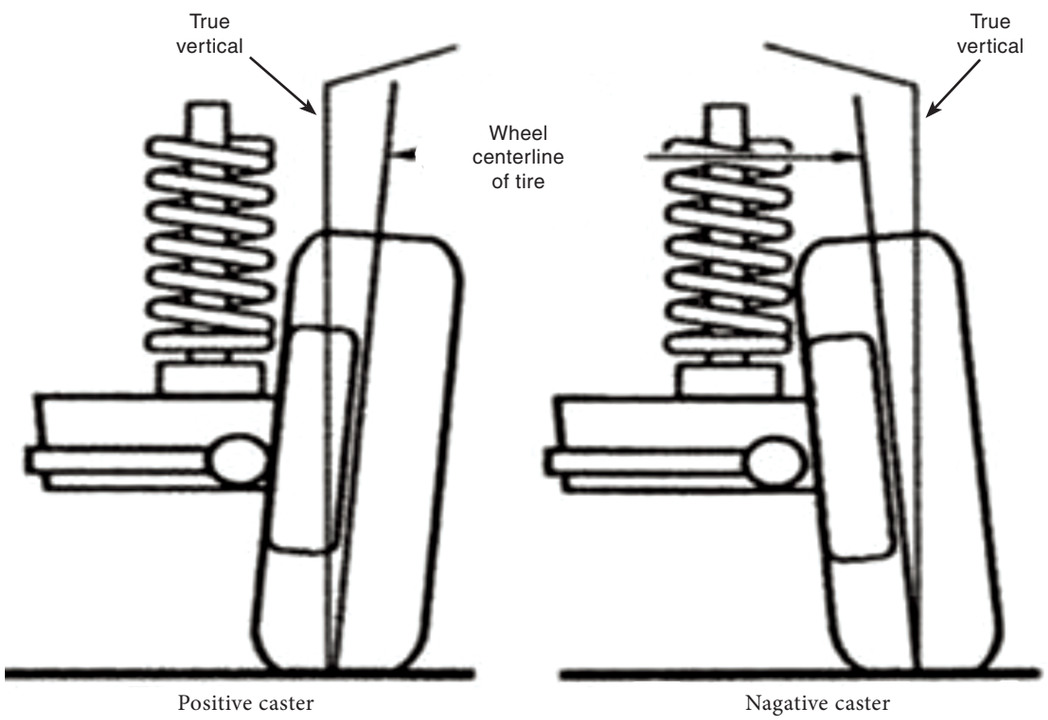


Figure 8.9.2.2 (c) Camber angle

Importance of Camber Angle

1. At the time of turning, camber angle ensures the ease of steering.
2. To reduce the tyre wear.
3. To reduce the load acting on the king pin and the wheel bearing due to weight of the vehicle.

8.9.2.3 King Pin Inclination

When the vehicle is viewed from front, the angle between the inclination of the king pin from the vertical axis is called the King pin Inclination. The inclination is normally kept 7° to 8°.

The reason for king pin inclination

1. It gives good road holding on turnings.
2. It reduces steering effort.
3. It reduces the load acting on the wheel bearing.

8.9.2.4 Toe-in and Toe-out

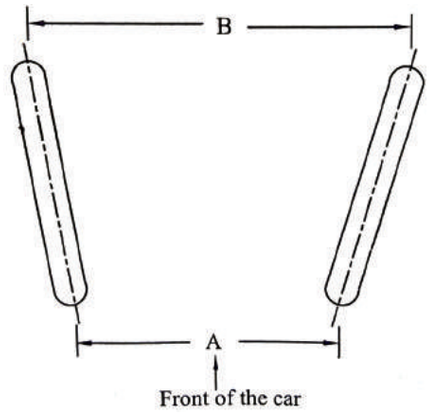
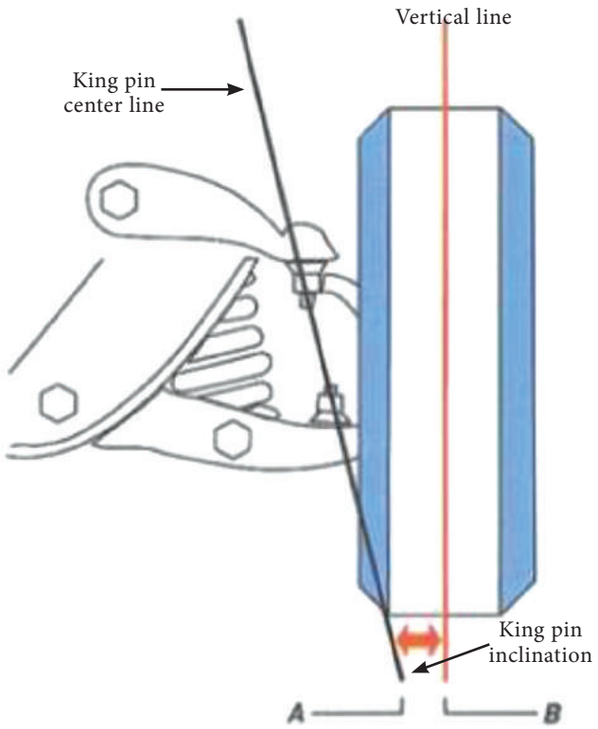


Figure 8.9.2.4 Toe-in

Toe-in

When viewed from the top, the distance between the front wheels at the front is less than the distance at the back is called Toe-in. Normally toe-in is up to 3 mm.



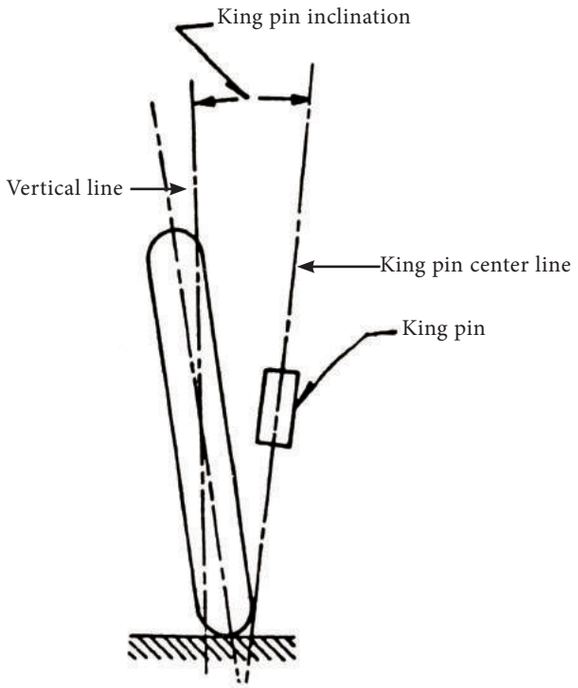


Figure 8.9.2.3 (a) & (b) King pin inclination

Toe-out

When viewed from the top, the distance between the front wheels at the front is more than the rear side is called toe-out

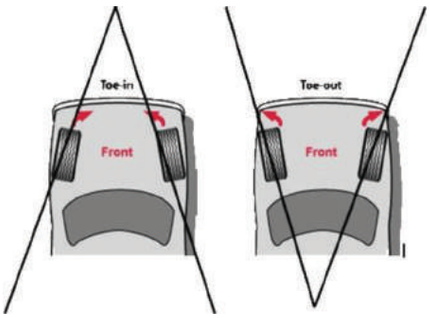


Figure 8.9.2.4 (a) Toe-in & Toe-out

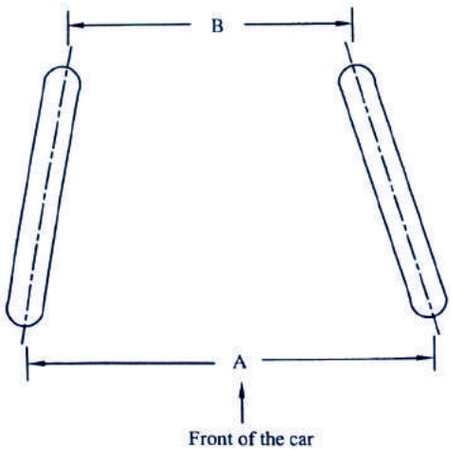


Figure 8.9.2.4 (b) Toe-out

DO YOU KNOW?

- An airbag takes only 40 milliseconds to deflate.

8.9.3 Effects of improper wheel alignment

1. Vehicle will roll over due to centrifugal force acting at the time of turning
2. Wheels are subjected to vibration
3. Increases the tyre wear
4. Reduce the tyre life
5. Hard steering
6. Vehicle pull on one side

8.10 Difference between Mechanical Steering and Power Steering

Sl No.	Mechanical Steering	Power Steering
1	Mechanical steering is a system in which Mechanical force is used for steering.	Power steering is a system that helps in steering the wheels using some source of power viz Hydraulic, Electric, Air.
2	Resistance to wheel movement is more.	Resistance to wheel movement is less
3	Widely preferred for Low weight vehicles.	Ease of steering in Comparatively heavy weight vehicles.
4	Steering wheel and column, a Mechanical gearbox and pitman arm or a rack and pinion assembly, linkages; steering knuckles and ball joints, and 4. the wheel spindle assemblies.	A hydraulic pump, fluid reservoir, hoses, lines; and either a power assist unit mounted on, or integral with, a power steering gear assembly.
5	Does not Absorbs road shocks.	Absorbs road shocks.
6	Efforts required for steering is high.	Efforts required for steering is less.
7	Very difficult to control directional at the time of emergency and directional stability is difficult to achieve.	Greater safety and controllability under emergency situation.

8.11 Front Axle

Front axle carries the weight of the front part of the vehicle. Front axle includes axle beam stub axles with brake assembly, track rod and stub axle arm to steer and brake the vehicle. To accommodate front engine and to provide stability and safety, the centre portion of the axle is dropped. It is called as front axle.

Construction

In light vehicles, front axles are tubular in section and in heavy commercial vehicles, the front axles are made up of I cross section. In both the ends, stub axles are connected with front axle by means of kingpin and steering track arm.

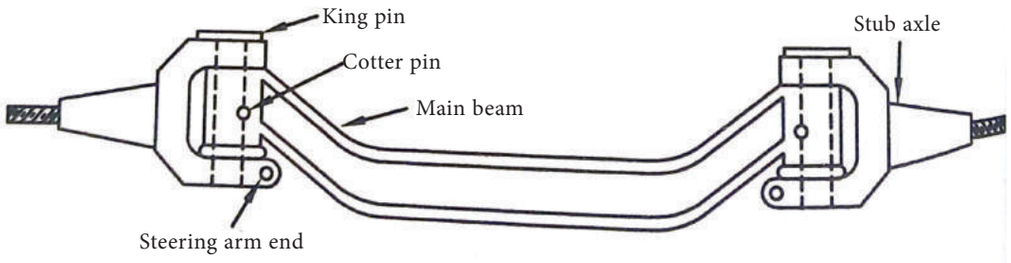


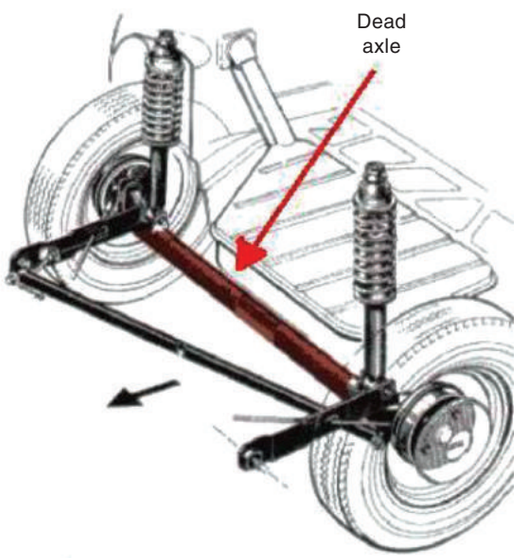
Figure 8.11 Front axle

8.11.1 Types of Front axle

1. Dead Axle
2. Live Axle

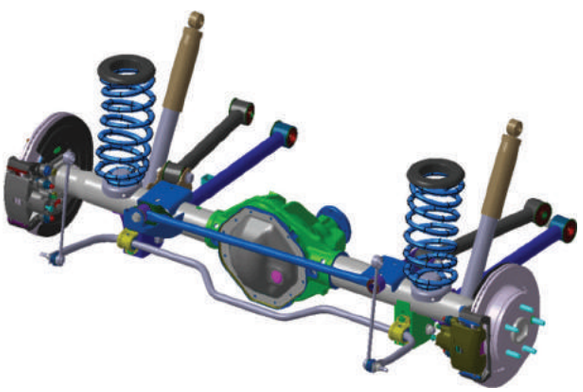
8.11.1.1 Dead axle

- It is a just dummy axle. It having no connections with engine. It has sufficient rigidity and strength to transmit the weight of the vehicle from the steering and brake system without differential and axle shaft.



8.11.1.2 Live axle

- Live axle is the one through which power is transmitted to the wheels by means of differential and axle shaft. In case of front wheel drive or in all wheel drive, the front axle will act as live axle.



8.12 Stub Axle

- Stub axle is a short axle. Stub axle are connected to the front axle by means of king pin. The front wheels are mounted on the stub axle.

- Stub axle is capable of limited angular movement about the kingpin for steering the vehicle.
- Stub axle helps to turn the vehicle at desired direction through steering linkage.

8.12.1 Types of Stub axle

Front axles are built according to four basic designs for attaching the steering knuckle to the beam. They are

1. Elliot type
2. Reverse Elliot type
3. Lemoine type
4. Reverse Lemoine type

1. Elliot axle

The Elliot type stub axle is shown in the figure 8.12.1 (a). The end of the axles are in the shape of a elliot. A king pin with cotter pin connects the stub axle. So the stub axle turns easily to and fro.

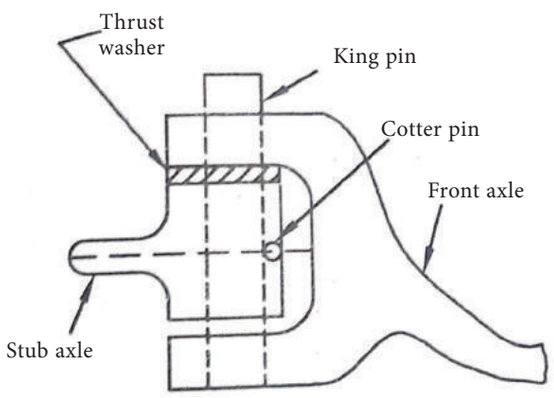


Figure 8.12.1 (a) Elliot type stub axle

2. Reversed Elliot axle

The reverse elliot type is shown in figure 8.12.1 (b) of the stub axle in the reversed Elliot shape. A king pin with cotter pin connects the stub axle. So the stub axle turns easily to and fro.

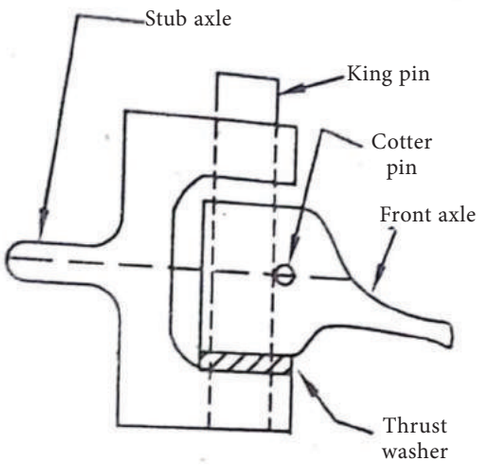


Figure 8.12.1 (b) Reversed elliot

3. Lemoine axle

Two spindles at right angles to each other, stub axle and axle center. Lemoine, a French axle and spring manufacturer designed this. In this design, pivot spindle extended up from the wheel spindle. Tends to raise the axle center above the wheel spindle, hence poorly suited to modern conditions, where low axle centres is preferred.

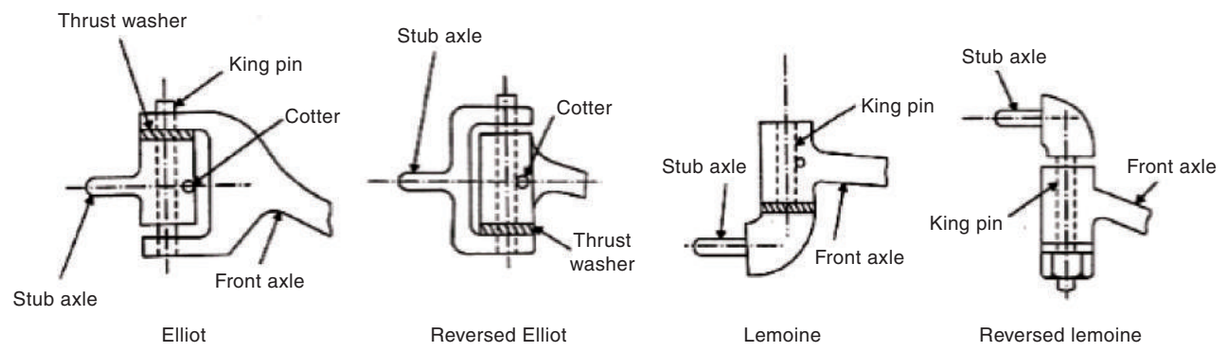


Figure 8.12.1 (a)

In this type, the stub axle is attached to the end of the axle by means of king pin. It is used in tractors. As shown in figure 8.12.1 (c).

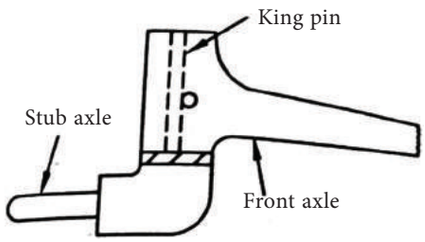


Fig 8.12.1 (c) Lemoine type

4. Reversed lemoine axle

Marmon, American passenger car manufacturer, reversed the arrangement and developed the design. A natural drop to the axle center, is an advantageous feature.

In this type, the stub axle is mounted on the top of the axle by means of king pin. It is used in tractors. As shown in figure 8.12.1 (d).

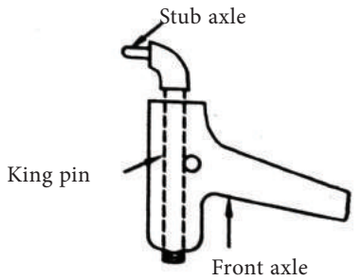


Fig 8.12.1 (d)

8.13 Troubleshooting, cause and remedy in a steering system

8.13.1 Excessive play in steering system

Sl. No.	Possible cause	Remedy
1	Loose / worn out steering gear (rack or box) mounting.	Tighten steering gear mounting bolts / replace mounting bushes.
2	Loose / worn out steering linkages.	Adjust or replace linkages.
3	Worn out of ball joints in steering system	Rectify / replace

8.13.2 Wheel Wobble

Sl. No.	Possible cause	Remedy
1	Mismatched tires or uneven tire pressure.	Inflate tyre upto recommended pressure
2	Unbalanced Wheel	Balance the wheel
3	improper camber angle and toe in	Check the wheel alignment and rectify

8.13.3 Hard Steering

Sl. No.	Possible cause	Remedy
1	Low inflation pressure in the tyres	Properly inflate tyre
2	Improper wheel alignment	Check and rectify the wheel alignment
3	Bend in the front axle	Rectify
4	Misalignment in chassis frame	Rectify
5	Broken / damage bearings and bushes in steering gearbox	Replace

8.13.4 Vehicle Pulling on one side

Sl. No.	Possible cause	Remedy
1	Uneven tyre wear	Tyre rotation
2	Improper brake adjustment	Check and adjust the brakes
3	Failure of damper / spring in one side	Replace the damper / spring

Student Activity

1. Students are advised to submit a report based on the visit to the nearest automotive workshop to study about various parts in steering system and its assembly procedure in vehicle.
2. Students are advised to submit a report on construction and working principle of steering system used in Modern cars with sketches based on the visit to the nearest Automotive workshop.

Glossary

1.	Alignment	–	ஒழுங்கமை
2.	Axle	–	அச்சு
3.	Kingpin	–	பிரதானபின் [சுழல் மூட்டுக்கம்பி]
4.	Camber angle	–	மேல் சாய்வு கோணம்
5.	Ball joint	–	பந்து கிண்ண இணைப்பு
6.	Steering	–	திசை திருப்பி
7.	Worm	–	திருகுருவப் பொருள்
8.	Power steering	–	விசைத் திருப்பி
9.	Irreversibility	–	மீளாத்தன்மை
10.	Stub axle	–	துணை அச்சு

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Evaluation

UKEQD8

PART - A

One mark questions

Choose the correct answer

1. During driving, the direction of vehicle is controlled by
   a. Steering system
   b. Brake system
   c. Engine
   d. Suspension system

2. In steering system, steering arm is connected to
   a. Steering wheel
   b. Drop arm
   c. Steering column
   d. Tie rod

3. The box in which steering gears are mounted is called as
   a. Suspension
   b. Steering gearbox
   c. Differential
   d. Steering geometry

4. How many types of steering gearbox are available?
   a. 3 b. 4
   c. 5 d. 8

5. In steering system, the component used to pull steering arm on one side and to push steering arm another side, is called as
   a. Steering shaft
   b. Steering gearbox
   c. Tie rod
   d. Stub axle

6. In power steering system, the percentage of amplification by means of hydraulic is
   a. 20 % b. 60 %
   c. 80 % d. 100 %

7. The permissible play in the steering wheel is known as
   a. Steering alignment
   b. Steering ratio
   c. Steering play
   d. Turning radius

8. The allowable caster angle in degree is
   a. 2° to 3° b. 7° to 8°
   c. 10° to 12° d. 5° to 6°

9. The angle between the central axis of kingpin and vertical axis, when viewed from vehicle front, is known as
   a. Camber angle
   b. Caster angle
   c. King pin inclination
   d. Toe-in

10. Name the angle, in between the king pin centre line and vertical line, when viewed at the front side of the vehicle.
    a. Camber angle
    b. Caster angle
    c. King pin inclination
    d. Toe-in

11. Front axles are classified into _____ types
    a. 2 b. 4
    c. 5 d. 6

PART - B

Three mark questions

1. State the functions of a steering gearbox.
2. List out the type of steering gearbox.
3. What do you mean by steering play?
4. Define steering ratio.
5. What are the parameters are there in a wheel alignment?
6. Write short notes on king pin inclination.

PART - C

Five marks questions

1. Arrange the parts in a steering gear box.
2. Discuss the power steering system and state the types.
3. Explain camber angle with simple sketch.
4. State the problem arises, if wheel alignment is improper.
5. Explain the role of front axle. Classify the types of front axle.

PART - D

Ten mark questions

1. With the aid of neat sketch, explain the construction and working principle of rack and pinion steering gearbox.
2. Describe the construction and working principle of worm and sector type steering gearbox with the aid of necessary sketch.
3. Tabulate the difference between mechanical steering and power steering system.
4. State the reason and remedial step for any two problem that are caused in steering system.

UNIT 9

Chassis and Body

Contents

7H1K34

Learning objectives

1. To make the student to understand about the need, purpose and types of Chassis frame, sub systems of chassis mounted on the chassis.
2. To make the student to understand on vehicle body, classification of vehicles.

9.0 Introduction

The various parts of the vehicle are mounted on the chassis frame. The chassis frame must strong enough to withstand total weight of the vehicle. The chassis frame carries engine, clutch, gear box, Propeller shaft, rear axle, suspension, steering gear box and brake. Frame is fixed with two longitudinal bars and four or five cross bars by rivet or bolts.

9.1 Chassis frame

- The skeleton of the vehicle is chassis frame.
- Chassis frames are made up of alloy steel and it is of high strength to make the rigid structure.
- Based on the construction, application, load capacity of the vehicle, the chassis frame is made up of different size and shape.
- Chassis frame forms the backbone of the vehicle.

9.1.1 Functions of the chassis frame

1. To withstand the weight of the vehicle, passenger and goods.
2. To form the base to mount the engine, suspension, steering and power transmission system.
3. To build the vehicle body on the chassis frame.
4. To withstand the reaction due to driving and braking force.
5. To absorb the ground reaction forces due to road undulations.
6. To withstand the static load and dynamic load of a vehicle.

9.1.2 Types of chassis frame

Chassis frame are broadly classified into three types, namely:

1. Conventional Frame
2. Semi Integral Frame
3. Integral or Unit Frame

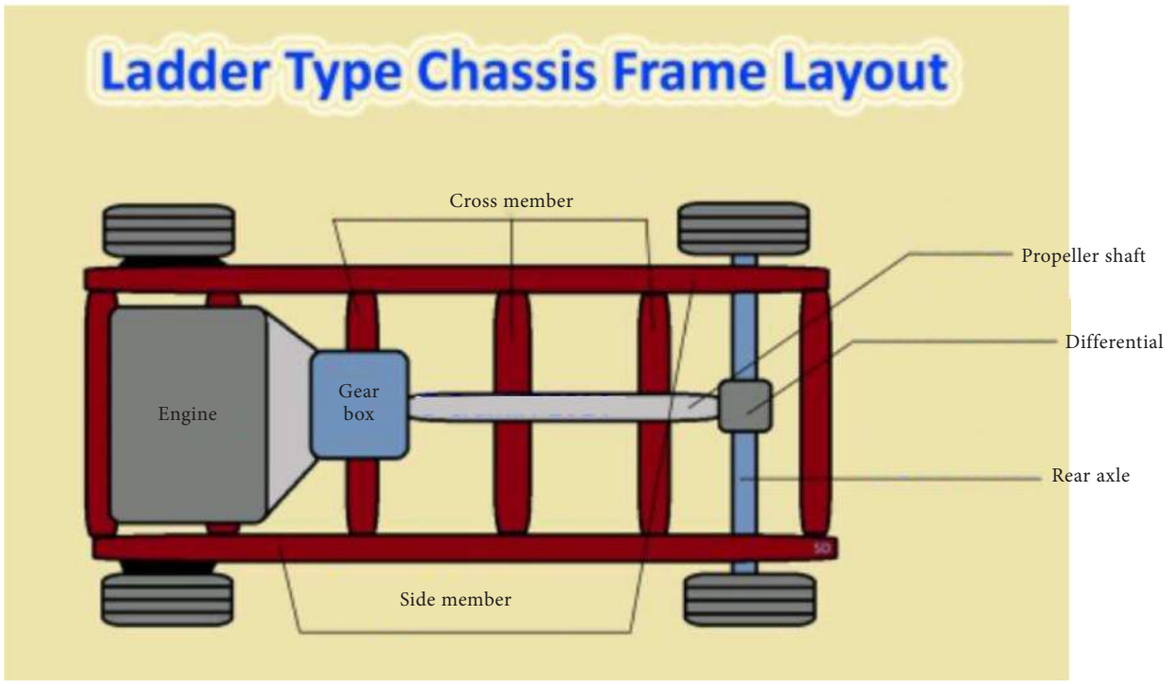
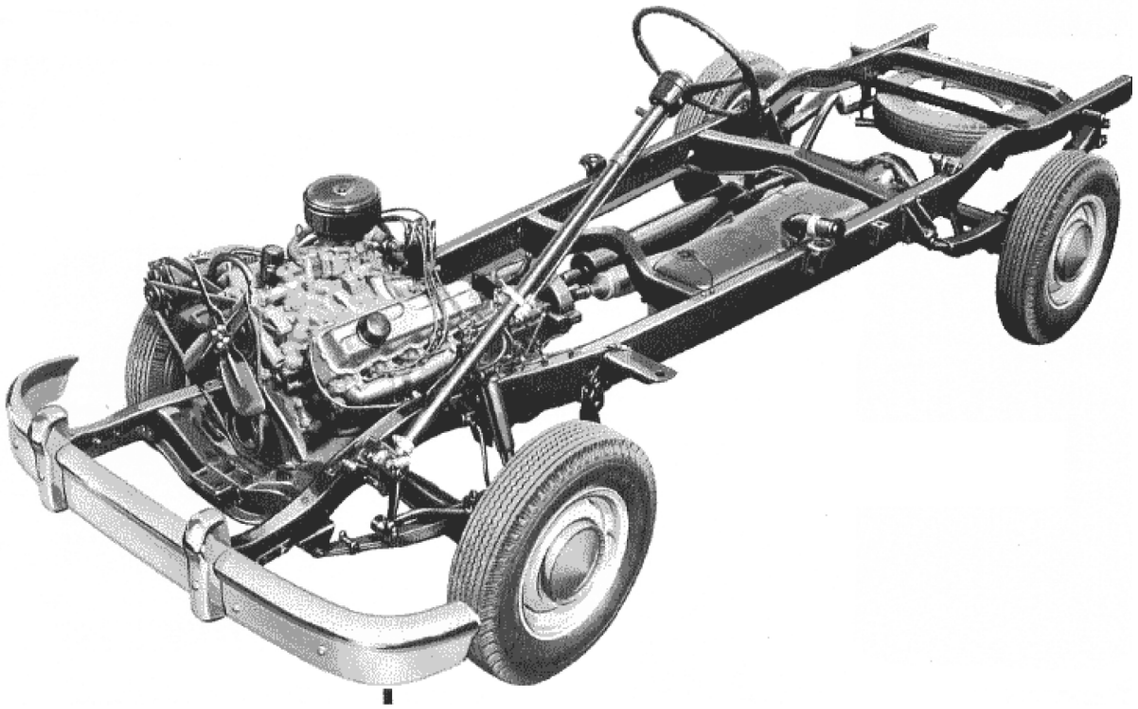
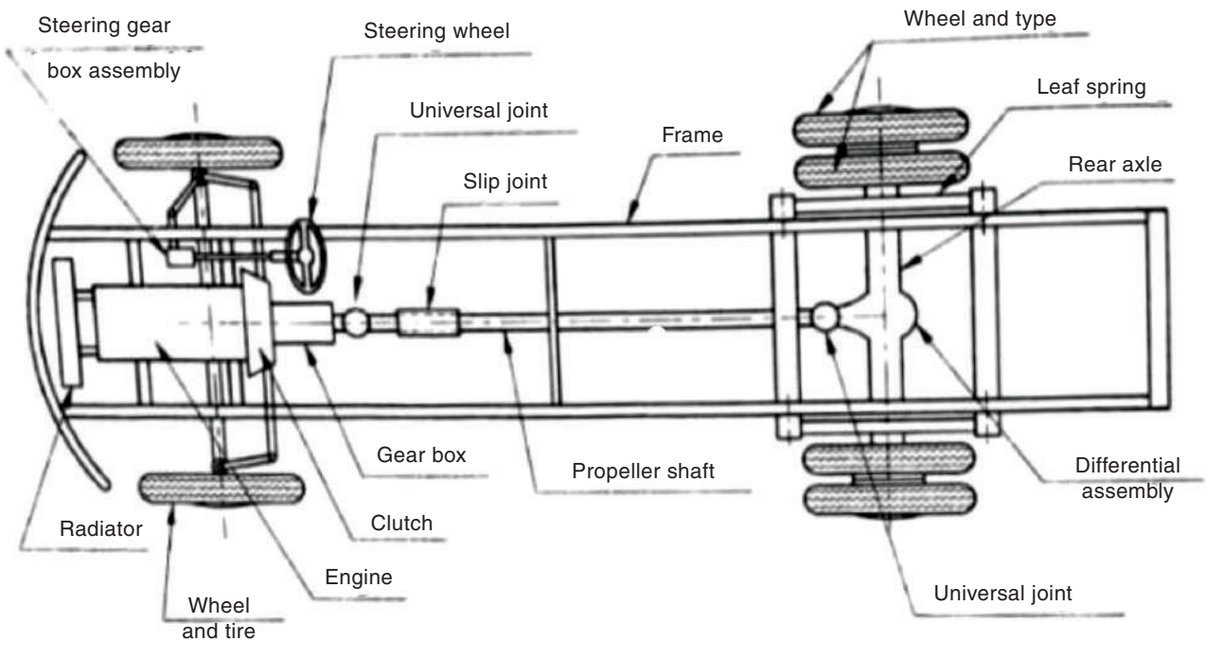


Figure 9.1 Ladder type chassis frame

9.1.2.1 Conventional Frame

Here the various components are attached to frame and the vehicle body are superimposed on it. The total frame is mounted on the wheel axle by means of springs. This arrangement makes the body completely isolated from the frame deflection. It is mostly used in heavy vehicles like buses, trucks etc.





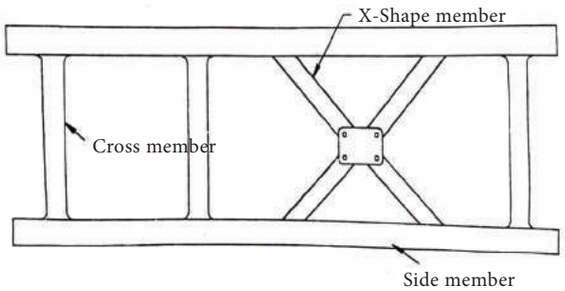


Figure 9.1.2.1 Conventional frame

9.1.2.2 Semi Integral Frame

This type of frames is made up of two or three sections and then it is integrated. The particular portion of the frame can be replaced if any damaged happens during accident instead of replacing the entire frame.

Figure 9.1.2.2 Semi integral frame

9.1.2.3 Integral Frame

In this type of construction, there is no separate frame. All the assembly units are attached to the body. Heavy side members of the frames are eliminated and cross members are combined with the floor of the body. The body of the vehicle gives a mounting for engine, transmission, suspension and other mechanical units. Weight of the vehicle is very much reduced and widely used in cars.

Figure 9.1.2.3 (a) Integral frame

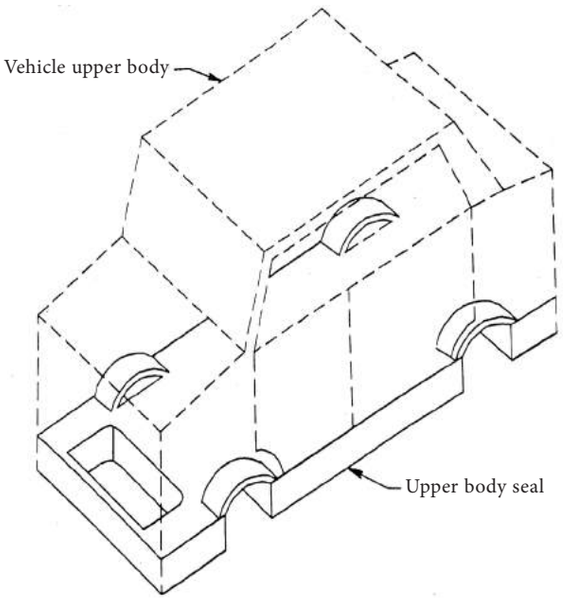


Figure 9.1.2.3 (b) Integral frame

Figure 9.1.2.3 (c) Integral frame

9.1.3 Various loads acting on the frame

1. Vertical loads when the vehicle comes across a bump or pit and road undulation
2. Engine torque and braking torque
3. Loads due to road camber, side wind, cornering force, Centrifugal force while taking a turn.
4. Aerodynamic forces at considerable speed
5. Weight of different components like engine, transmission, passengers, fuel tank, seats, exhaust acting at mounting points
6. Sudden impact loads during a collision

9.2 Chassis

In an automobile, all the subsystems excluding the body is called as Chassis.

9.2.1 Construction of the chassis

The layout of various subsystems is shown in the figure.

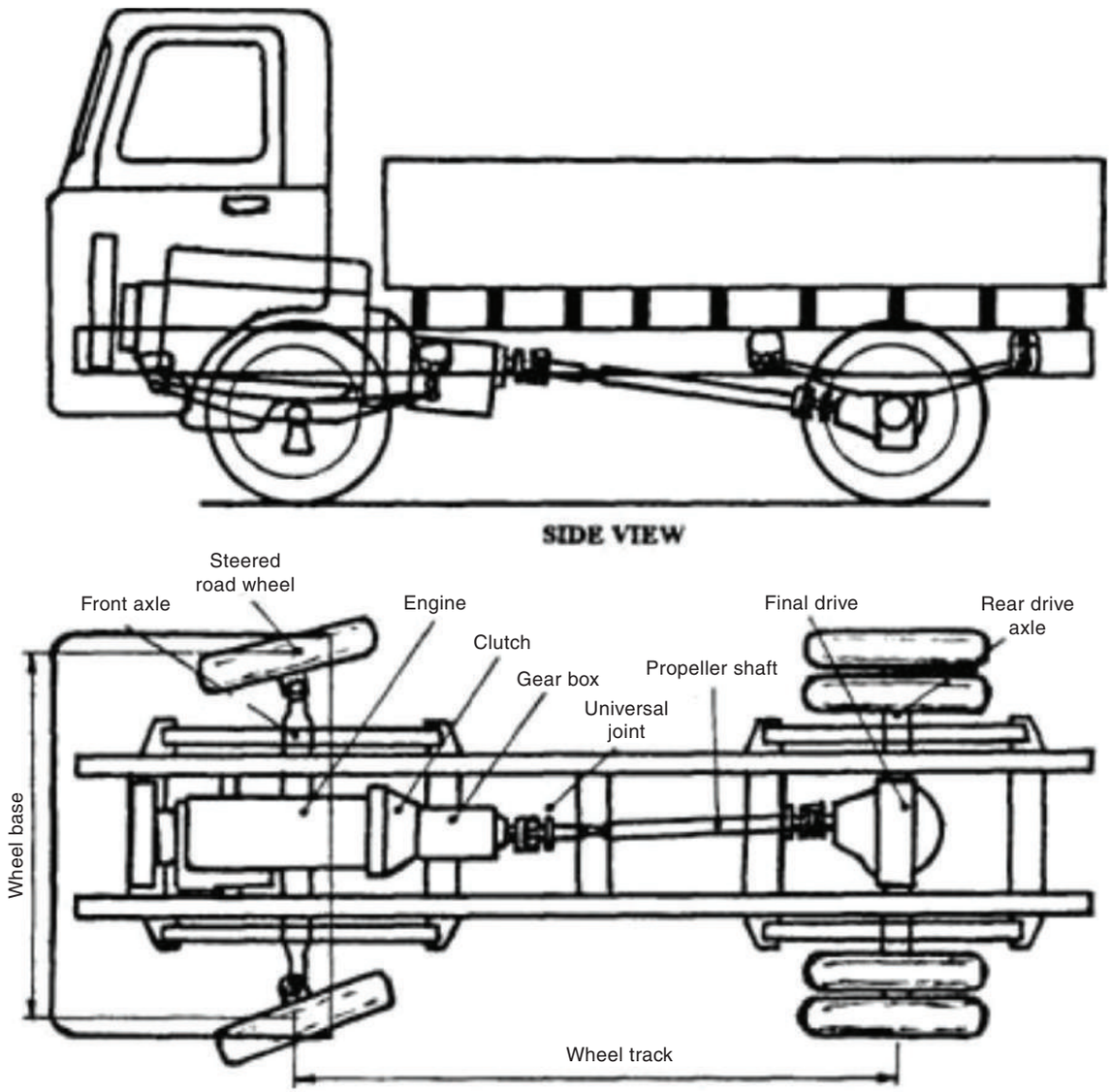


Figure 9.2.1 (a) Construction of the Chassis

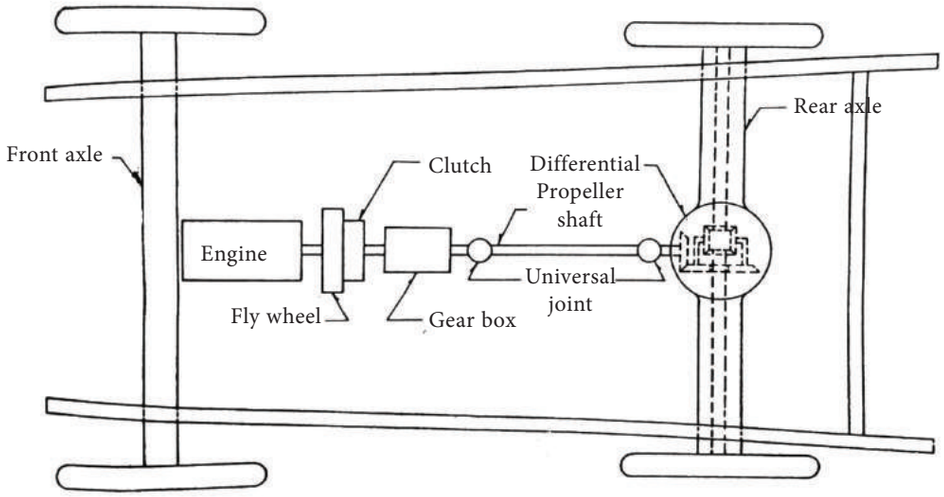


Figure 9.2.1 (b) Construction of the Chassis

In the present manufacturing of the vehicle, the body is separately fabricated and it is mounted over the chassis. The importance subsystems that are connected in the chassis frame includes engine, clutch assembly, gear box, suspension system, wheels and tires, steering system, brake, fuel tank, electrical system etc.

9.2.2 Parts mounted on the chassis frame

1. Chassis frame

Chassis frame is fixed with two longitudinal bars and four or five cross bars by rivet or bolts. Quality alloy steel is used to withstand the total weight of the vehicle. It is considered as the backbone of the vehicle.

2. Engine

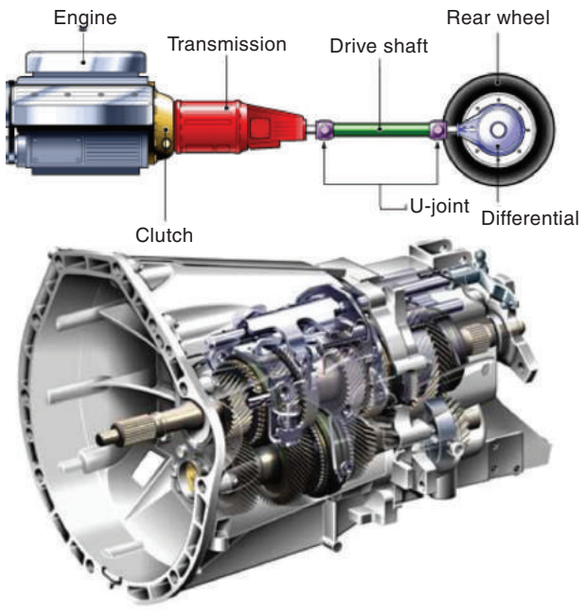
The driving power of the vehicle is provided by the engine. It converts the chemical energy in the fuel into mechanical energy to propel the vehicle. The engine power is transmits to road wheel through clutch, gear box and rear axle.

3. Clutch

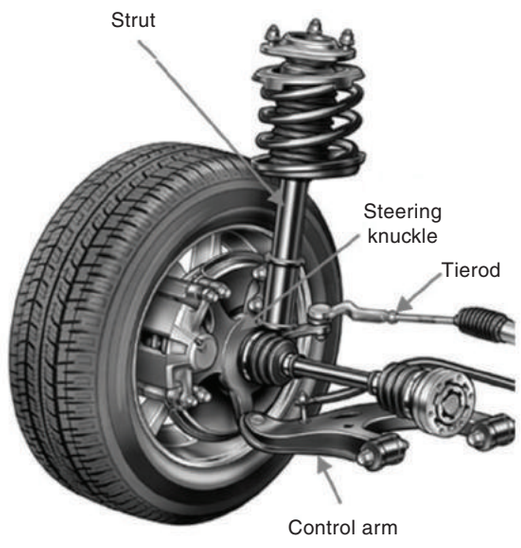
The main function of the clutch is to take up the drive smoothly from the engine and to release or disengage whenever desired. It is fixed in between engine and gear box. To avoid broken of gears in the gear box.

4. Gearbox

According to operating conditions, to provide the necessary torque variation from the engine to the drive wheels, gear box is used. Also, to reverse the direction of the vehicle whenever required.



5. Suspension system



Suspension system is used to prevent the road shock and to enhance ride comfort to the passenger and to the various vehicle components. They also preserve vehicle stability under various road conditions. It is fixed in between axle and chassis frame.

6. Brake system

Brake systems are used to stop the vehicle, or to reduce the vehicle speed, and to prevent rolling of the vehicle when travelling on inclined surface. Brakes are fixed in each four wheels. Its functions by using mechanical linkage, hydraulic power and air.

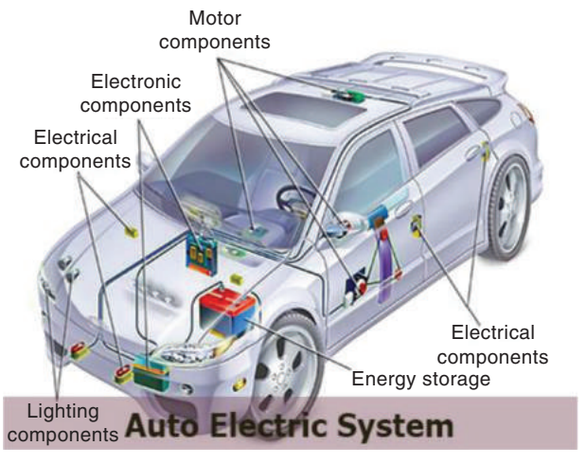
7. Steering system

Steering system is used to change the direction of the vehicle as desired by the driver. The steering systems helps in reducing the drivers work through mechanical advantage, to control the vehicle according to road condition and speed.

8. Electrical system

Electrical system includes ignition system lighting system, starting system,

charging system and other electrical accessories. Electrical energy for all the system is provided by the battery. Battery is known as heart of the electrical system.



9.2.3 Materials Used for the Chassis Frame

Frame should be extremely rigid and strong so that it can withstand shocks, twist, stresses and vibrations when vehicle is moving on road. The chassis frame should be made from high strength materials. The following materials are widely used for the manufacture of the chassis frame.

1. Mild sheet Steel
2. Carbon sheet Steel
3. Sheet Nickel Alloy

The chemical composition of nickel alloy steel is

Carbon – 0.25% - 0.35%

Manganese – 0.35% - 0.75%

Silicon – 0.30%

Nickel – 3%

Phosphorus – 0.05%

Sulphur – 0.5%

9.3 Important dimensions of the vehicle

1. Wheel base

- Wheel base is the distance between the centres of the front and rear wheels.

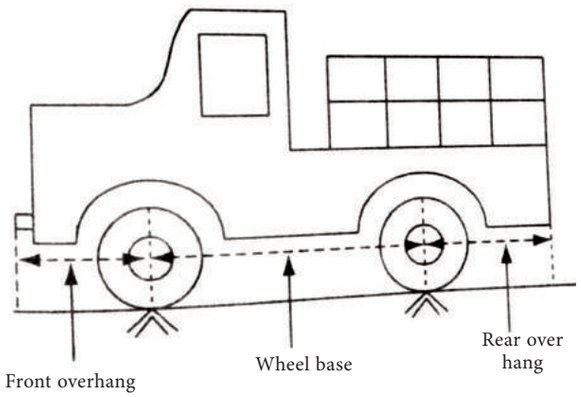
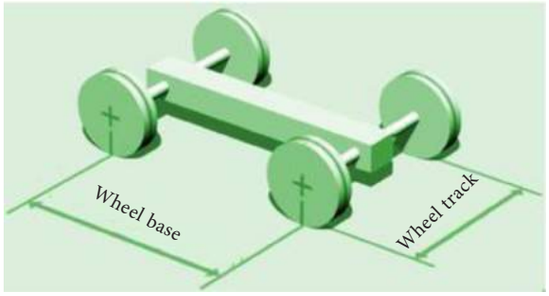


Figure 9.3.1 Wheel base

2. Wheel track



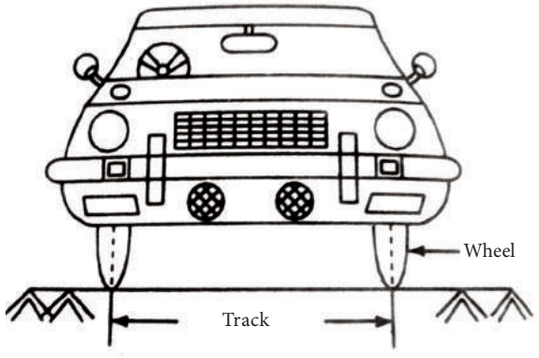


Figure 9.3.2 Wheel track

- Wheel track is the distance between both the front wheels or rear wheels measured from the centres of tyres.

3. Front over hang

Front over hang is the distance between the front bumper and centre of front axle.

4. Rear over hang

Rear over hang is the distance between the rear bumper and centre of rear axle.

5. Over all width

The distance between the two side members is called over all width.

6. Over all height

It is the amount of space between the ground surface to the upper side of the vehicle body is called over all height.

7. Over all length

The distance between the centre of front and rear bumper is called as over all length.

8. Ground Clearance

- Ground clearance is the amount of minimum space between the road surface and the underside of the chassis.

9.4 Body

Body is the superstructure for all vehicles. It may either constructed separately and bolted to the chassis or manufactured integral with the chassis.

- The chassis and body make the complete vehicle.
- A body consists of windows and doors, roof, luggage compartment, passenger seats etc.
- A body should be designed such that it will against the air resistance, gradient resistance and rolling resistance.

9.4.1 Functions of the vehicle body

1. Vehicle body protects the passengers and the goods from sunlight.
2. Prevent the dust from entering into the vehicle.
3. Protects the passenger from rainfall.

9.4.2 Requirements of the vehicle body

1. Weight of the body should be as minimum as possible.
2. It should have minimum number of components.
3. It should have reasonable fatigue life.

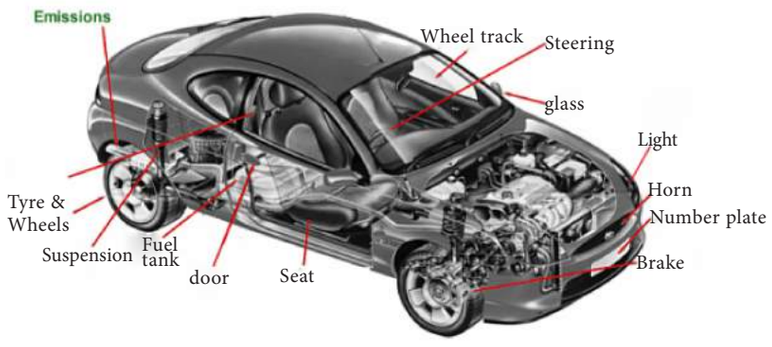


Figure 9.4 Body

4. It must provide adequate space for both the passenger and the luggage.
5. It should create minimum vibration during running.
6. Weight and stresses induced in the body should be distributed evenly to all portions.
7. It should be able to cope with impact loads of reasonable magnitude and safeguard the passengers during accidents.
8. The shape of the body should be such that the air resistance is minimum
9. It is easy to manufacture as weIl as cheap in cost.
10. It should be easy to maintenance.

9.4.3 Types of vehicle body

Vehicle bodies are classified into two types namely

1. Goods vehicle body
2. Passenger vehicle body.

9.4.3.1 Goods vehicle body

This type of vehicle bodies is used for transportation of goods. Based on the nature of the goods transported, Engine horsepower, load carrying capacity, the vehicle bodies are designed.

9.4.3.2 Passenger vehicle body

This type of vehicle bodies is used for transportation of passengers. Based on the number of passengers, level of luxury, engine horsepower, the vehicle body is designed.

The various types of vehicle bodies are shown in 9.4.3 table.

Passenger Transport

a. Small car bodies up to six seat capacity.
b. Medium car bodies up to ten seat capacities.
c. Mini bus Bodies.
d. Large bus body for common and Luxurious transport.
e. Railway coach bodies.
f. Three Wheeled Bodies

Vehicle body classifications

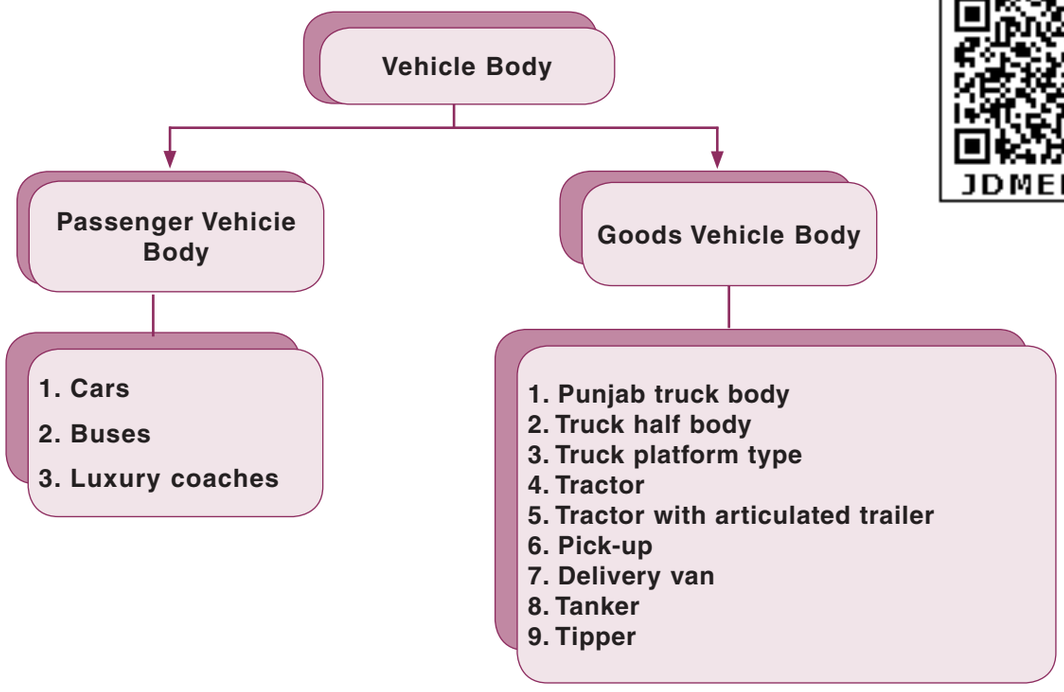


Table 9.4.3 Vehicle body classifications

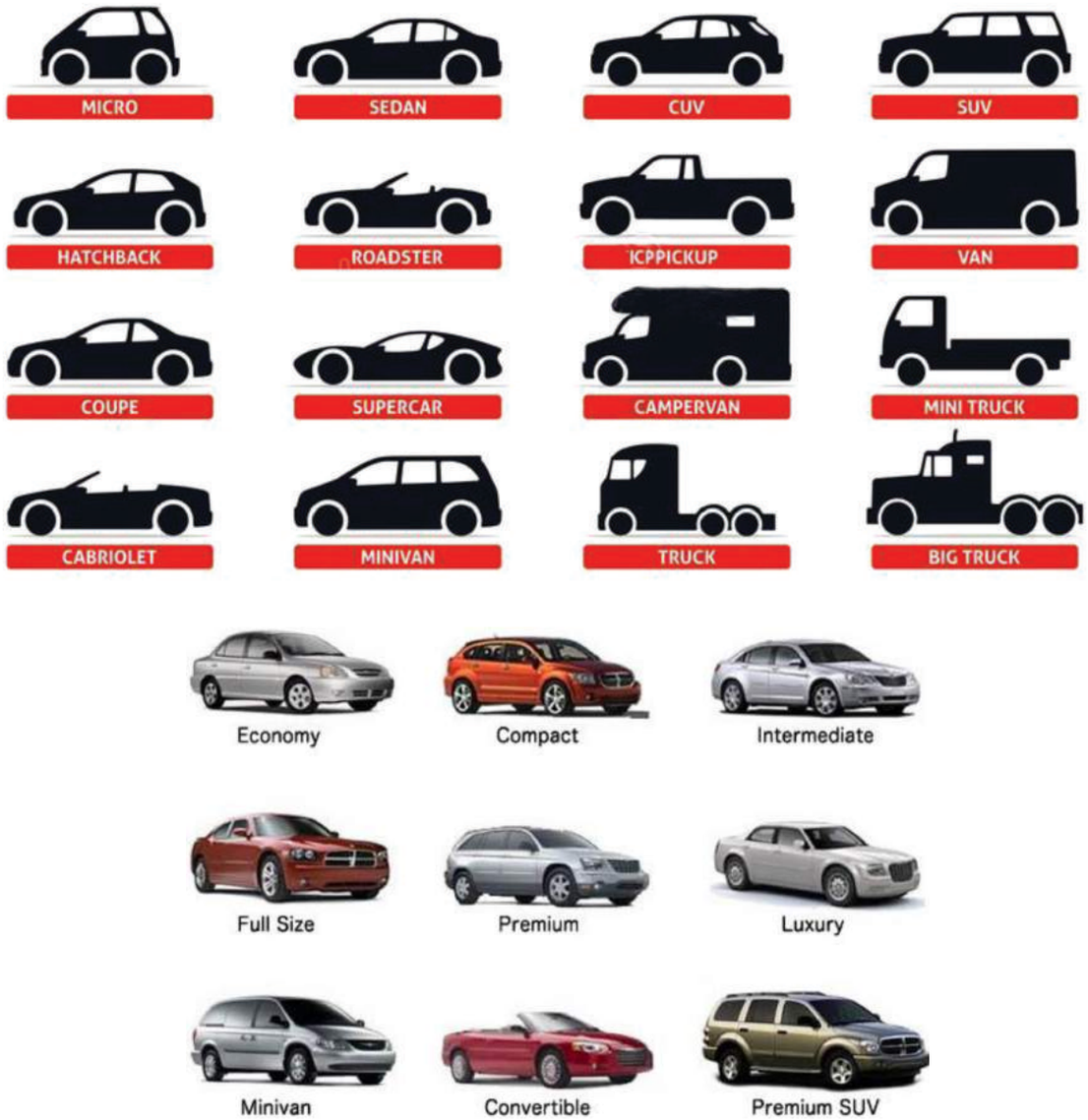


Figure Types of vehicle body

Vehicle type	Other names	Examples of cars in the category
Small car	Hatchback, micro-car, city cars, small family car	Toyota Carolla, Hyundai i10, Mazda2, Nissan Micra, Ford Fiesta
Medium car	Sedan, medium family car	Opel Astra, Ford Fiesta, Hyundai i20
Large car	Saloon, family car	Toyota Camry, Ford Falcon, Audi A6, Ford Mondeo
Sports car	Roadster	Honda CR-V, Mazda MX5, Audi TT
People Mover	Mini van	Toyota Tarago, Chrysler Voyager,
Compact SUV	Mini SUV, Mini 4x4	Hyundai i35, BMW X1, Skoda Yeti
Medium SUV	Large 4x4	Toyota RAV4, Ford Kuga, Mitsubushi Outlander, Jeep Wrangler, Audi Q3
Large SUV	Large 4x4	Toyota Land Cruiser, Mitsubishi Pajero, Hyundai Santa Fe, land Rover Range Rover

Goods Transport

a. Truck Bodies
b. Tanker Bodies
c. Minivan Bodies
d. Medium load Carrying vehicle
e. Heavy load carrying Bodies
f. Three wheeled Bodies.
g. Tipper bodies.

9.5 Tinkering and painting

9.5.1 Tinkering

Figure 9.5.1 Tinkering

Tinkering is performed to remove dents, scratches, chemical erosion, environmental erosion occurred on the exterior surface. This will improve the aesthetic appearance of the vehicle.

9.5.2 Tools used for tinkering

1. Gas and Arc welding unit
2. Alloy steel sheets
3. New chassis sub frame to be replaced
4. Sheet metal cutter
5. Spray painting gun
6. Required matching colour
7. Thinner
8. Emery sheet
9. Cleaning clothes
10. Patti and scrapper
11. Wood hammer (or) mallet

9.5.3 Painting

Painting on vehicle bodies are used for both surface protection from corrosion and decoration purposes.

Figure 9.5.3 Painting

Steps followed in painting

1. Preparation
2. Primer
3. Base coat
4. Clear coat
5. Polishing

- Wash the area to be painted with plain water and soap and scrub off any deposits with a micro fibre cloth. Allow the surface to be dried.
- Remove badges, trims, door handles, side-indicator lamps, headlights, windscreen etc that will hinder the paint job using right tools.
- Remove the dents using wooden hammer.
- Finish doing the dent work for the area to be painted. Use emery sheet to clean any rust on the area to be painted. If any new metal is welded, then ground the weld seam. Treat rusted areas with corrosion protection spray (optional).
- Fill in small imperfections with body filler, and sand back the surface with smooth grades of emery paper, until the surface is smoothed out.
- Mask the surrounding area with Brown paper.
- Degrease the surface to be painted using a degreaser and wipe the surface free of dust.
- Apply the primer and allow it to dry.
- Apply 2 - 3 base coat with the required matched colour evenly on the surface using spray gun. Ensure complete dryness between each coat.
- Apply the 1 – 2 clear coat to form a glossy and transparent coating and allow it to dry.
- Polish the painted surface.
- Inspect for any paint run and gently remove these with thinner.
- Finally remove all masking from the car.
- Then wash it thoroughly and wax when dry.

9.5.4 Precautions to be followed during tinkering and painting

1. Before tinkering, the vehicle must be raised to the required height by jack and firmly parked.
2. Axles and wheels in the vehicle should be removed
3. Remove the fuel tank, lubrication oil sump and other fluids in the vehicle.
4. All electricity circuits must be securely grounded.
5. Clean the vehicle with compressed air
6. Grease and Wax sticking on the vehicle surface should be cleaned using degreaser
7. The area to be painted should be washed and dried thoroughly.

உங்களுக்குத் தெரியுமா?

- It takes 15 ml of gasoline to start the average vehicle.

- It takes about 25 hours to build a car, a whopping 10 hours of that 25 is spent painting the car.

Student Activity

1. Students are advised to submit a report based on the visit at automobile body building shop on various chassis subsystems.
2. Students are advised to submit a report based on the visit at automobile body building shop on mounting body over the chassis frame and various mounting methods.

Glossary

1.	Chassis Frame	-	அடிச்சட்டம்
2.	Chassis	-	அடித்தளம்
3.	Body	-	மேற்கூடு
4.	Integral	-	ஒருங்கினைந்த
5.	Static Load	-	நிலைப்பளு
6.	Construction	-	கட்டுமானம்
7.	Wheel base	-	இருசு இடைத்தூரம்
8.	Resistance	-	தடை
9.	Gradient	-	சரிவு
10.	Immerse	-	மூழ்குவி

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Evaluation

WA99GV

PART - A

One mark questions

Choose the correct answer

1. The metal used for manufacturing of chassis frame is _____
   a. Alloy steel
   b. Rubber
   c. Asbestos
   d. Wood powder

2. Chassis frames are classified into _____ types
   a. 2
   b. 3
   c. 4
   d. 5

3. In heavy vehicles, _____ type of chassis frame is used.
   a. Conventional frame
   b. Semi – integral frame
   c. Integral frame
   d. None of the above

4. An automobile without body is called as
   a. Frame
   b. Clutch
   c. Body
   d. Chassis

5. The distance between the two front wheels is called as
   a. Wheel base
   b. Wheel track
   c. Ground clearance
   d. Overall width

6. The vehicle part which prevent the passenger from sunlight, rain, dust is known as
   a. Frame
   b. Windshield wiper
   c. Body
   d. Transmission system

7. The backbone of the automobile is _____
   a. Chassis frame
   b. Body
   c. Engine
   d. Differential

8. The chassis in which the body and the frame are acting as a single unit is known as
   a. Conventional frame
   b. Semi – integral frame
   c. Integral frame
   d. Chassis frame

9. The complete vehicle is obtained when _____ is integrated with the chassis frame.
   a. Windshield wiper
   b. Differential
   c. Body
   d. Electrical accessories

10. Generally, vehicle bodies are classified into _____ types.
    a. 2 b. 3
    c. 4 d. 5

Part – B

Three mark questions

1. Classify the types of Chassis Frame.
2. What do you mean by Chassis?
3. List any three parts that are mounted on the chassis.
4. List out the materials that are used to manufacture the chassis frame.
5. Define wheelbase.
6. State the functions of vehicle body.
7. What is painting process?

Part –C

Five mark questions

1. Highlight the functions of chassis frame.
2. Draw the chassis frame with indicate the parts
3. Explain the vehicle body and list out the functions.
4. Explain the various parts that are connected to the chassis frame?

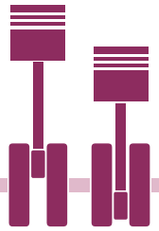
Part – D

Ten mark questions

1. Indicate the various loads that are acting on a Chassis Frame.
2. List out the requirements of a vehicle body.
3. Briefly explain about important dimensions of a vehicle.

UNIT 10

Electrical System



Contents

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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.

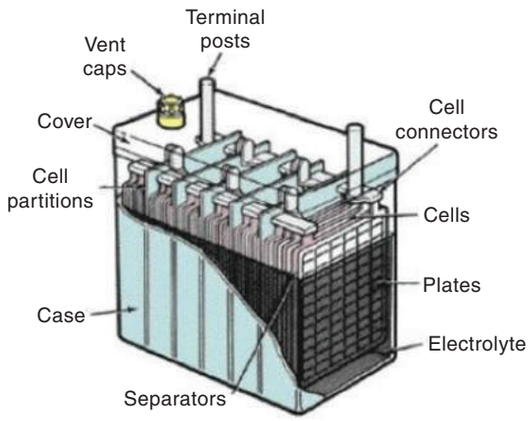
1. Starting System
2. Ignition System
3. Lighting System
4. Generation, Storage and Distribution System
5. Accessories

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

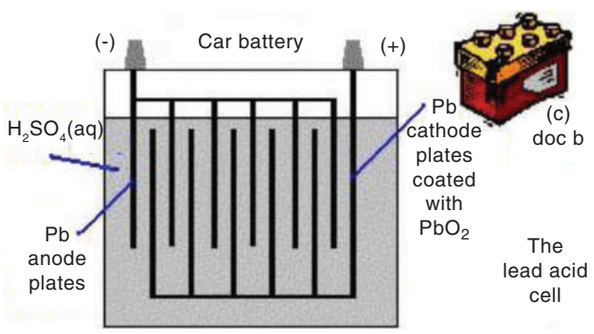
Cellcover is used to cover the complete cell. It protects the cell from the dust as well as other external impurities. Vent holes are provided to exhaust the gases generated in the cell to the atmosphere. Filler openings are available to fill up the electrolyte.

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 beginning 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

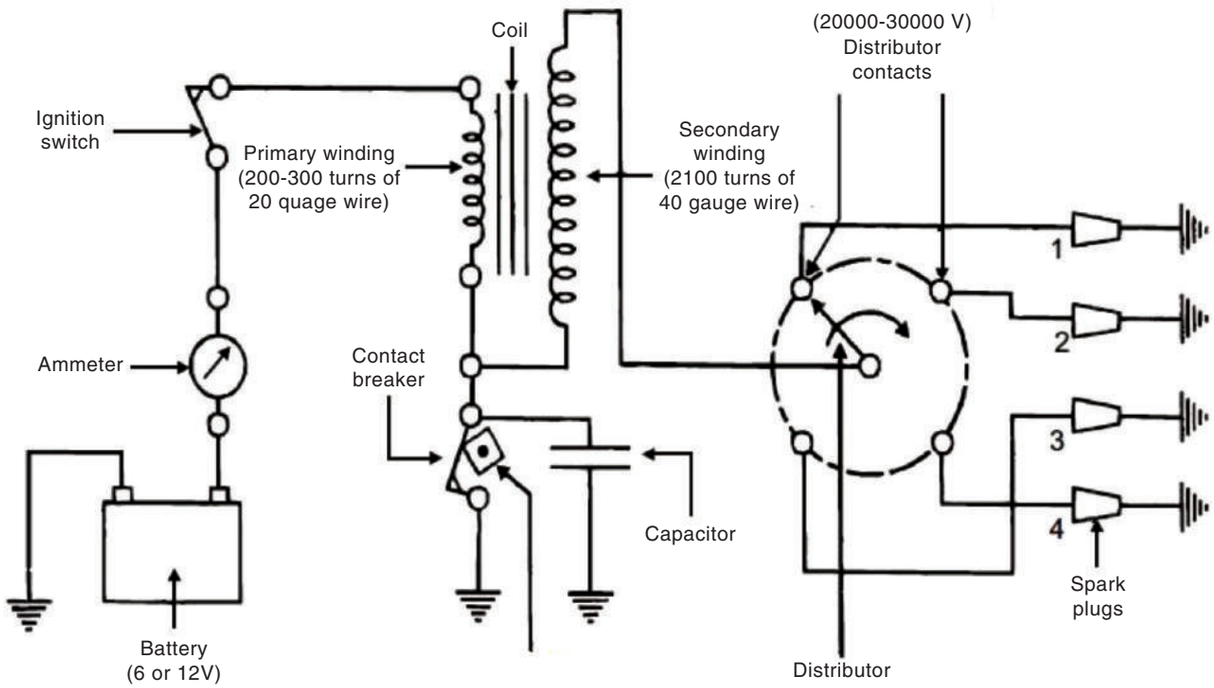


Figure 10.2.1.1 (a) Battery coil ignition system

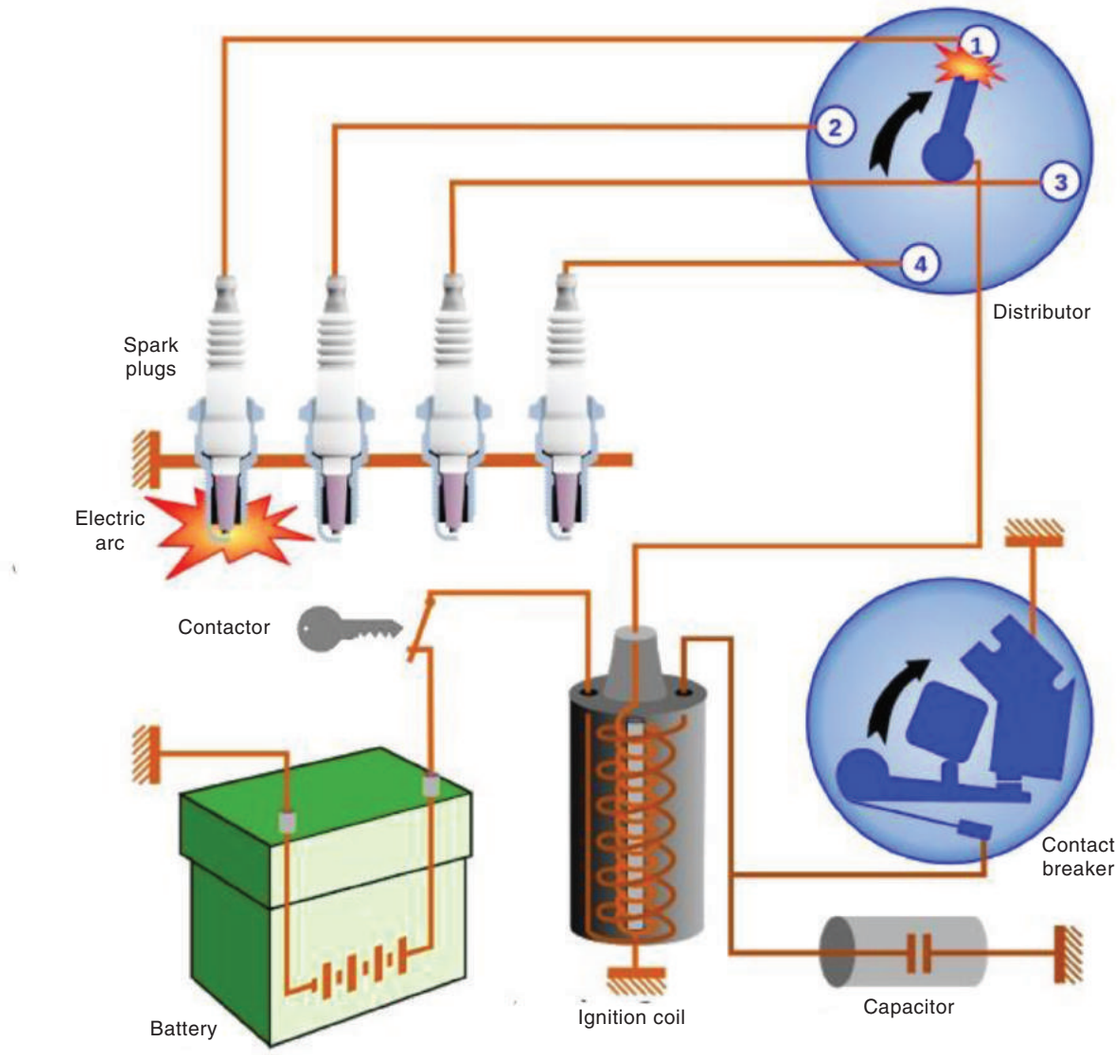


Figure 10.2.1.1 (b) Battery coil ignition system

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.

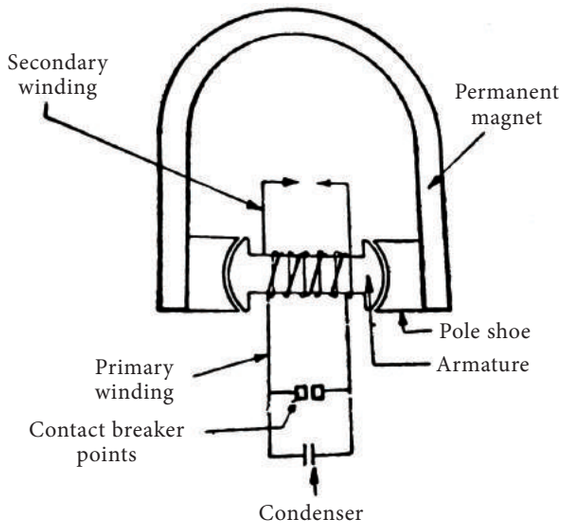


Figure 10.2.1.2 (a) Rotating armature type magnet ignition

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

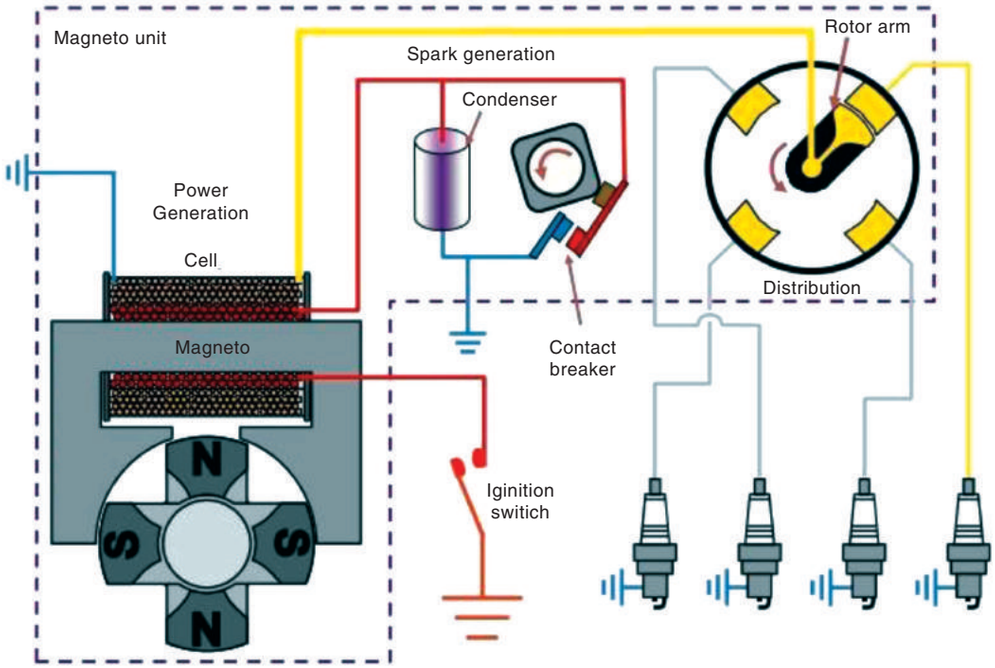


Figure 10.2.1.2 (a) Rotating armature type magento system

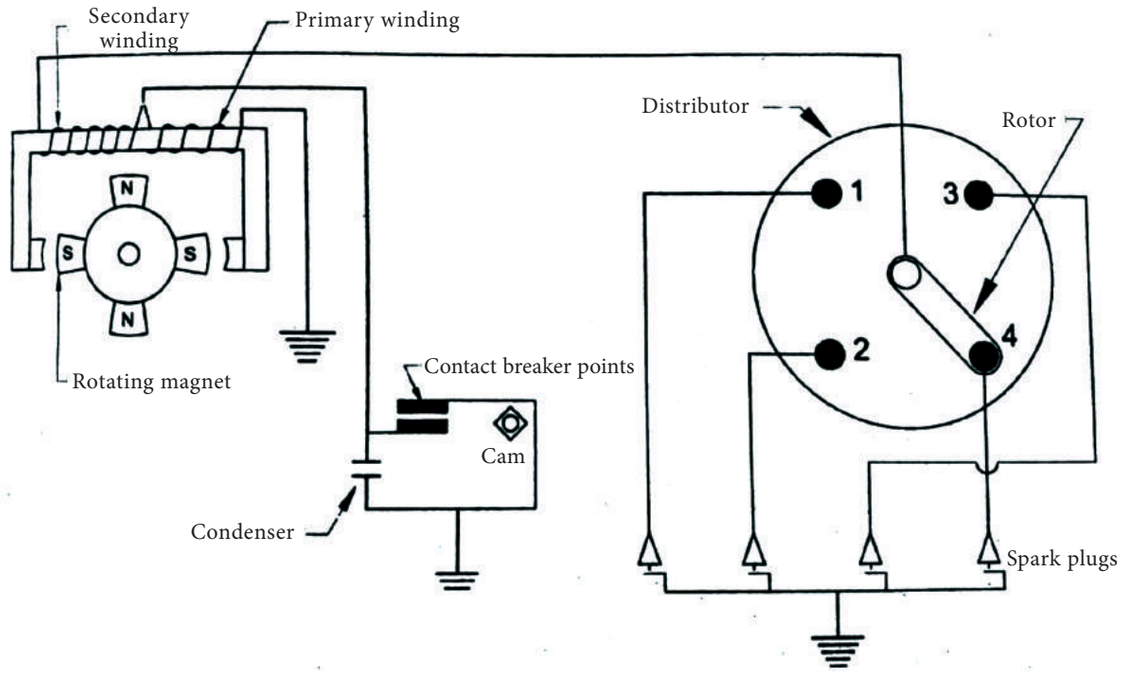


Figure 10.2.1.2 (b) Rotating magnet type magneto ignition system

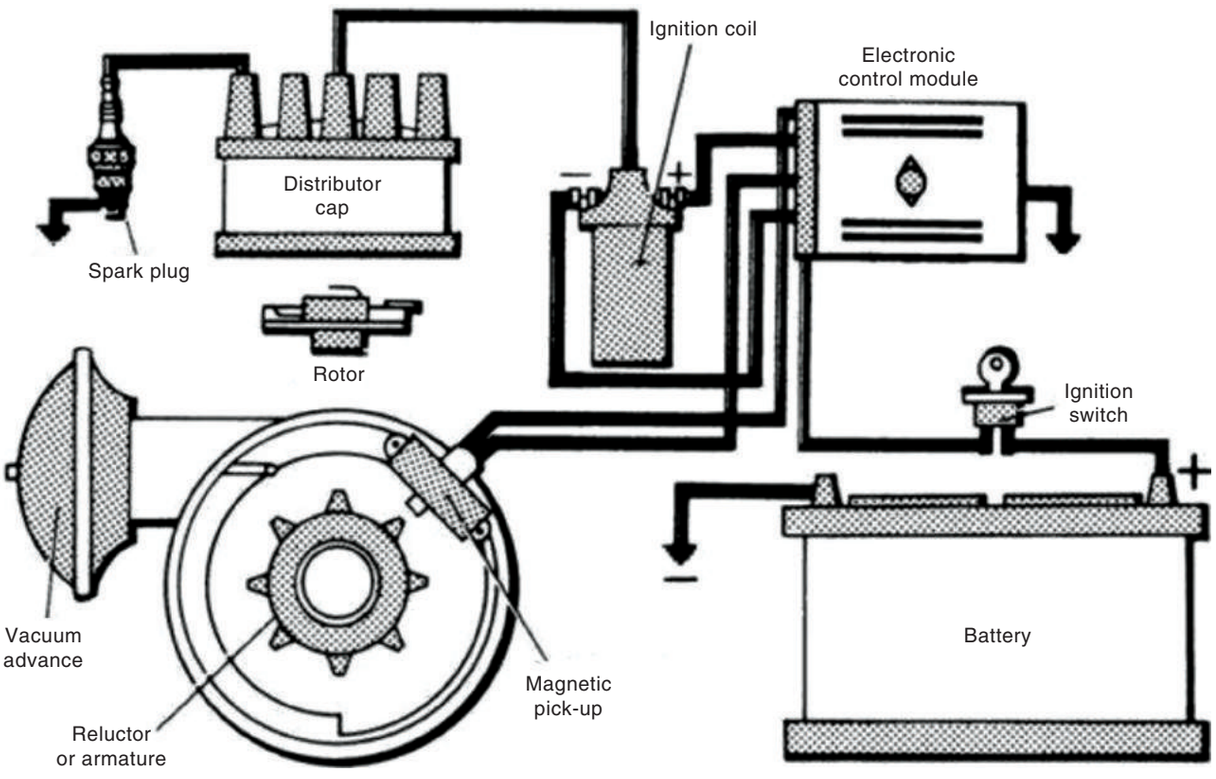


Figure 10.2.1.3 (c) Electronic ignition system

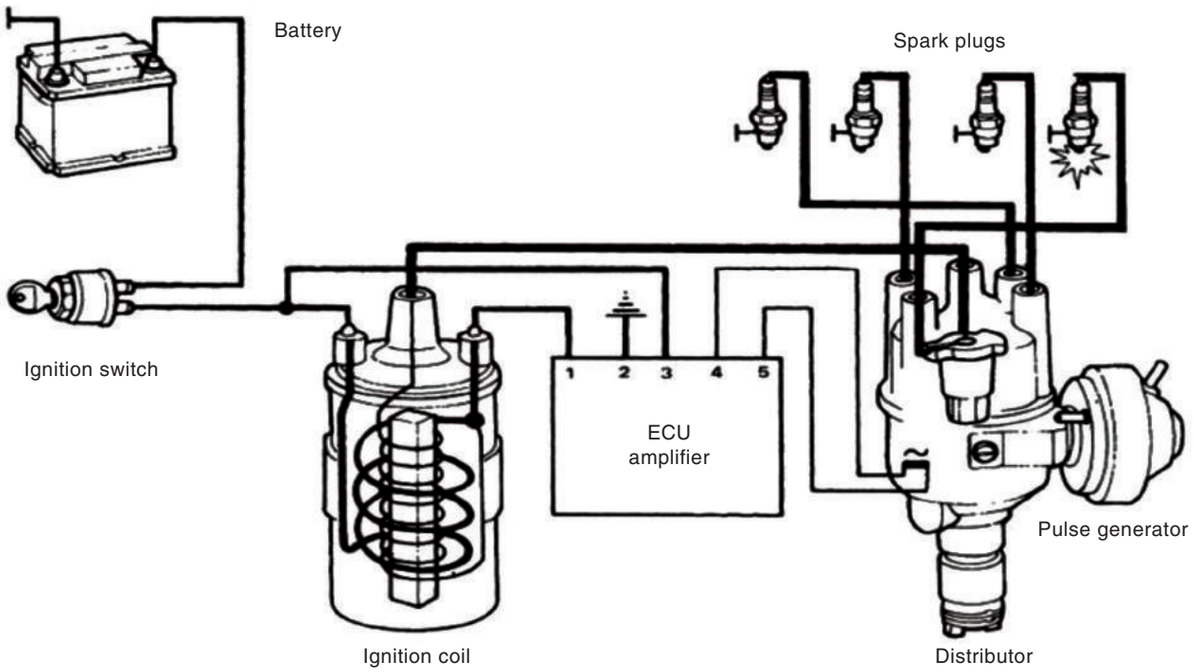


Figure 10.2.1.3 (b) Electronic ignition system

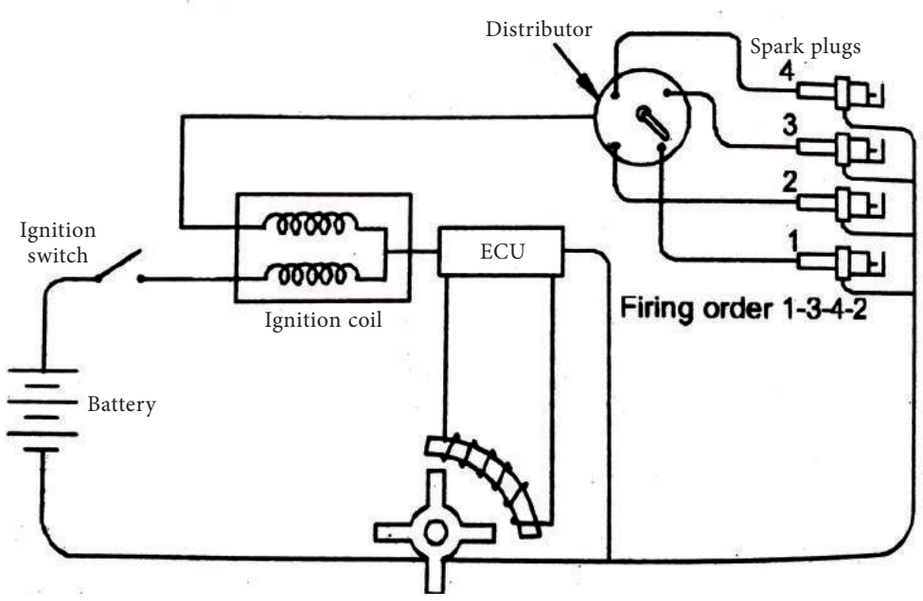


Figure 10.2.1.3 (c) Electronic ignition system

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

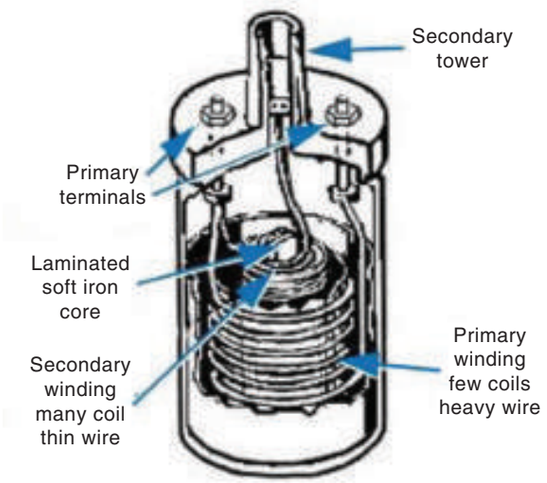


Figure 10.3 (a) Ignition coil

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.

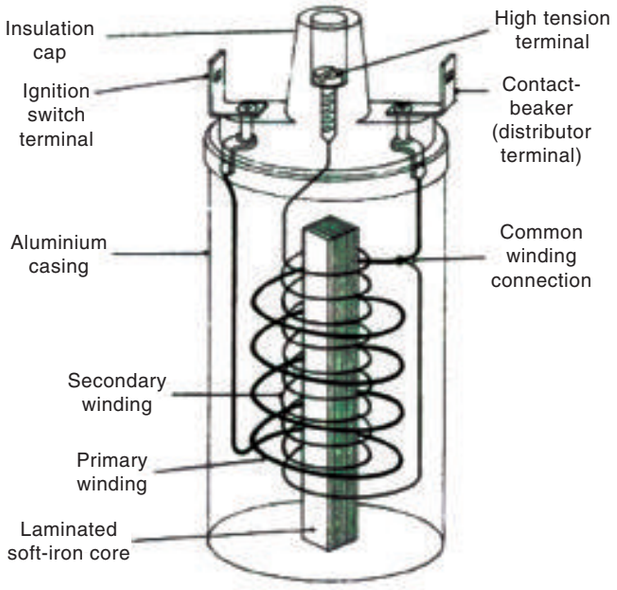


Figure 10.3 (b) Ignition coil

Types of Ignition coil

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

10.4 Spark plug

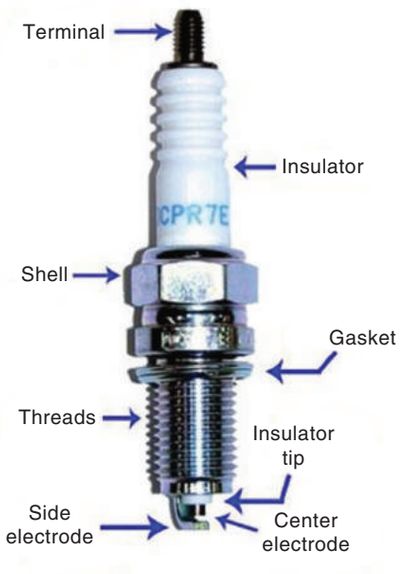


Figure 10.4 (a) Spark plug

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.

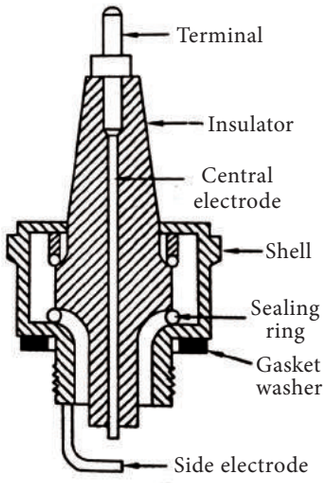


Figure 10.4 (b) Spark plug

10.4.1 Types of spark plug

1. Hot spark plug
2. Cold spark plug

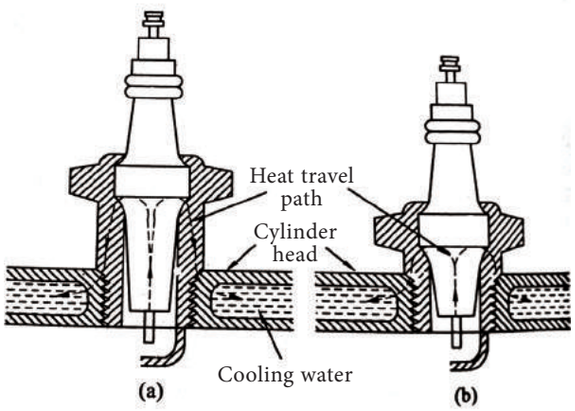


Figure 10.4.1 (a) Types of spark plug

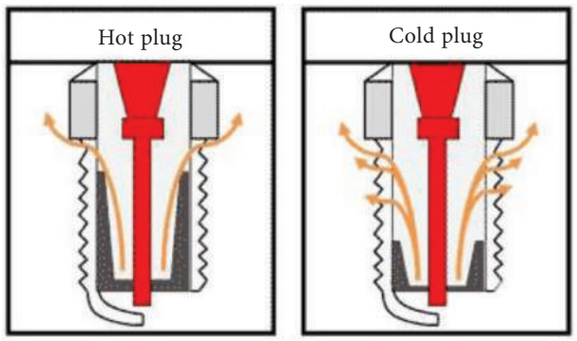


Figure 10.4.1 (b) Types of spark plug

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 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 (expect 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.

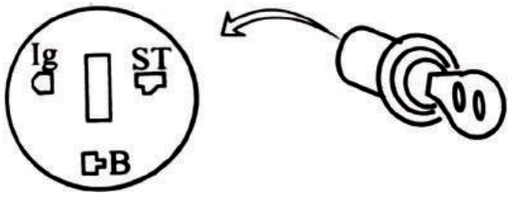


Figure 10.4.2 Ignition Switch

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 arcing 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 thesparkplug in the cylinder that is ready to fire.

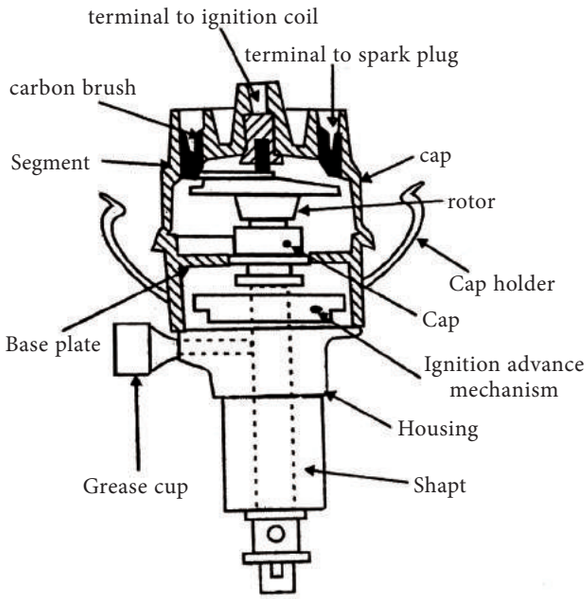


Figure 10.6 (a) Distributor

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 lessair-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.

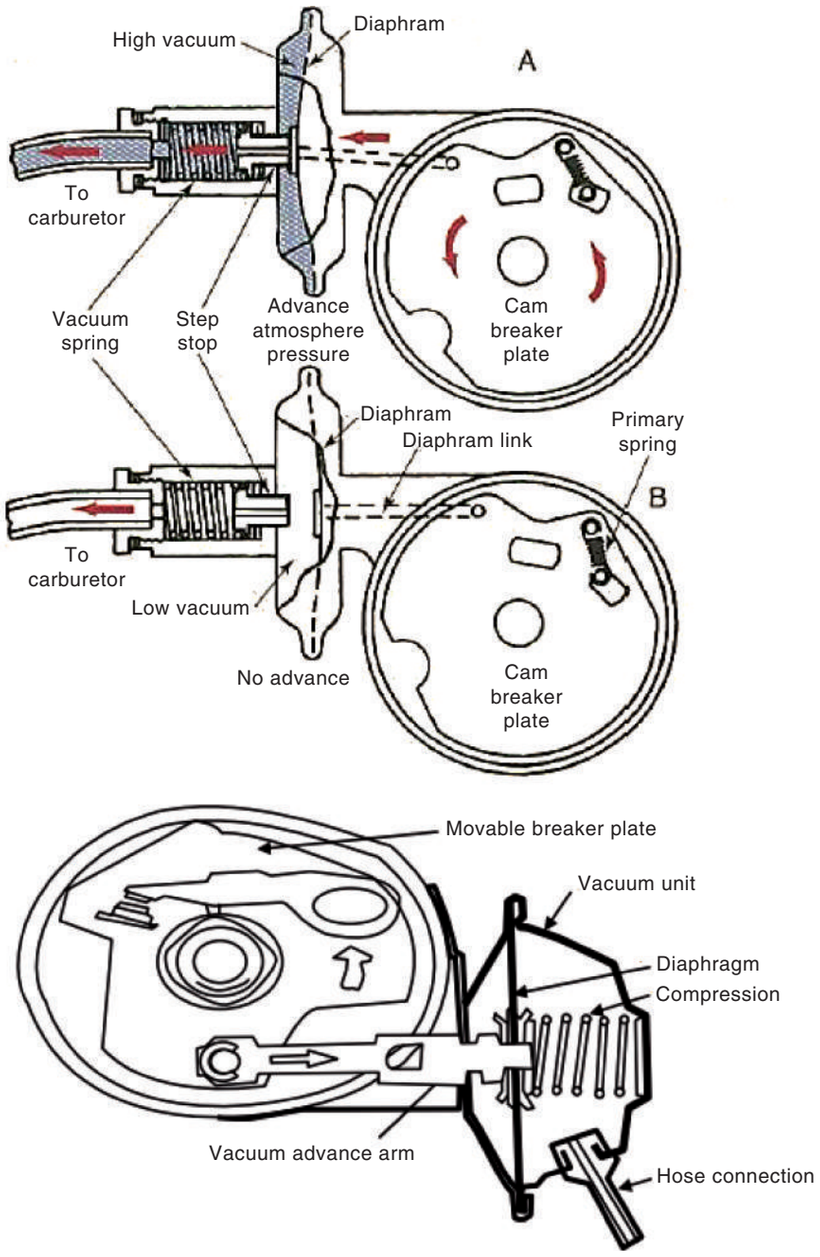


Figure 10.7 (a) Vacuum advance system

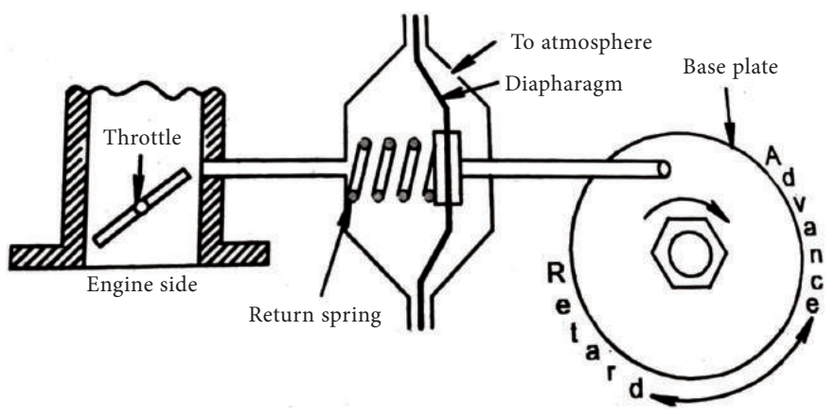
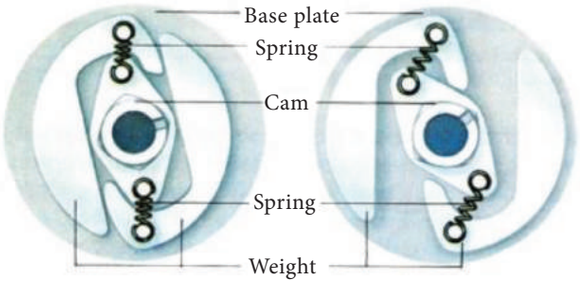
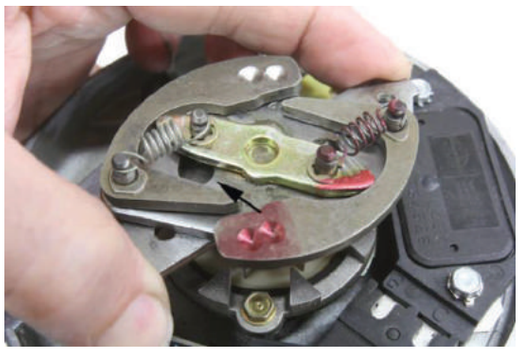


Figure 10.7 (b) Vacuum advance system





உங்களுக்குத் தெரியுமா?

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

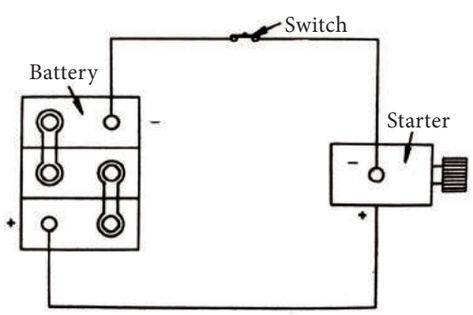


Figure 10.8 Engine starting circuit

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.

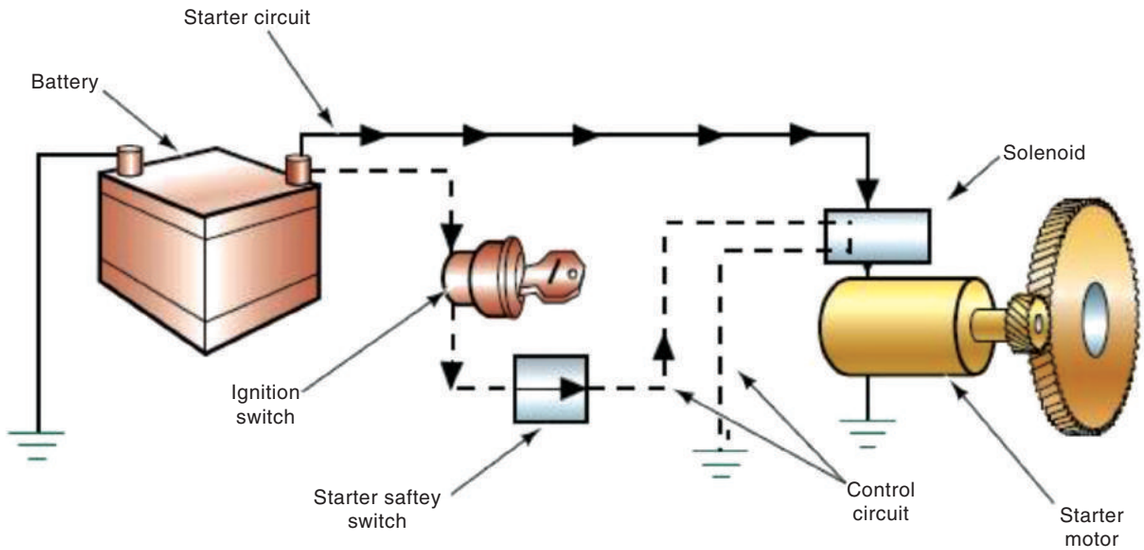


Figure 10.8 Engine starting system

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

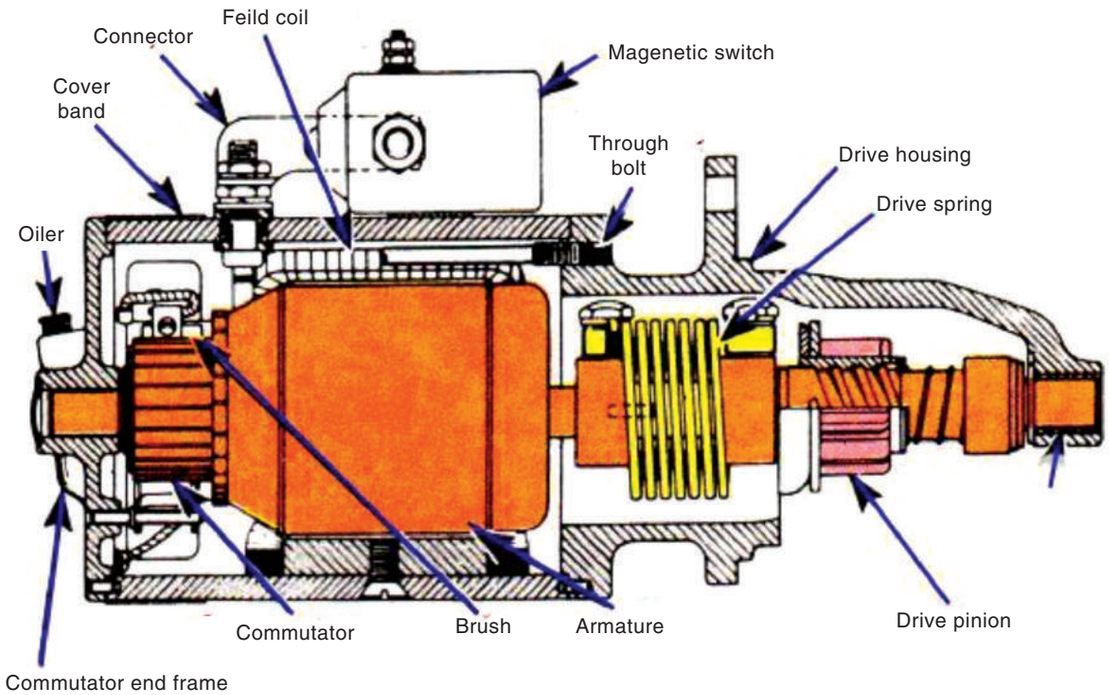
10.8.1.1 Bendix drive starting system

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 wear and start the engine. As the engine speed increases, the pinion retracts and go away from the engine flywheel.



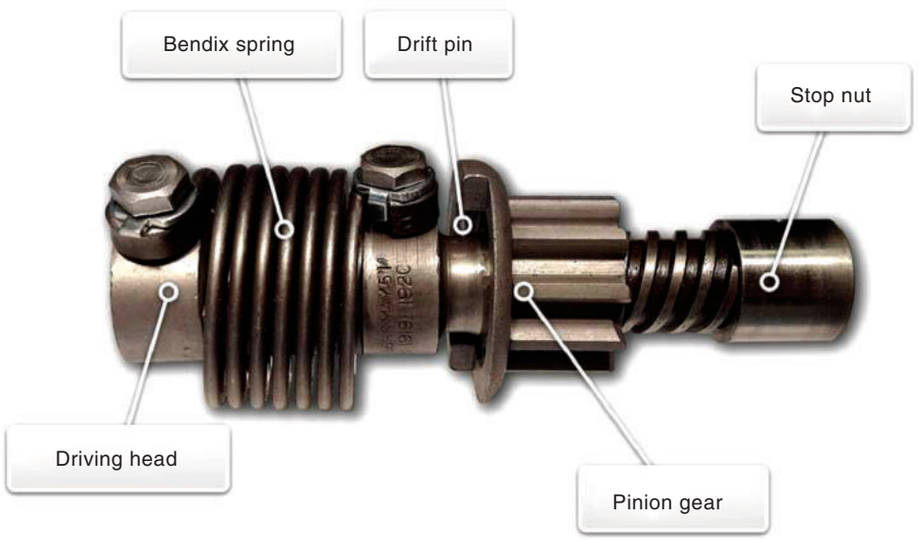
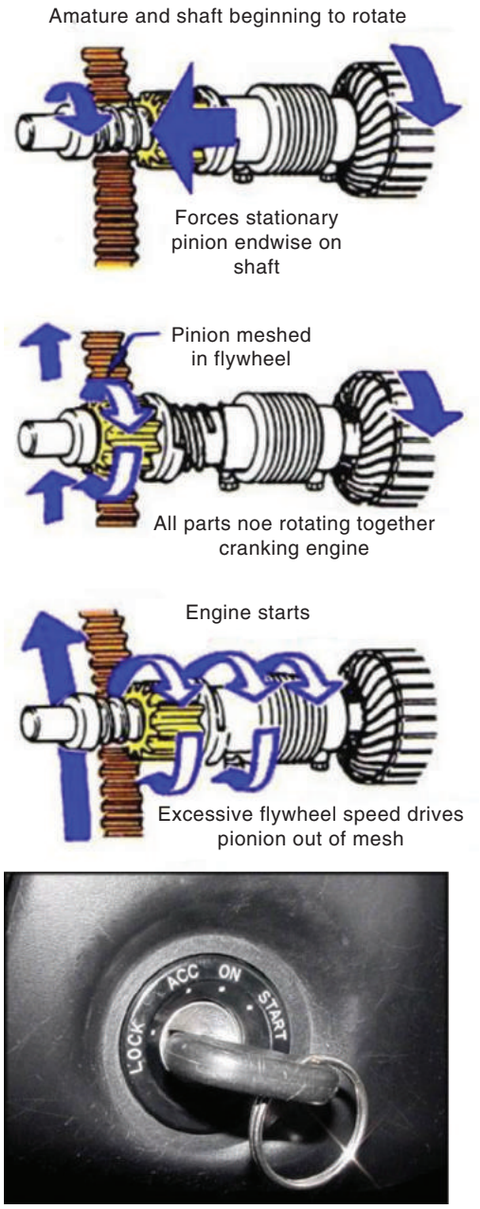


Figure 10.8.1.1 (a) Bendix drive starting system

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

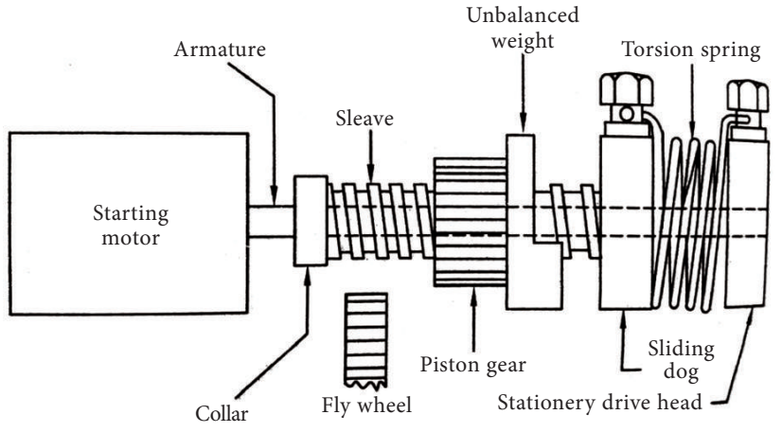
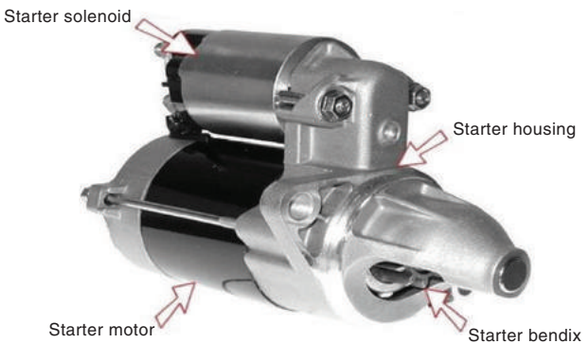


Figure 10.8.1.1 (b) Bendix drive starting system



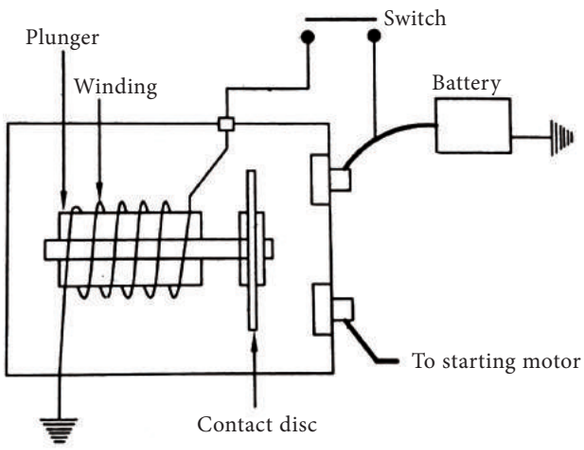


Figure 10.8.2 Starting Switch

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

N7KFYY

உங்களுக்குத் தெரியுமா?

- 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.

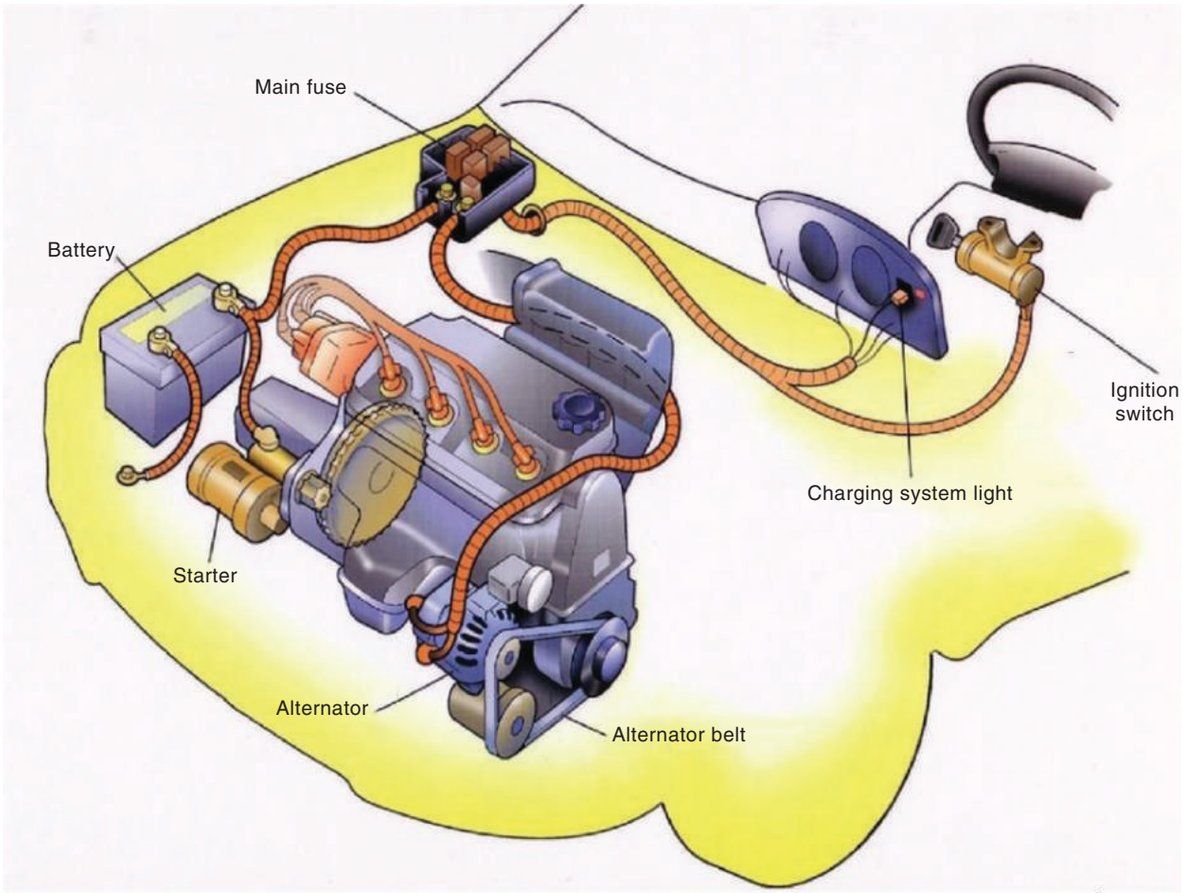


Figure 10.9 (a) Changing system

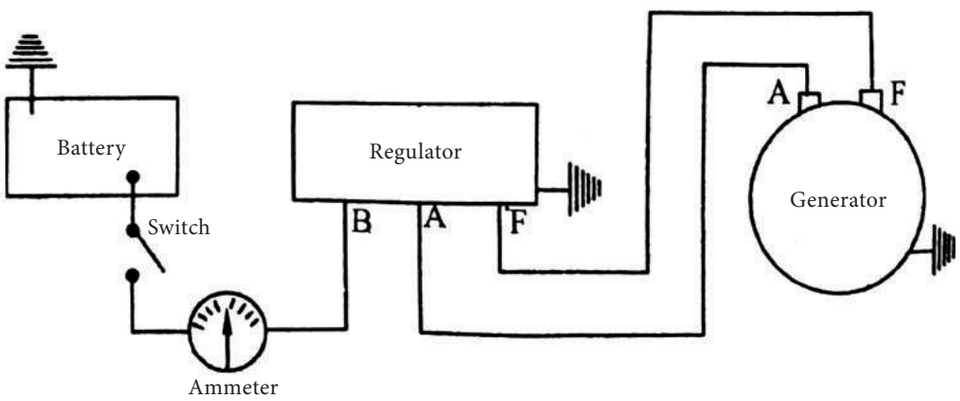


Figure 10.9 (b) Charging system

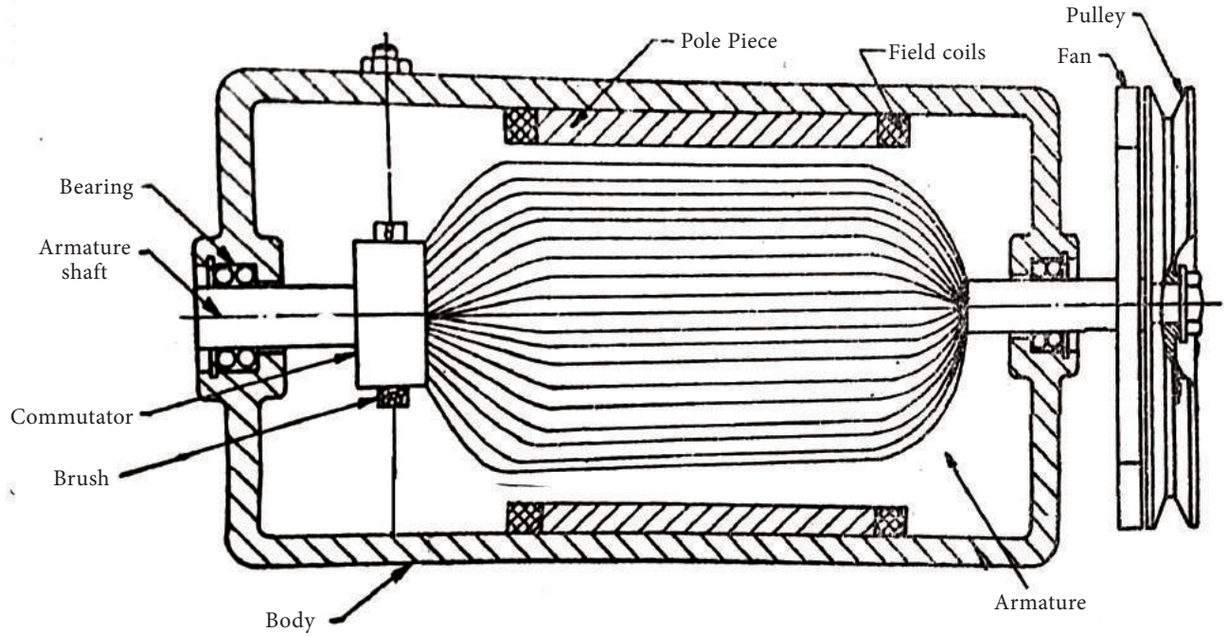


Figure 10.9.1 Dynamo (or) D.C. Generator

4. Brush
5. Pole shoe
6. Field coil

The engine crankshaft pulley drives the alternator 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.

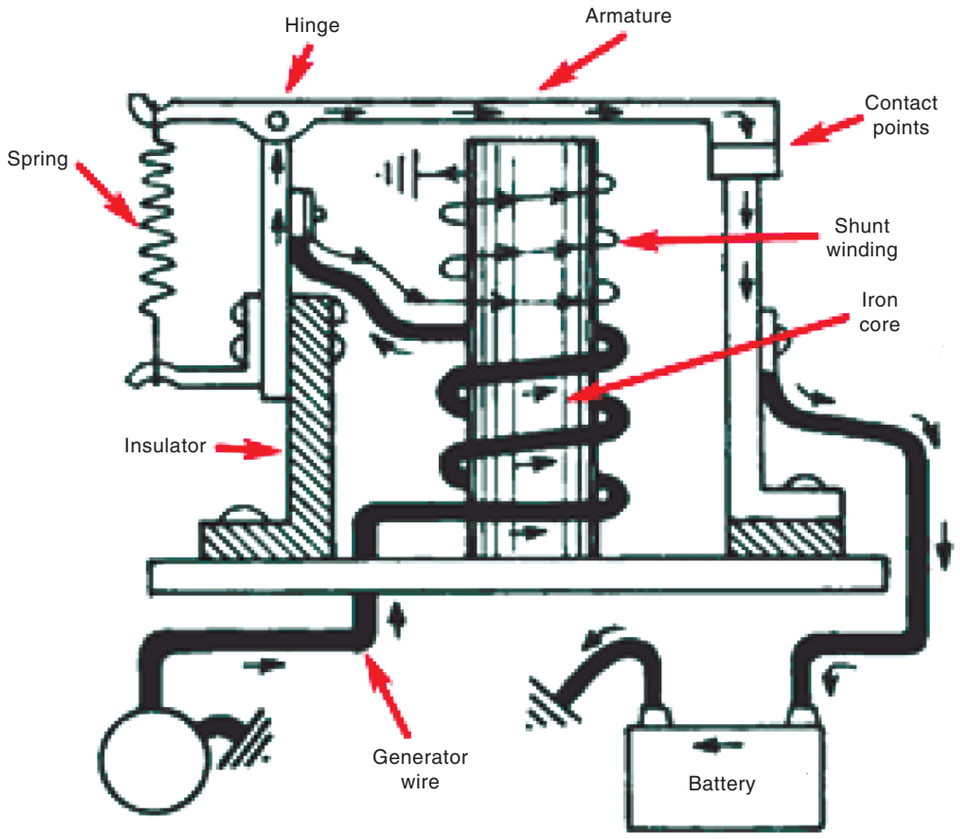


Figure 10.9.2 (a) Cut out relay

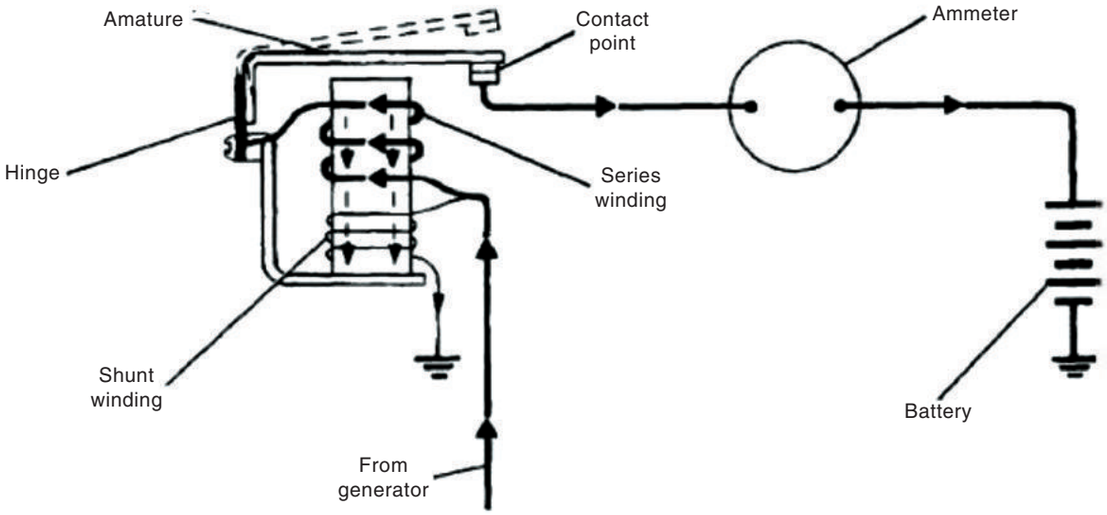
10.9.3 Alternator

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.



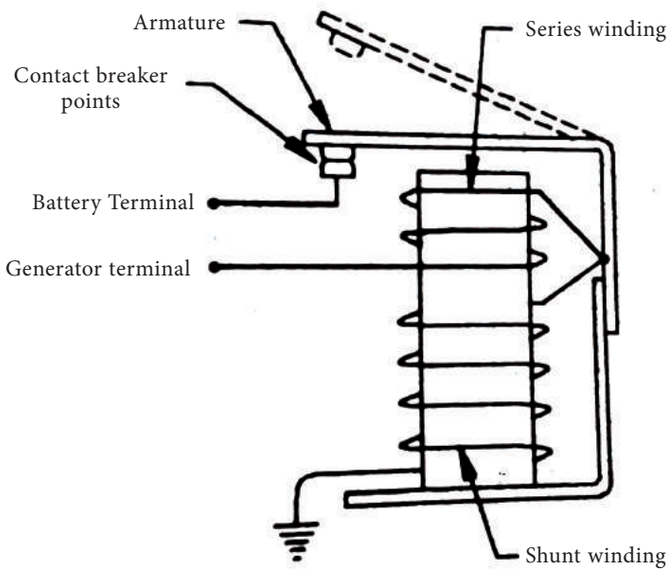


Figure 10.9.2 (b) Cut out Relay

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.

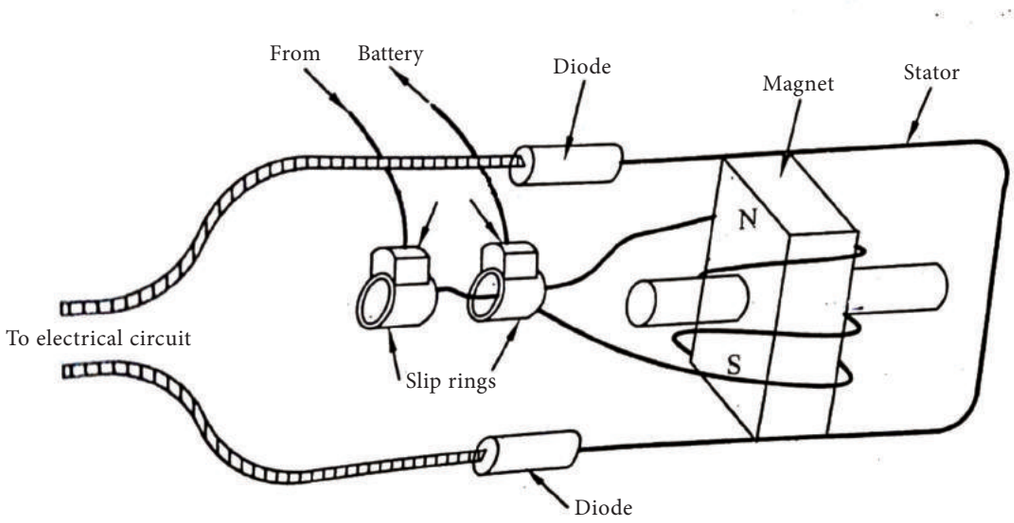
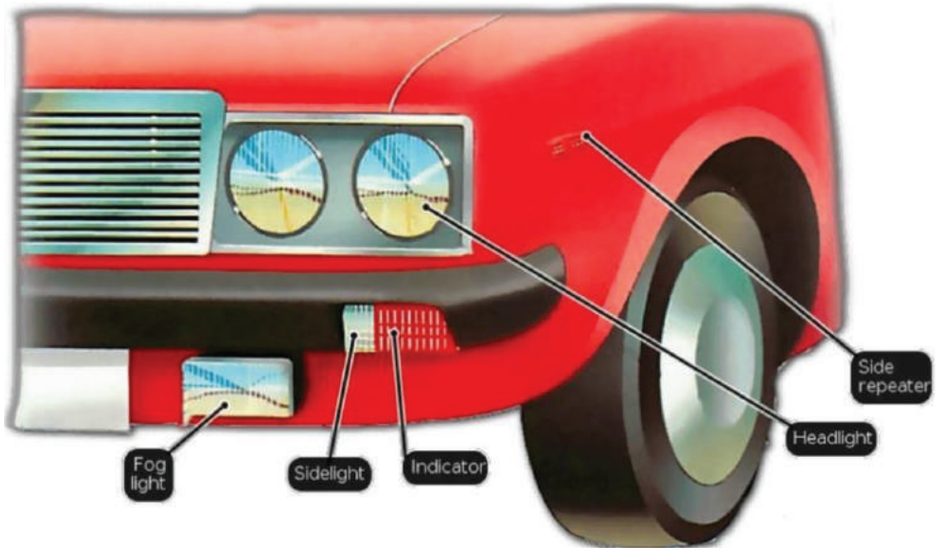


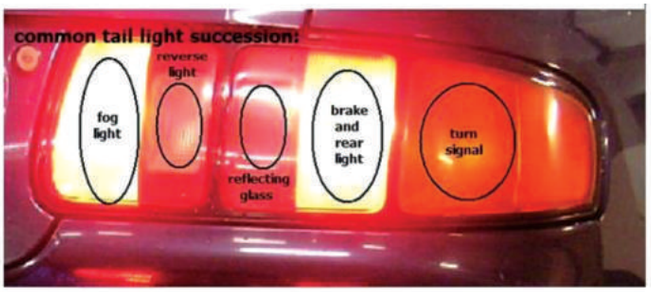
Figure10.9.3 Alternator

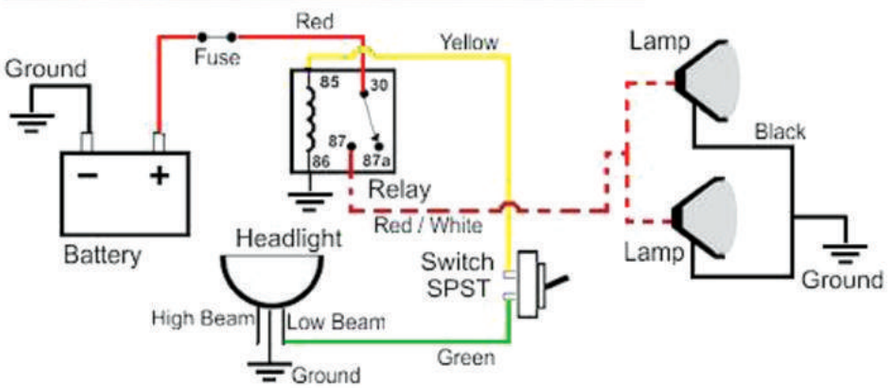
10.10.1 Important lights in a lighting system and its purpose

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







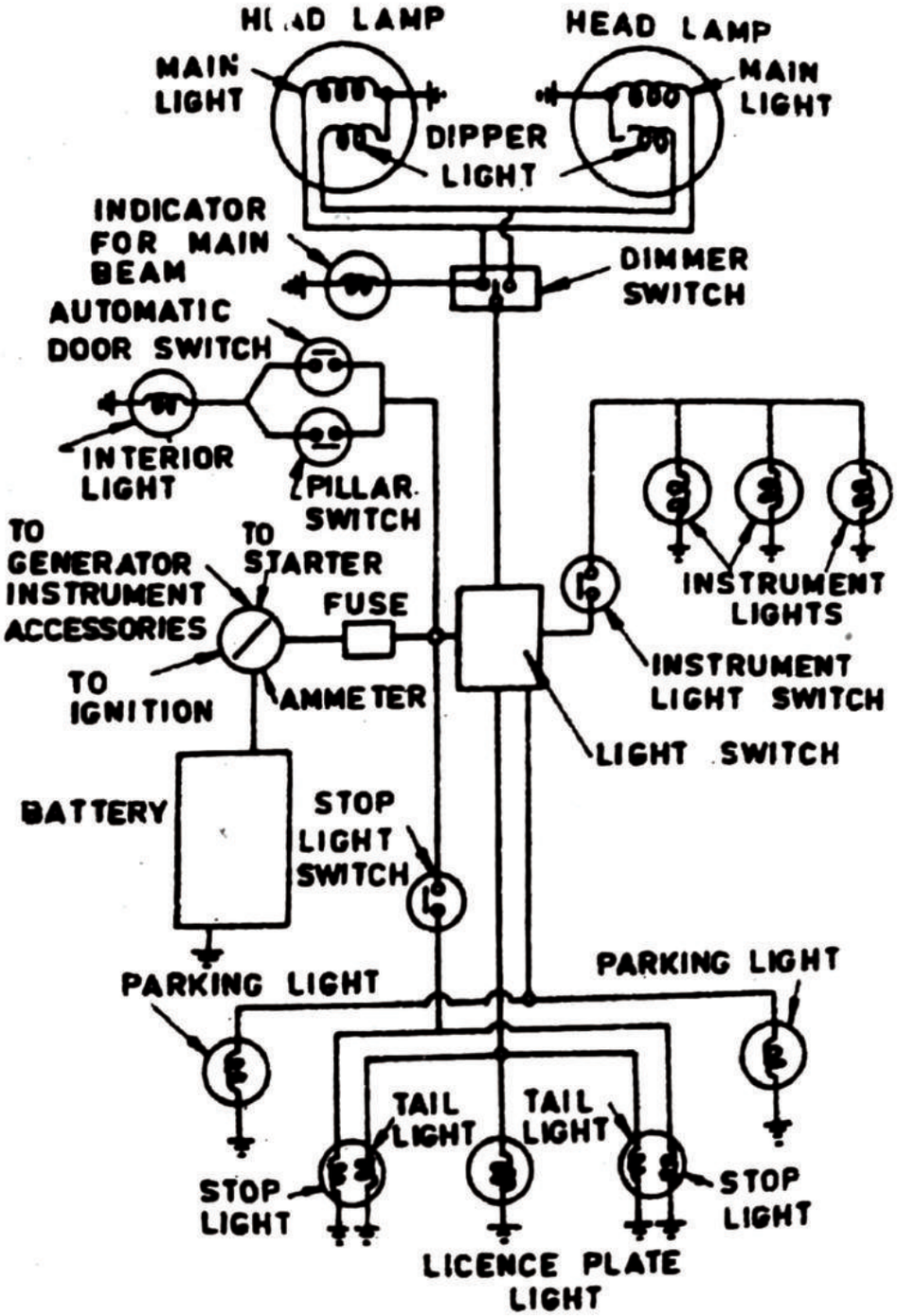


Figure 10.10.2 Lighting system

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

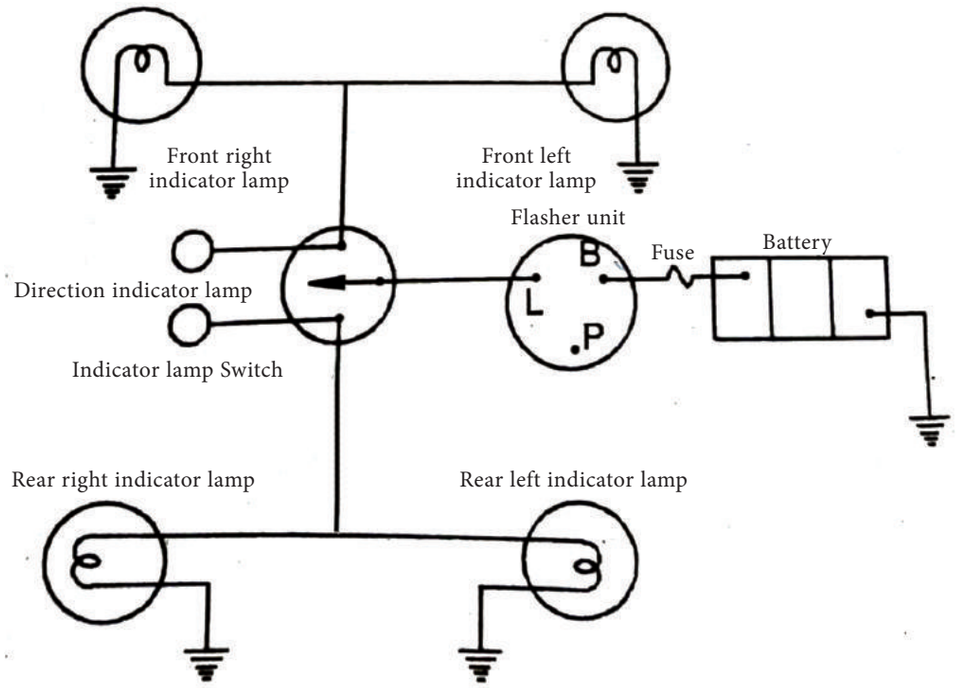


Figure 10.10.3 Directional signal circuit

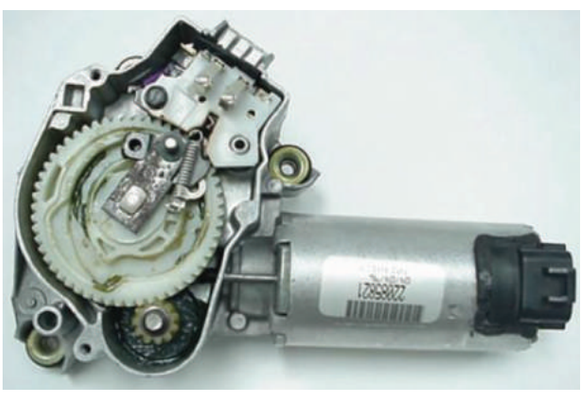
times per minute to make more noticeable to the other driver. After completing the turn, the return movement of the steering wheel automatically cancels the turn signal and the lever moves back to its neutral position, opening the circuit.

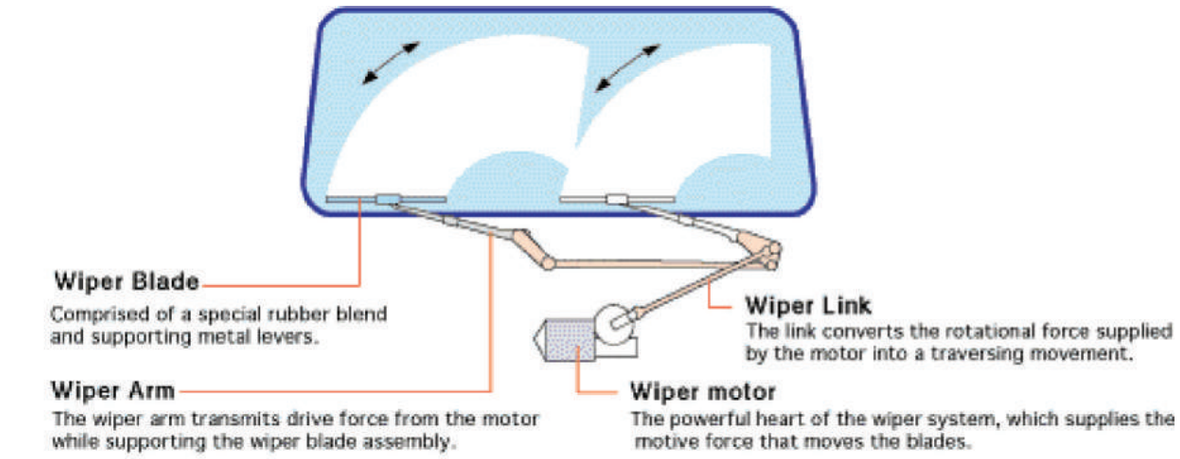
10.11 Wind Screen Wiper

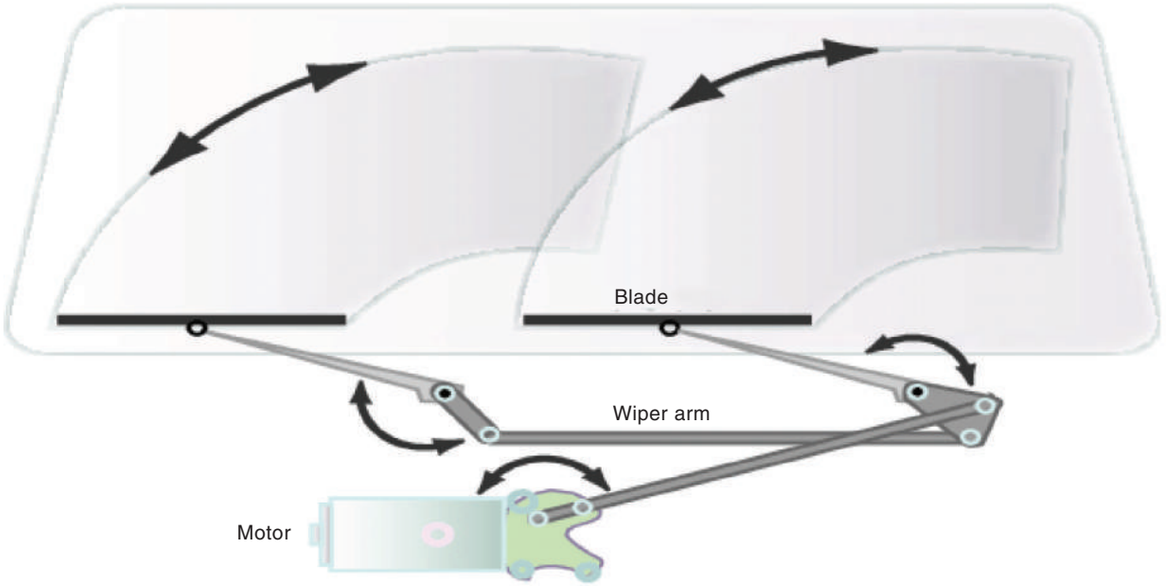
Windshield wipers clean the windshield so that the driver can see clearly while driving on rain or snow or dirt on the windshield. The wipers are operated by an electric motor.

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.







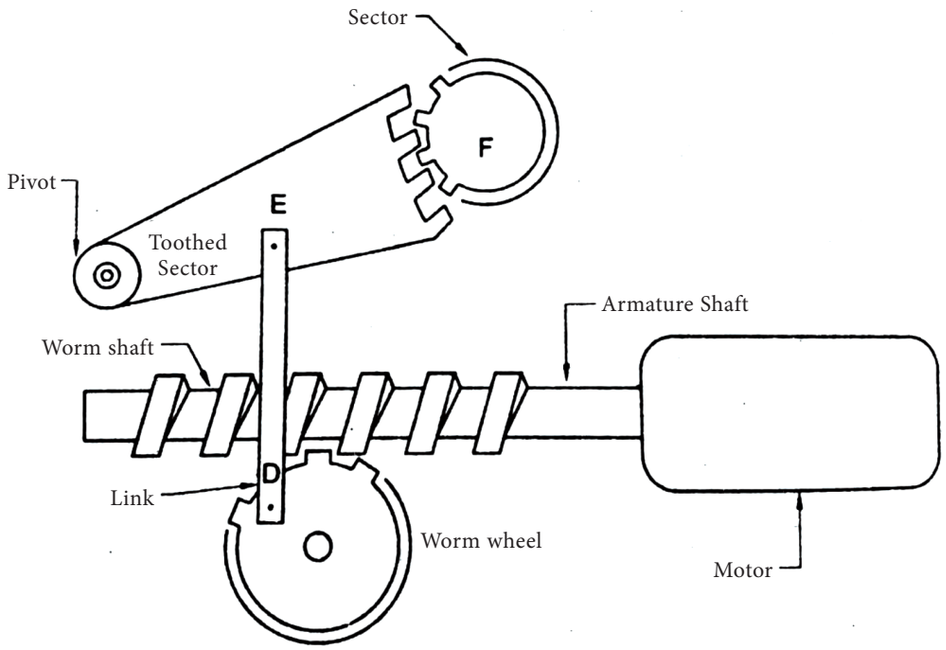
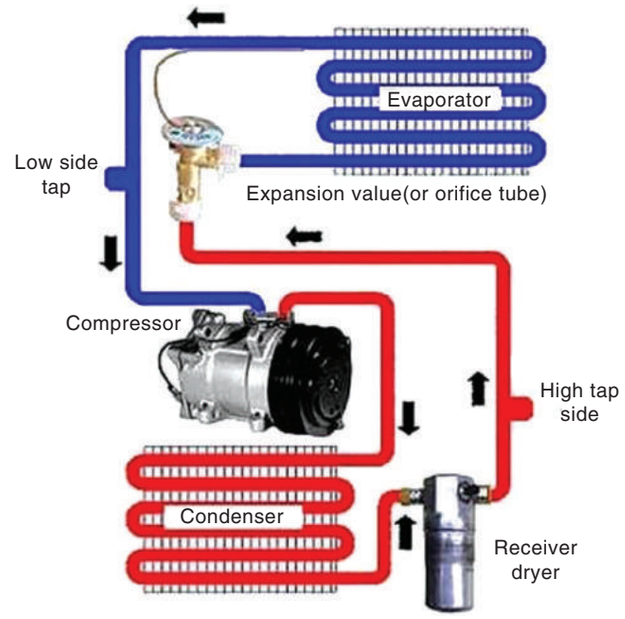


Figure 10.11 Wind screen wiper

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



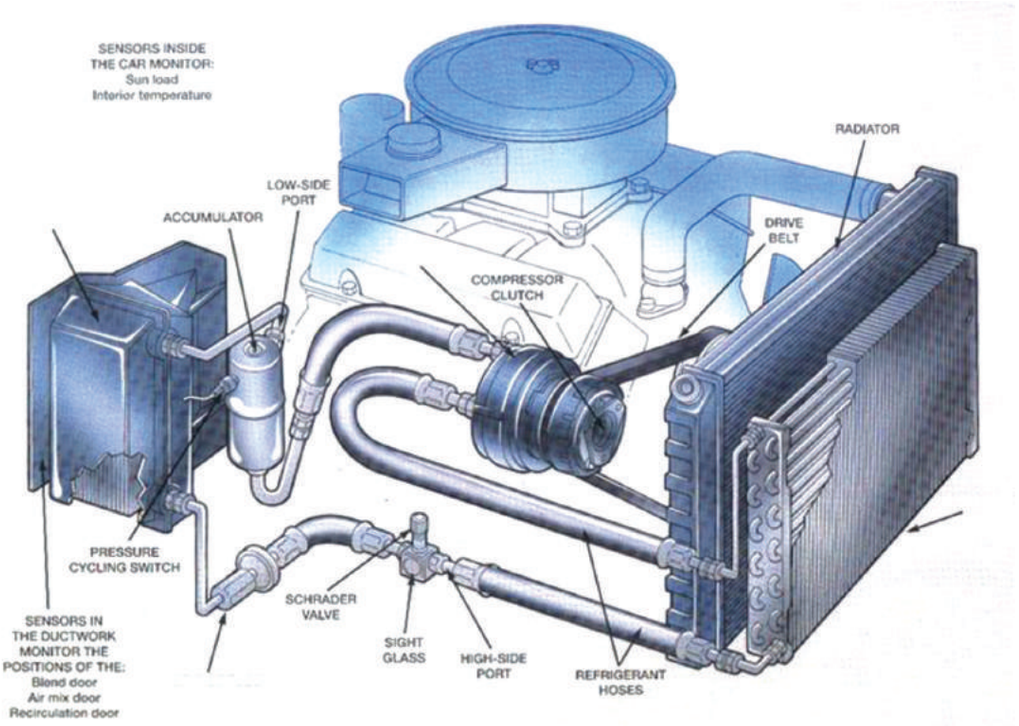


Figure 10.12.1 (a) Air conditioning System

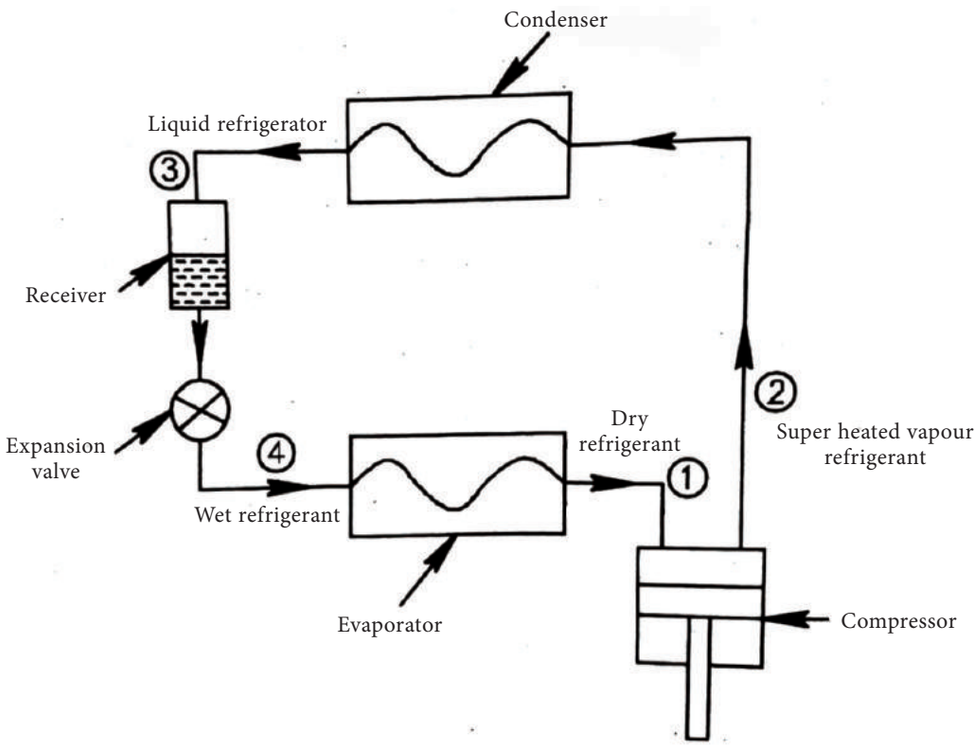


Figure 10.12.1 (b) Simple steam air conditioning system

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 compress or 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.	Faculty 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

PWEZ3L

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.

Model Question Paper (Mark Evaluation) +2 Basic Automobile Engineering Vocational Theory

Theory Marks – 90	Internal Assessment Marks – 10	Total Marks – 100

Part – A	Choose the best answer	15 × 1=15
Part – B	Answer the following Questions (Answer any 10 out of 13 Questions)	10 x 3 = 30
Part – C	Answer the following Questions (Answer any 5 out of 7 Questions)	5 x 5 = 25
Part – D	Answer all the Questions (Either or Type)	2 x 10 = 20

+2 Model Question Paper (English Medium)

(Theory Marks : 90)

Part – A

Choose the correct Answer

Answer all the questions. **15 × 1 = 15**

1. The Transmission system which has good road grip is,
   a. Front engine rear wheel drive
   b. Rear engine rear wheel drive
   c. Front engine front wheel drive
   d. Front engine four wheel drive

2. Types of Multiplate clutch
   a. 3 b. 4
   c. 2 d. 5

3. In which type of clutch, there is no need of clutch pedal?
   a. Single plate clutch
   b. Multiplate clutch
   c. Diaphragm clutch
   d. Centrifugal clutch

4. Which type of lubricating oil is used in gear box?
   a. S.A.E 30
   b. S.A.E 40
   c. S.A.E 90
   d. S.A.E 120

5. Top Gear ratio is
   a. 1:2
   b. 2:1
   c. 1:1
   d. 3:1

6. Which device is used to adjust the angle Variation and transmit the power?
   a. Propeller shaft
   b. Sliding joint
   c. Differential
   d. Universal Joint

7. Tyre strength is indicated by
   a. Bead
   b. Tread
   c. Ply rating
   d. side wall

8. Brake shoes are made up of
   a. Asbestos
   b. Aluminium alloy
   c. Steel Alloy
   d. Copper

9. Which type of brake is mostly used in cars?
   a. Vaccum brake
   b. Hydraulic brake
   c. Mechanical Brake
   d. Air Brake

10. The up and down movement of the vehicle is called
    a. Rolling b. Skidding
    c. Bouncing d. Pitching

11. Caster angle is
    a 1o to 2o b. 2o to 4o
    c. 3o to 4o d. 2o to 3o

12. Back bone of the vehicle is
    a. Chassis frame b. Body
    c. Engine d. Gear box

13. The number of turns in the primary winding of the ignition coil is
    a. 100 to 150
    b. 150 to 300
    c. above 400
    d. 600 to 700

14. How does the dynamo (or) Generator get the drive?
    a. connecting rod
    b. Piston
    c. Engine Crank shaft
    d. Engine Cam shaft

15. The part used to connect front axle and stub axle is
    a. Piston pin
    b. King pin
    c. Cotter pin
    d. Circlip

Part – B

Answer any ten Questions. Question number 25 is compulsory $10 \times 3 = 30$

16. Explain Air Resistance.

17. What are the advantages of diaphragm clutch?

18. What are the types of gear box?

19. What are the types of rear axle Shaft?

20. What is the effect of low tyre pressure?

21. What are the properties of brake fluid?

22. What are the advantages of Anti – lock – brake system?

23. What are the types of shock absorber?

24. Define – steering ratio.

25. Define – wheel base.

26. What is the use of cut out unit?

27. What is the use of condenser?

28. State any three types of clutch.

Part - C

Answer any five questions. Question number 33 is compulsory $5 \times 5 = 25$

29. Draw and explain briefly the front engine Rear Wheel drive transmission system.

30. Draw and mark the parts of propeller shaft.

31. What are the advantages and disadvantages of independent suspension system?

32. What are the requirements of vehicle body?

33. Draw and label the parts of head lamp circuit.

34. What are the reasons and remedies for clutch slip?

35. What are the advantages and dis – advantages of power steering?

Part – D

Answer all the Questions $2 \times 10 = 20$

36. Explain the construction and working of single plate clutch with neat sketch

(Or)

Draw and explain the construction and working of differential unit.

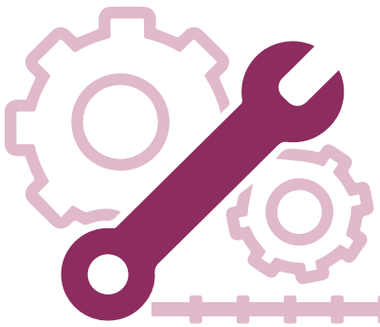
37. Explain the construction and working of battery coil ignition system with neat sketch

(Or)

Explain the construction and working of master cylinder with neat sketch

+2 – Basic Automobile Engineering Practical

Content



Practical – 1
Clutch Unit

Aim:

Dismantling, inspecting and assembling the given clutch.

Equipments:

Given Clutch

Tools Required:

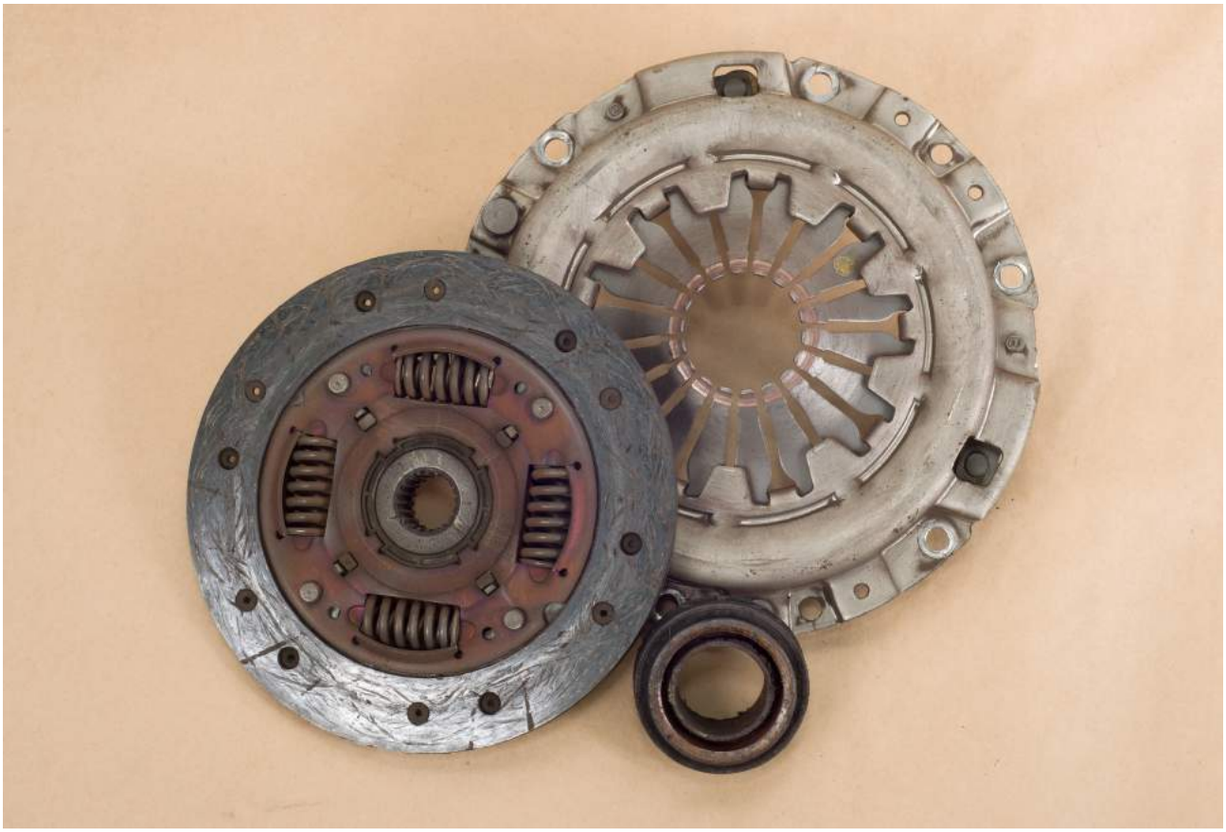
1. Box Spanner
2. Arber press
3. Reverting machine
4. Spring Tester
5. Long nose pliers
6. Double end spanner

Materials Required

1. Cotton waste
2. Kerosene
3. Petrol
4. Emery sheet
5. Metal tray

Reason for dismantling:

- Clutch is not disengaged when the clutch pedal is pressed.
- Difficult to press the clutch pedal.
- More noise in clutch.
- Vehicle speed is low even engine is in good condition.
- Manufacturer POI (Pencil of Inspection)



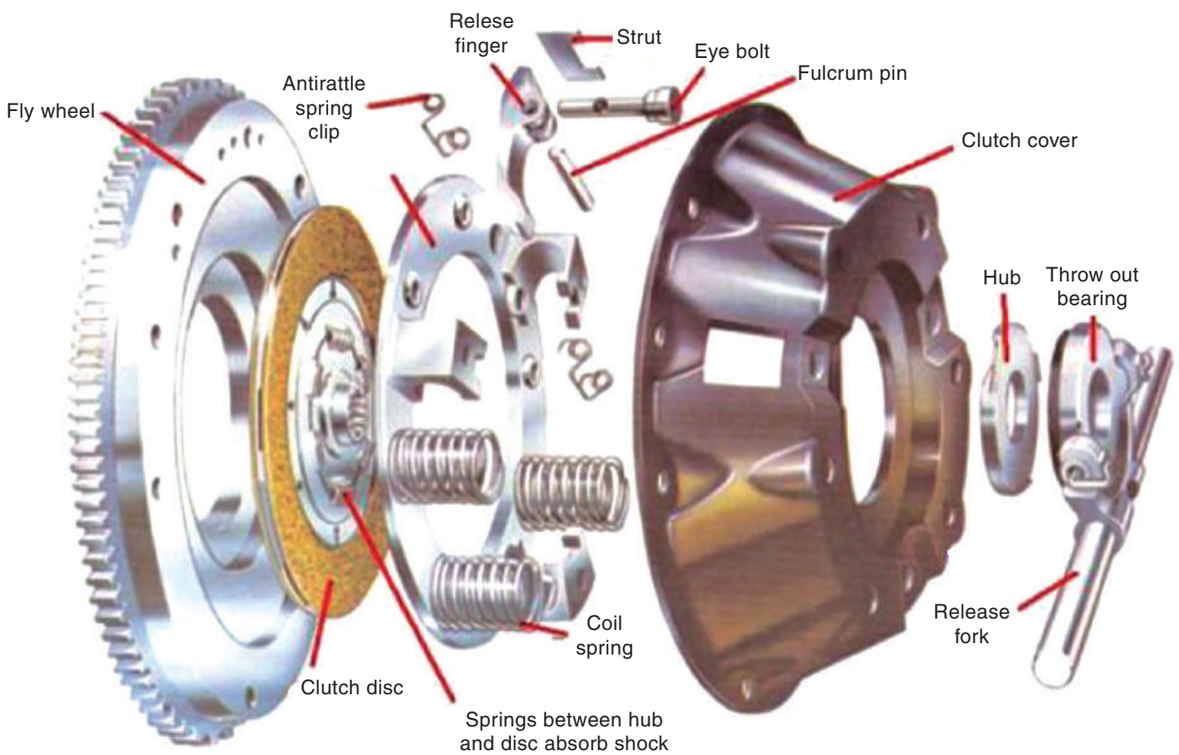
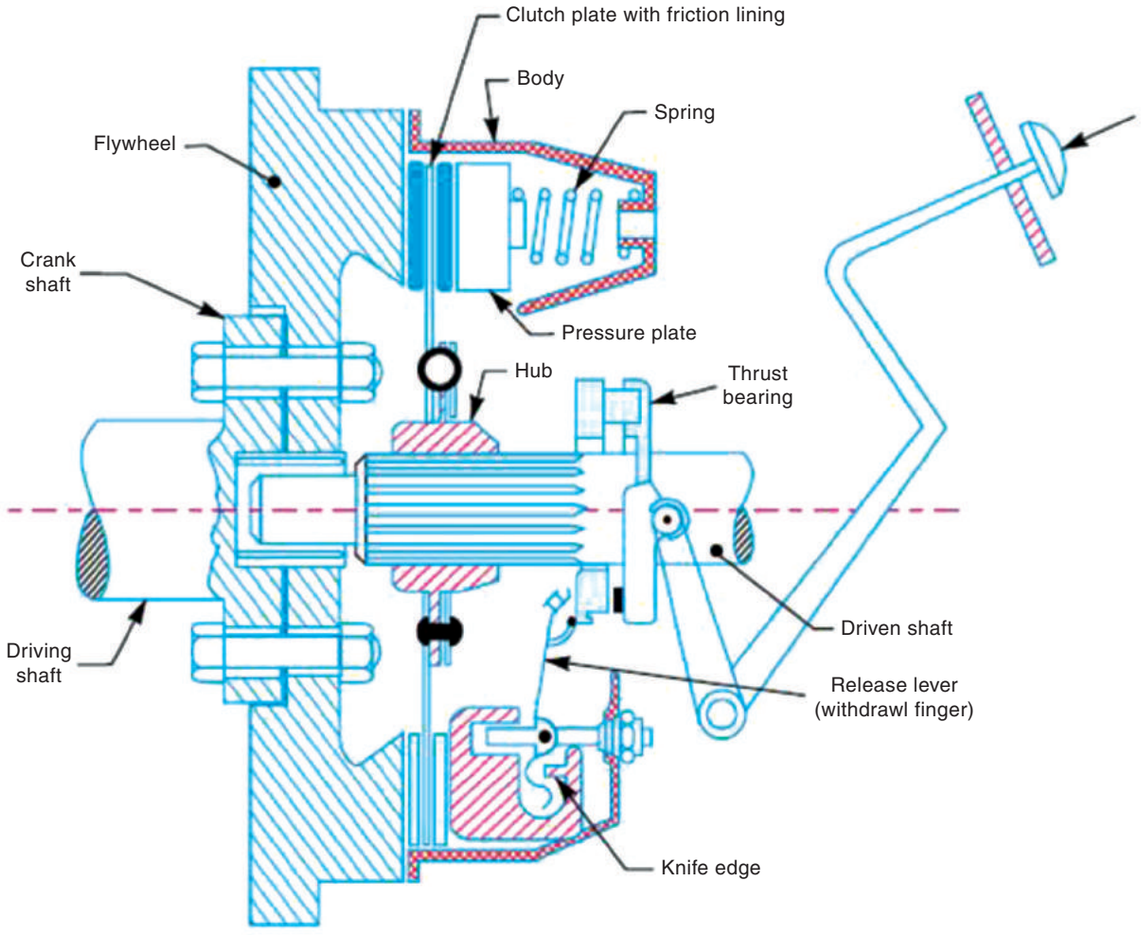


Fig 2.5.1 (a) Single plate clutch



Dismantling:

- Remove the universal joint bolts, center bed bolts, propeller shaft assembly and speedometer cables from the gear box.
- Remove clutch fork connection, gear box, clutch mounting bolts.
- Remove the gear box from the vehicle with the help of rope.
- Place the clutch in the Arber press and remove the clutch casing bolts.
- Remove pressure springs, release lever finger, pressure plate, clutch plate and etc…

Inspection:

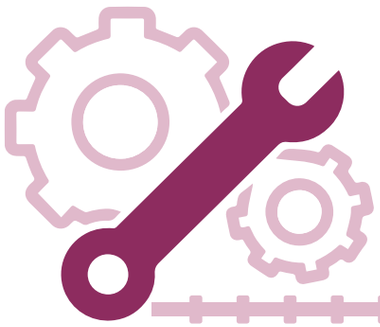
- Inspect the clutch plate, pressure plate, linings, release lever, pressure spring, bolt, nuts, washer and etc… for any damage.
- Check the release lever spring tension it is more than 5 pounds replace by new one.
- Check the coil spring length before and after compression by using coil spring tester.
- Check the clutch free pedal play.

Assembling

- Assembling is the reversing process of dismantling.
- Place the clutch cover on the fly wheel and tighten the bolts. [Marking on clutch cover and flywheel should be in coincide].
- Check the clutch and gear box is working properly.

Result:

Thus the given clutch unit was dismantled, inspected and reassembled.



Practical – 2
Gear box

Aim:

Dismantling, inspecting and assembling the given gear box.

Equipments:

Given Gear box

Tools Required

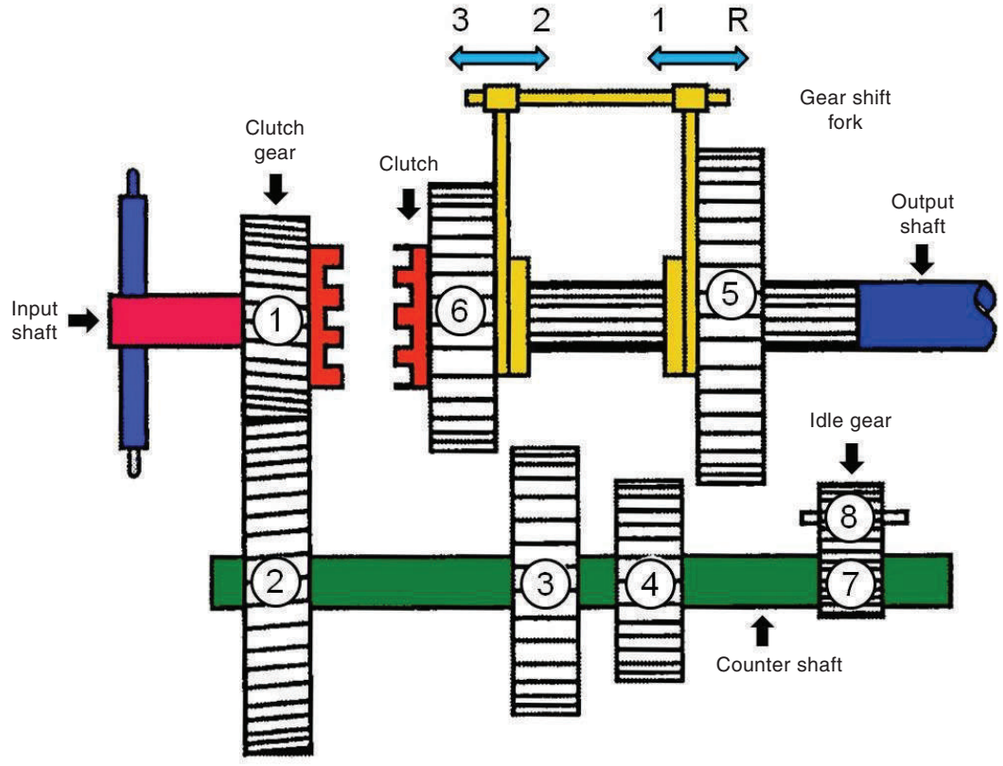
1. Ring spanner
2. Double end spanner
3. Screw driver
4. Ball pein hammer
5. Drift punch
6. Wooden hammer

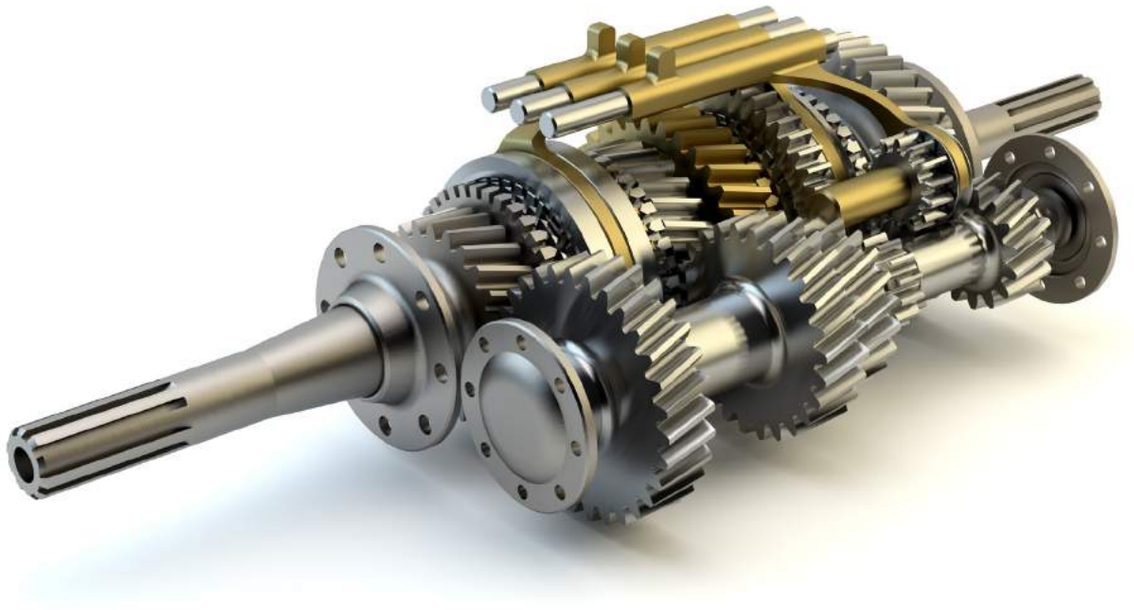
Materials Required:

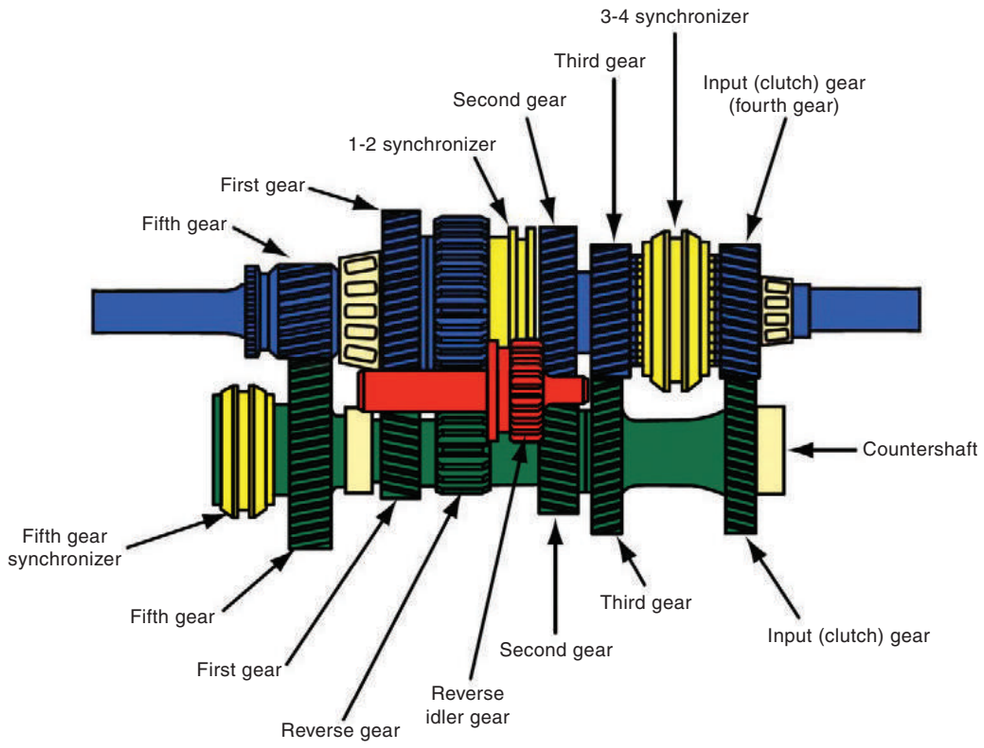
1. Cotton waste
2. S.A.E 90 oil
3. Metal tray
4. Grease
5. Kerosene

Reasons for Dismantling

- Gear slip
- More noise in neutral position
- Difficult to operate gear shifting lever
- Gear changing is very hard
- Manufacturer POI is over







Speed	Gear Ratio
First gear	7:1
Second gear	3:3:1
Third gear	1:7:1
Top gear	1:1

Dismantling procedure:

- Remove the gear box from the vehicle and place it on the work bench.
- Drain the gear box oil.
- Remove the gear shifting lever, selector rod mechanism, end cover, bearings, main shaft gears, main shaft, clutch shaft with gear, counter shaft and etc…

Inspection:

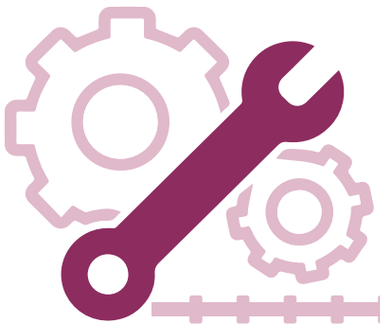
- Clean all the pants.
- Clean the gear box casing and inspect for any damage.
- Check the main shaft, gears, counter shaft gears and clutch gear for any damage and replace the new one if any damage.
- Check the clutch shaft, main shaft and counter for any damage.

Assembling:

- Assembling is the reverse process of dismantling.

Result:

Thus the given gear box was dismantled, inspected and reassembled.



Practical – 3
Differential

Aim:

Dismantling, inspecting and assembling the given differential.

Equipment:

Given differential unit.

Tools Required:

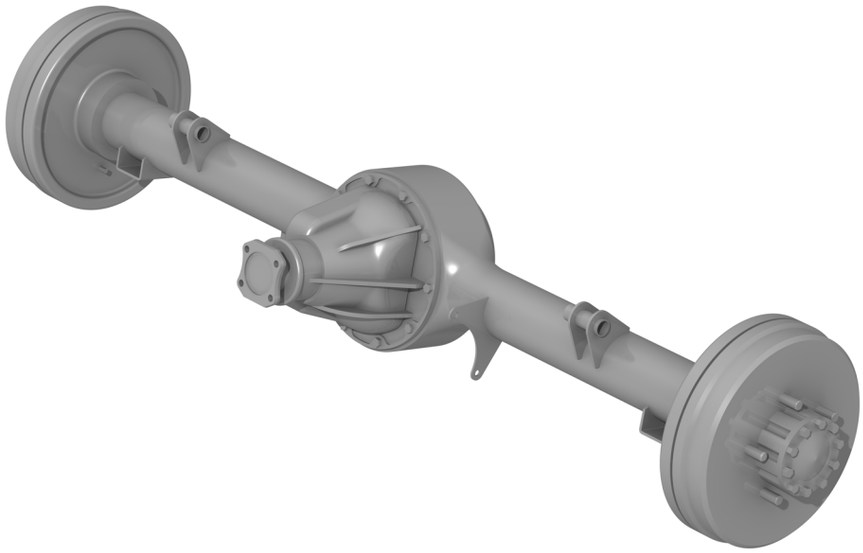
1. Ring spanner
2. Double ended spanner
3. Copper hammer
4. Iron hammer
5. Drift punch

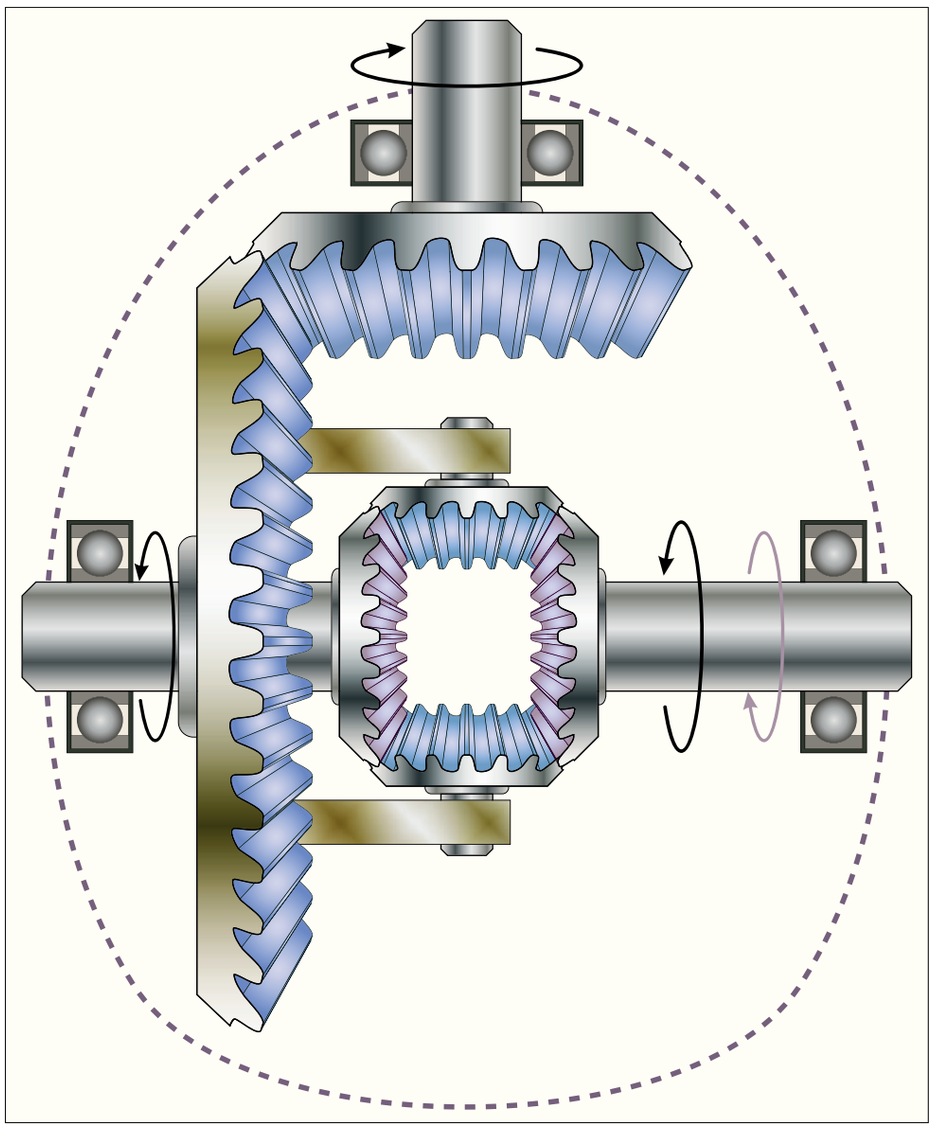
Materials Required:

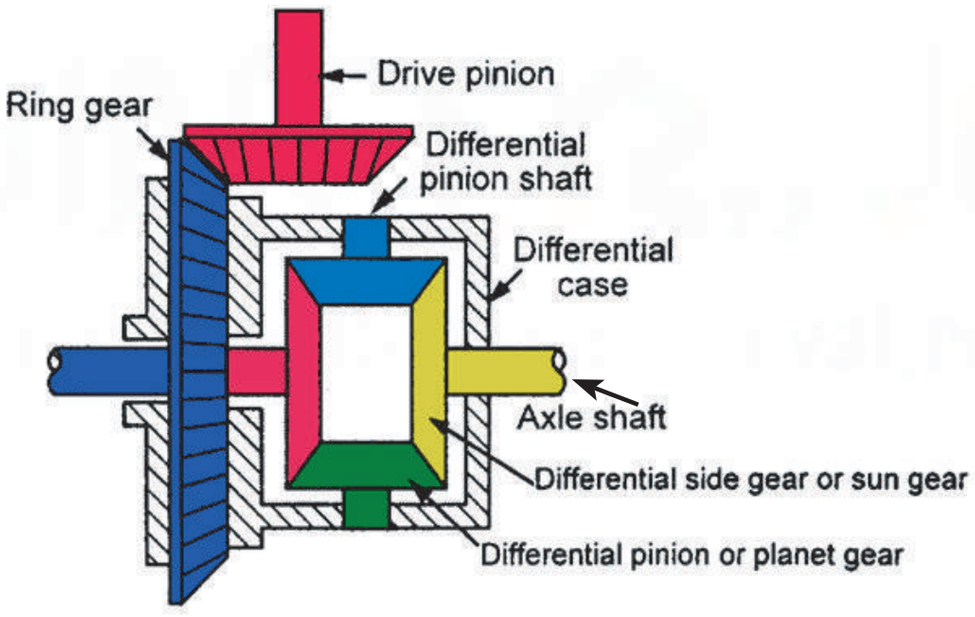
1. Cotton waste
2. S.A.E 90 oil
3. Metal tray
4. Grease
5. Kerosene
6. Degreaser

Reasons for Dismantling:

- More noise in differential
- Rear wheel rotate in low speed
- Rear wheel does not turns easily
- Low power transmits to rear wheel
- Manufacturer POI is over.







Dismantling:

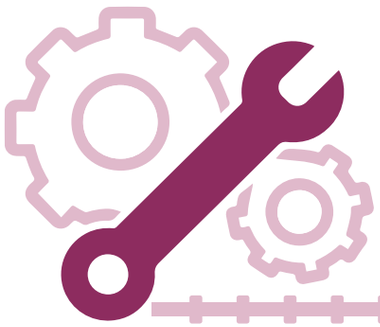
- Place the differential unit on the work bench.
- Remove the crown wheel.
- Remove the differential cage.
- Remove the sun gear, planet gears.
- Clean all the parts with kerosene.

Assembling:

Assembling is the reverse process of dismantling.

Result:

Thus the given differential was dismantled, inspected and reassembled.



Practical – 4
Steering Gear Box

Aim:

Dismantling, inspecting and assembling the given steering gear box

Equipments:

Given steering gear box

Tools Required

1. Double end spanner
2. Ring spanner
3. Box spanner
4. Plastic hammer
5. Ball pein hammer
6. Screw driver
7. Plier
8. Drift punch
9. Feeler gauge
10. Torque wrench
11. Metal tray

Materials Required:

1. Cotton waste
2. Kerosene

Reasons for Dismantling:

- Hard steering wheel
- More vibration
- Movement of steering arm is not transmitted to stub axle
- Manufacturer POI is over.

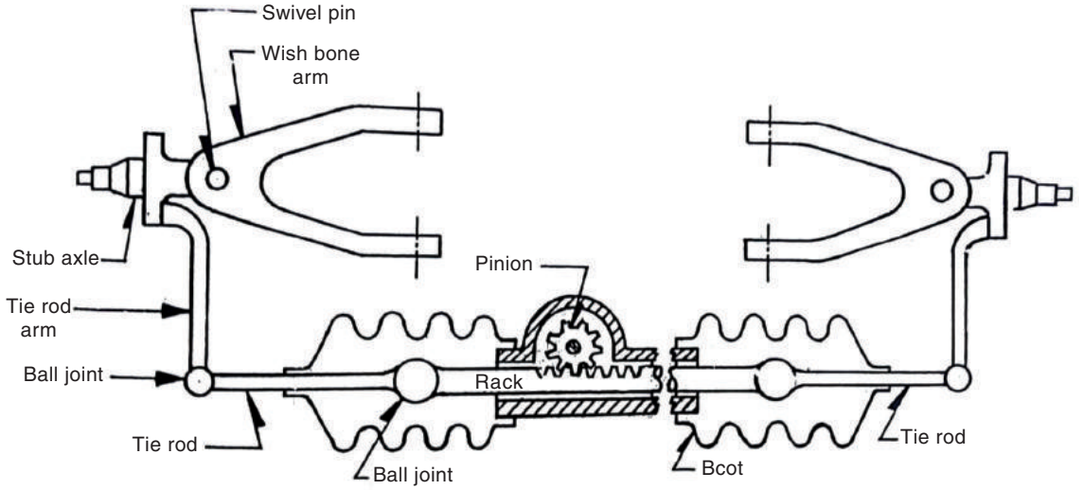
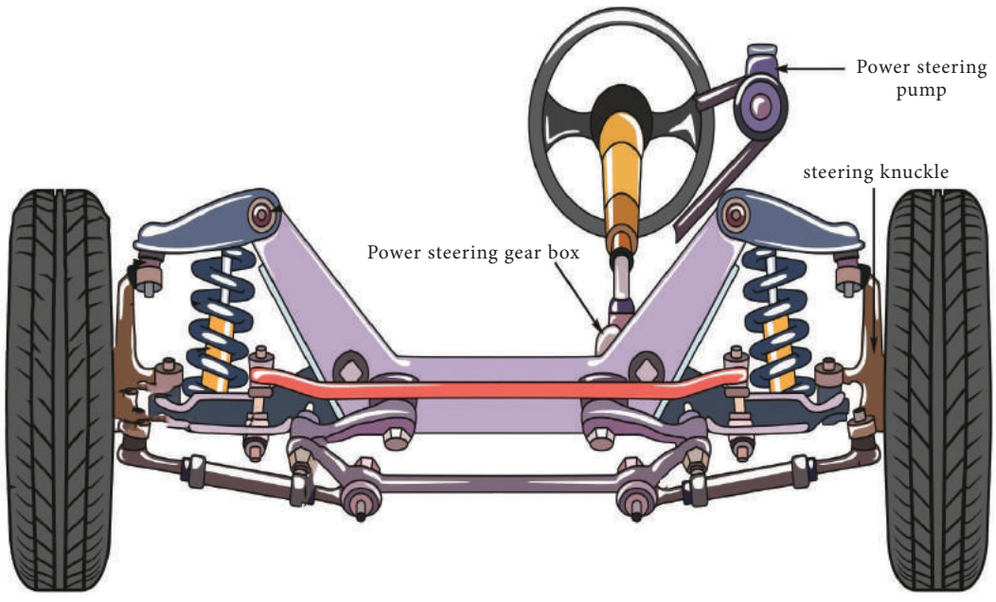
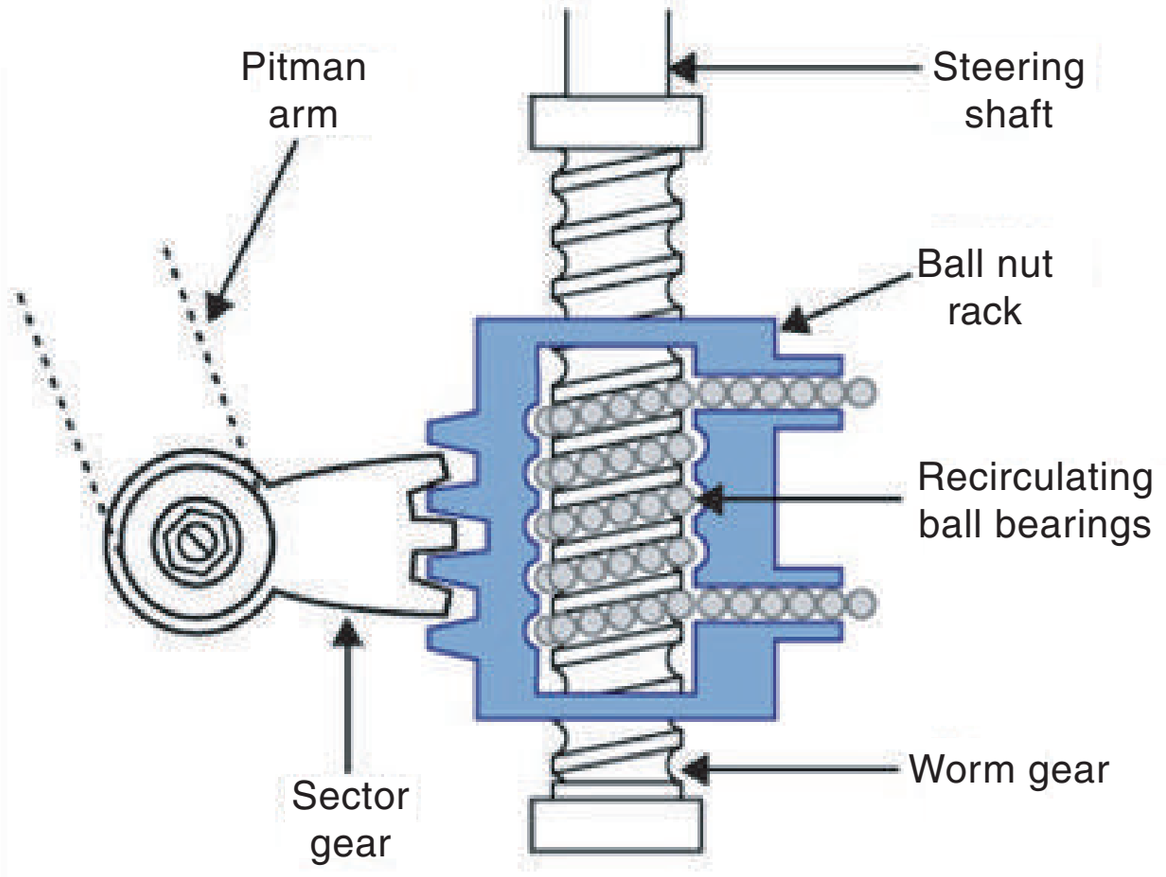


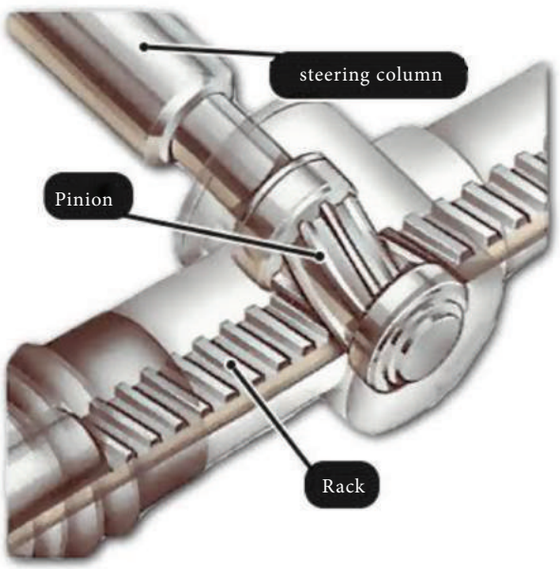
Fig (a) Rack and pinion type steering gear box



Dismantling

- Remove the horn switch.
- Remove the steering wheel by loosening the wheel lock nut.
- Remove the end play column, thrust bearing and shaft.
- Remove the steering column, thrust bearing, and shrin
- Remove the drop arm drag link
- Remove the steering gear.





Inspection

- Clean all the parts by karocene
- Inspect the, steering wheel steering shaft and worm gear for any damage.
- Inspect the cross shaft and drop arm

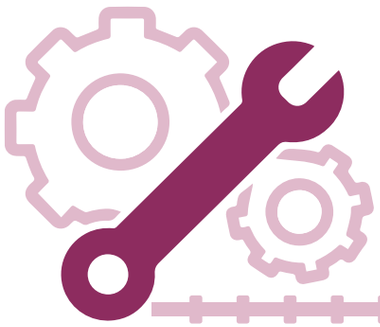
- Inspect the bolts, nuts and screw.
- Inspect the thrust bearing shim and housing for any damage.
- Inspect the roller for any damage.
- Replace all the damaged parts by newone.

Assembling

Assembling is the reverse process of the dismantling.

Result

Thus the given steering gear box was dismantled, inspected and reassembled.



Practical – 5
Master Cylinder

Aim

Dismateling, inspecting and assembling the given master cylinder.

Equuipments

Given master cylinder

Tools required

1. Ring sapanner
2. Double end spanner
3. Screw driver
4. Wooden hammer

Material required

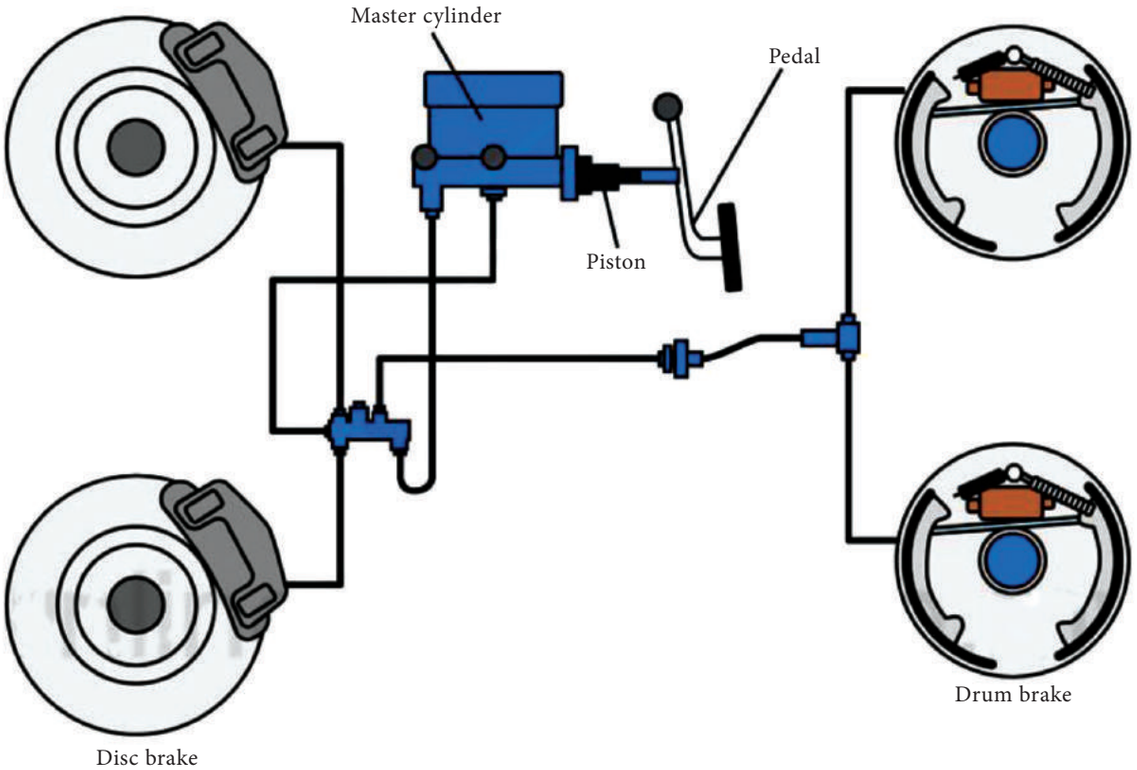
1. Cotton waste
2. Diesel
3. Brake oil

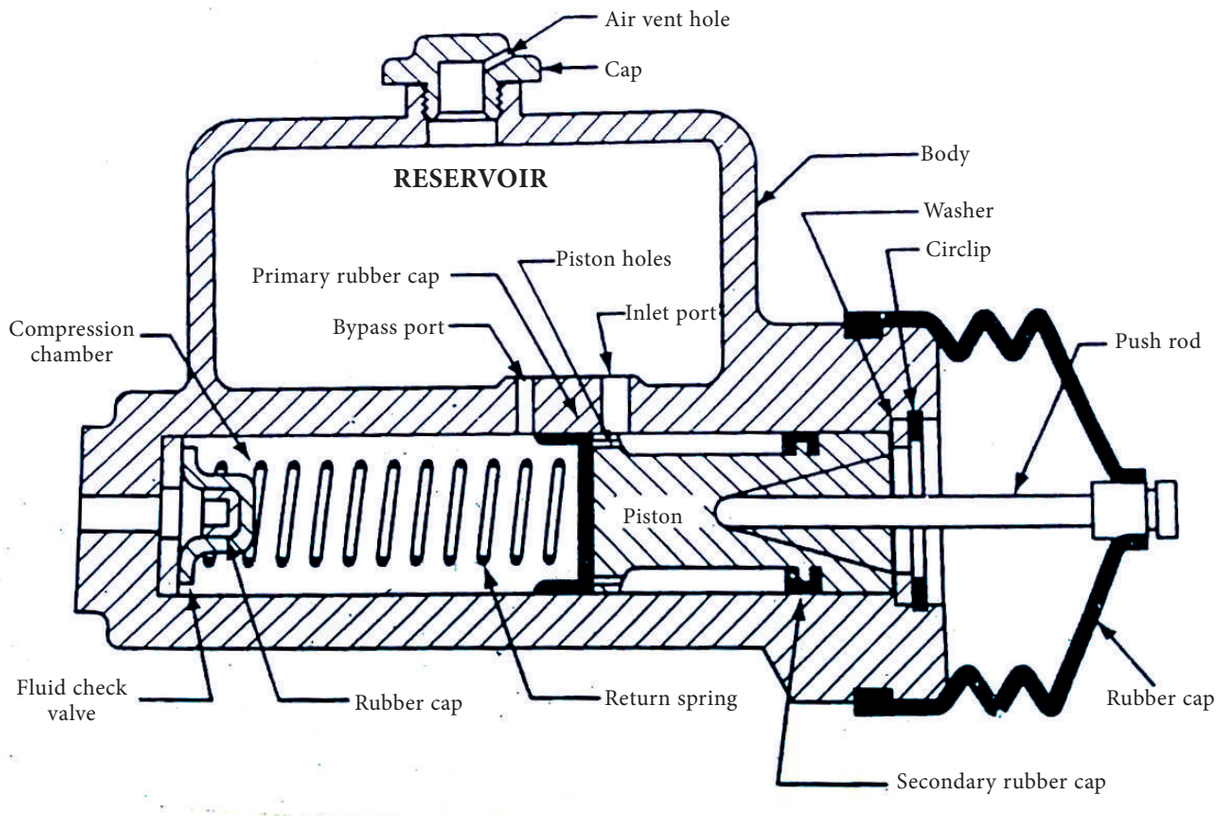
Reason for dismantling

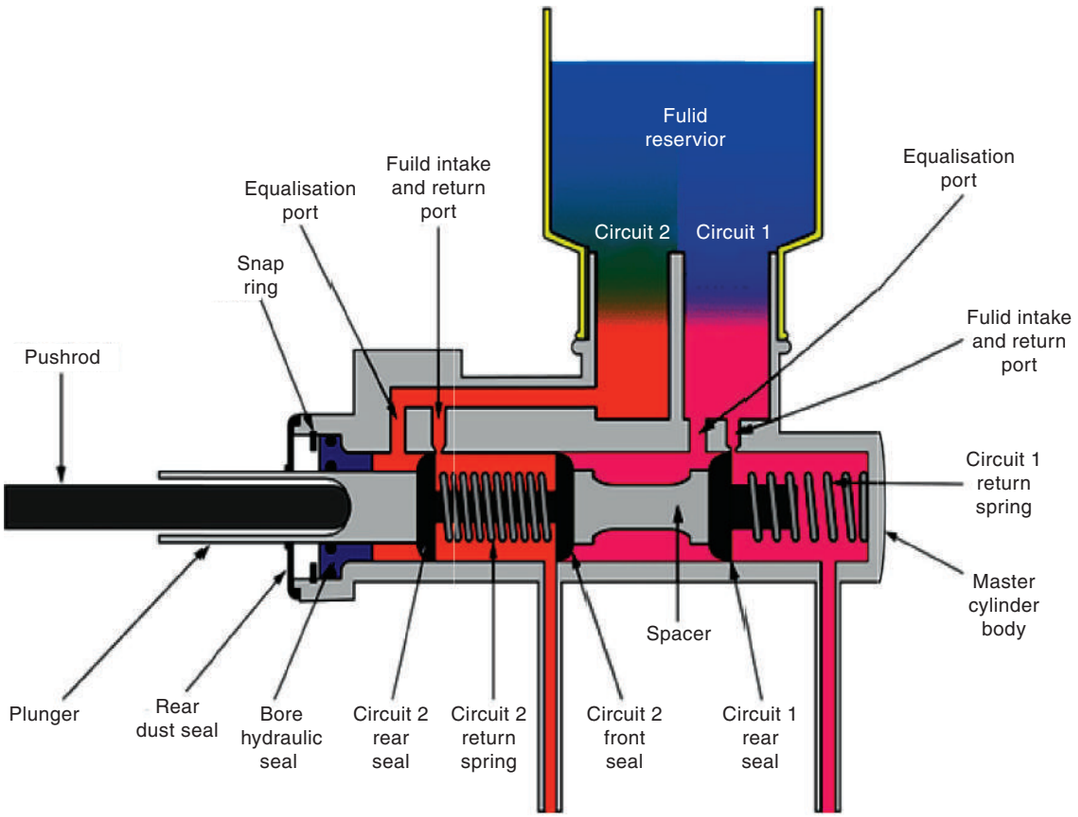
1. Breaking system not functioning properly
2. Leakage if break fluid from master cylinder.
3. Less breaking efficiency

Dismantling

- Remove the oil lines from the master cylinder
- Dis connect the brake pedal connection from the master cylinder from the chassis
- Drain out the brake fluid from the master cylinder.
- Remove the circlip by using the circlip plier
- Remove the piston assembly and value spriting from the master cylinder by using wooden hammer.







Inspection

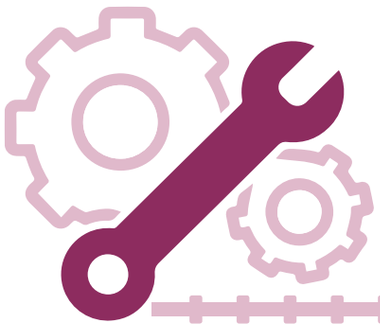
- Clean all the parts
- Check the inlet port and by pass port for any blockage.
- Check the spring force
- Check the piston hole
- Piston spring, force, value, rubber cups, and brake, pedal linkage
- Replace the defective parts by a new one

Assembling

Assembling is the reverse process of dismantling

Result

Thus the given master cylinder dismantled, inspected and re assembled.



Practical – 6
Wheel Cylinder

Aim

Dismateling, inspecting and assembling the given wheel cylinder.

Tools Required

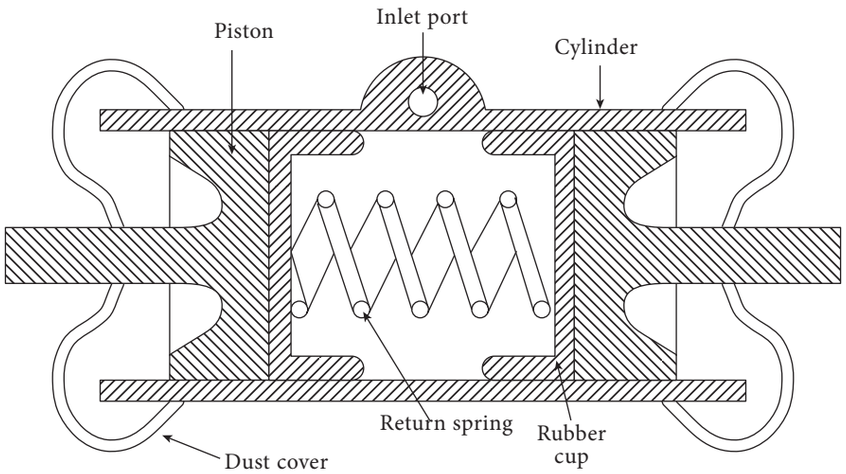
1. Long nose plier
2. Double end spanner
3. Ring spanner
4. Screw driver
5. Brake shoe tonques
6. Wooden hammer

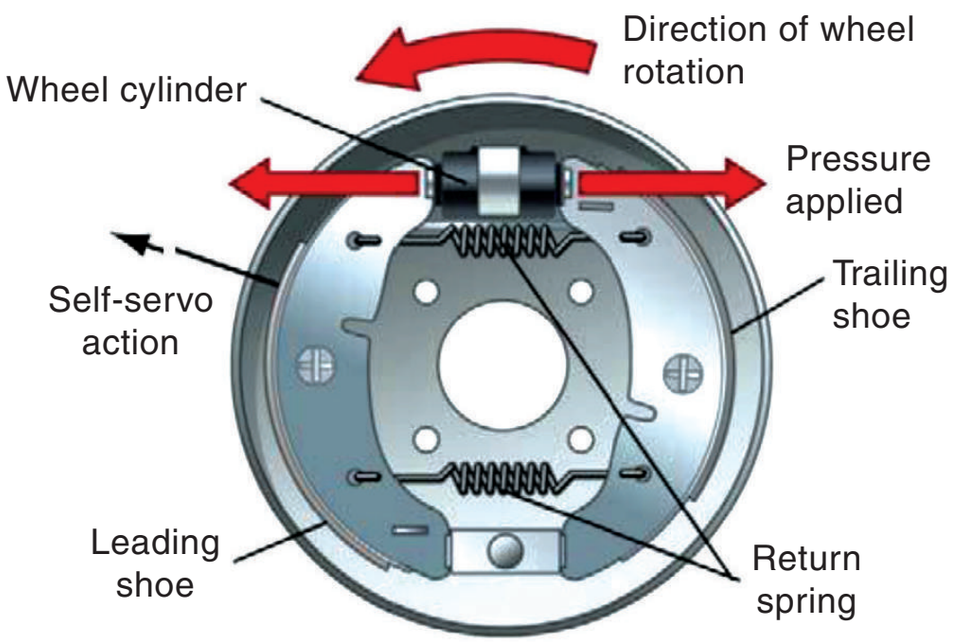
Material required

1. Cotton waste
2. Karosene
3. Brush

Reason for dismantling

1. Brake is not applied when brake pedal is pressed
2. Brake is not released even return spring is in good condition
3. Leakage of brake fluid through dust cover
4. Less brake efficiency
5. Wear and tear of rubber cup
6. Difficulties in brake pedal operating
7. Manufacture POI is over





Dismantling

- Disconnect the brake fluid pipe line connection
- Remove the wheel
- Remove the brake drum
- Remove the brake shoe return spring & brake shoe
- Remove the brake shoe tappet
- Remove the mounting bolts of the wheel cylinder
- Remove the wheel cylinder from the brake plate
- Place the wheel cylinder on the work bench
- Remove the dust cover
- Dismantled the wheel cylinder
- Remove the piston, rubber cup and spring.

Inspection

1. Clean all the parts
2. Check the wear and tear or any damage in the piston
3. Check the wheel cylinder body and the condition of in let port and the bleeder port.
4. Check the condition of the spring
5. Check the primary and secondary rubber cup.

Assembling

1. Assembling is the reverse process of dismantling
2. Check the brake condition after assembling

Result

Thus the given wheel cylinder was dismantled, inspected and reassembled.

Practical – 7
SHOCK ASORBER

Aim
Dismantling, inspecting and assembling the given shock absorber.

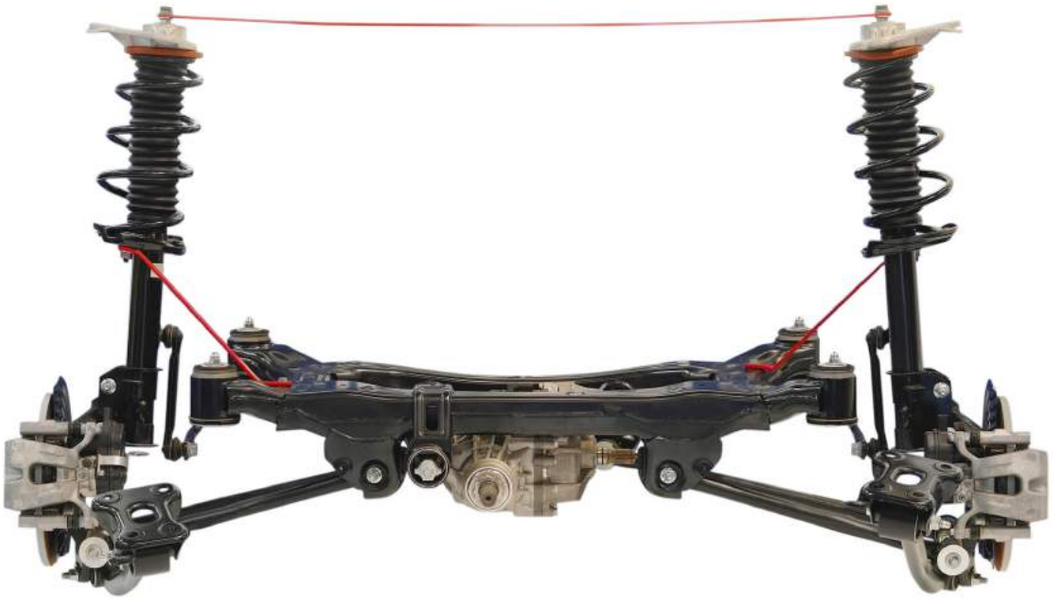
Equipment required
Given shock absorber

Tools required
1. Double end spanner
2. Screw driver
3. Drift punch
4. Wooden hammer

Material required
1. Cotton waste
2. Grease
3. Oil tray

Reasoning for dismantling
- More noise suspension system
- Vehicle pulling to one side
- Improper functioning of shock absorber
- Manufacturing POI is over

Dismantling
1. List the front axle of the vehicle by using jack
2. Remove the lower eye and upper eye mounting bolts of the shock absorber
3. Remove the shock absorber form the vehicle



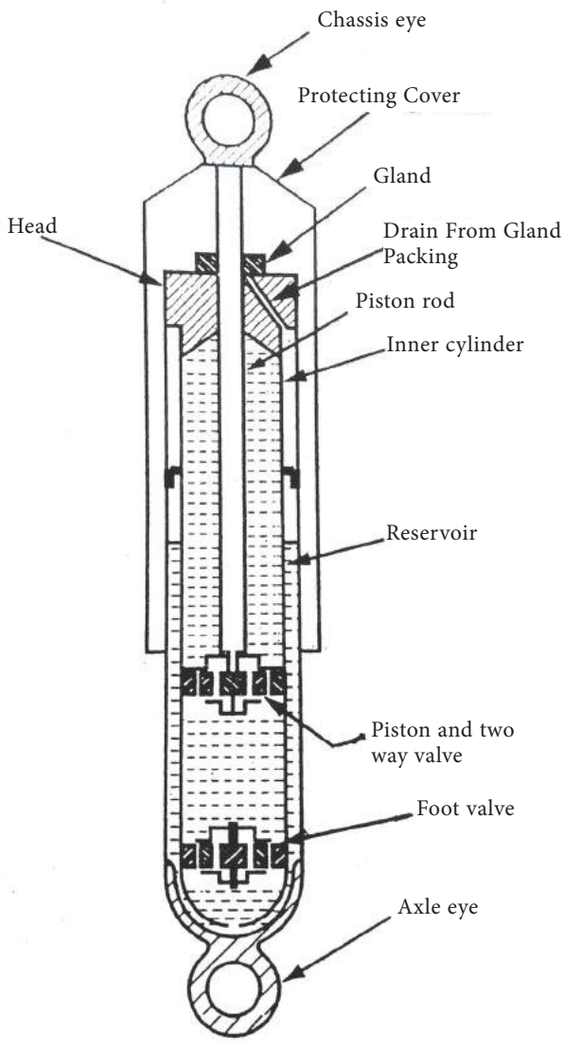


Fig 7.5.2.2 Telescopic type Shock absorber

4. Clean the shock absorber by kerosene or water
5. Loesten the outer tube hut and remove the foot value in the inner tube
6. Remove the dust cover
7. Remove the piston and value assembly .

Inspection

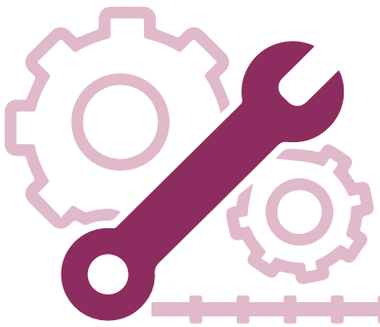
- Inspect the upper eye and lower eye for any damage
- Inspect the inner tube, outer tube , foot value, cylinder, piston assembly and etc..
- Replace the defective parts by new one.

Assembling

Assembling is the reverse process of dismantling

Result

Thus the given shock absorber was dismantled, inspected and assembled.



Practical – 8
SELF STARTER MOTOR

Aim

Dismantling, inspecting and assembling of self starter motor.

Equipment required

Given starter motor.

Tools required

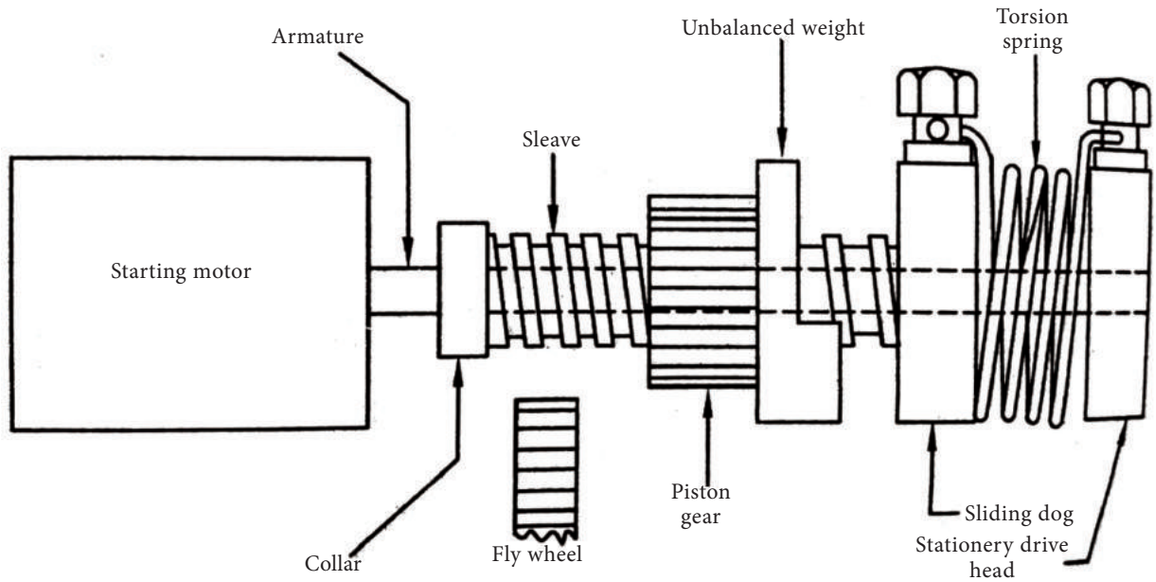
1. Double end spanner
2. Double spanner
3. Wooden hammer
4. Screw driver
5. Armature growler
6. Insulation tester

Material required

- Fine cloth
- Kerosene
- Fine emery sheet
- Insulation tape
- Metal tray
- Work bench

Reasoning for dismantling

- Armature not rotating
- Armature rotate is slowly
- Armature rotates continuously
- More noise while running
- Manufacture POI is over



Dismantling

- Disconnect all the electrical connections
- Disconnect the mounting bolts and nuts of the starting motor
- Remove the starting motor from the vehicle and clean the outer portion
- Place the starting motor on workbench
- Remove the end cover
- Remove the armature shaft
- Dismantled the drive mechanism [pinion, Bearing, Spring and etc.]

Inspection

- Clean all the parts
- Inspect the armature, field winding, colar, sleeve un balanced weight, pinion, drive mechanism, spring, bearing and etc… for any damage.

Insulation test

- An A.C circuit containing two poles and one light switch is used for this test
- One pole is connected with the armature coil and other is with the segment
- 'ON' the light switch, if the light, glows change the brush plates.
- Connect one pole to the field terminals and other end with the wice, if the light, glows change the field

Armature glower tester

It used to check any short circuit in the armature

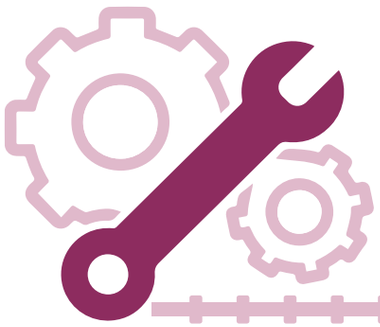
If a growling sound comes, then there is a short circuit in the armature, otherwise if is ok.

Assembling

Assembling is the reverse process of dismantling

Result

Thus the given self starter motor dismantled, inspected and assembled.



Practical – 9
DYNAMO

Aim

Dismantling, inspecting and assembling the & given dynamo

Equipments required

Given Dynamo

Tools required

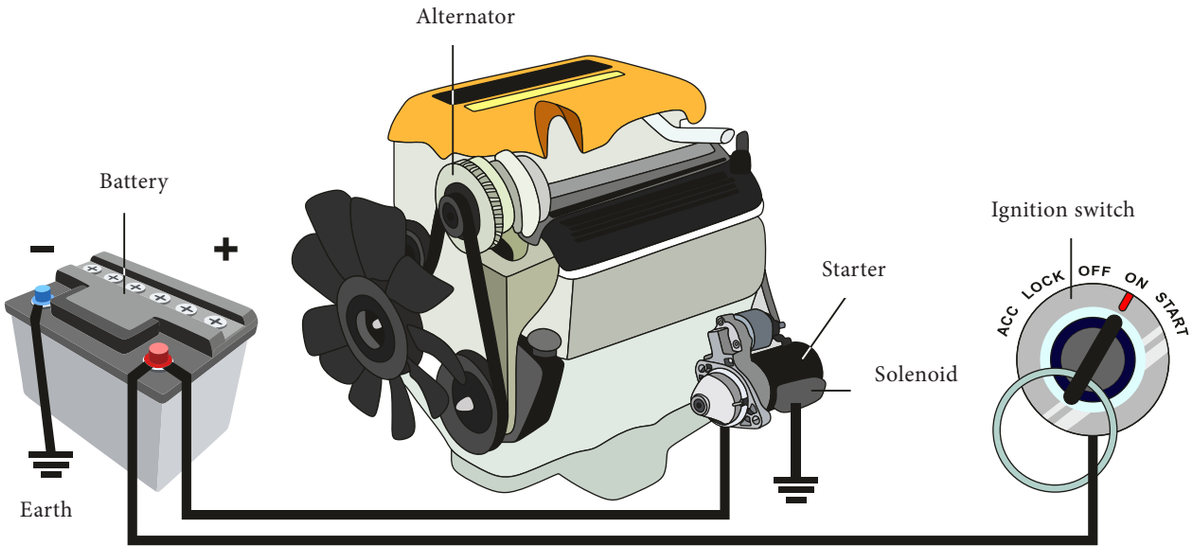
1. Ring spanner
2. Double end spanner
3. Screw driver
4. Drift punch
5. Wooden hammer
6. Armature growler
7. Insulation tester
8. Puller
9. Copper hammer

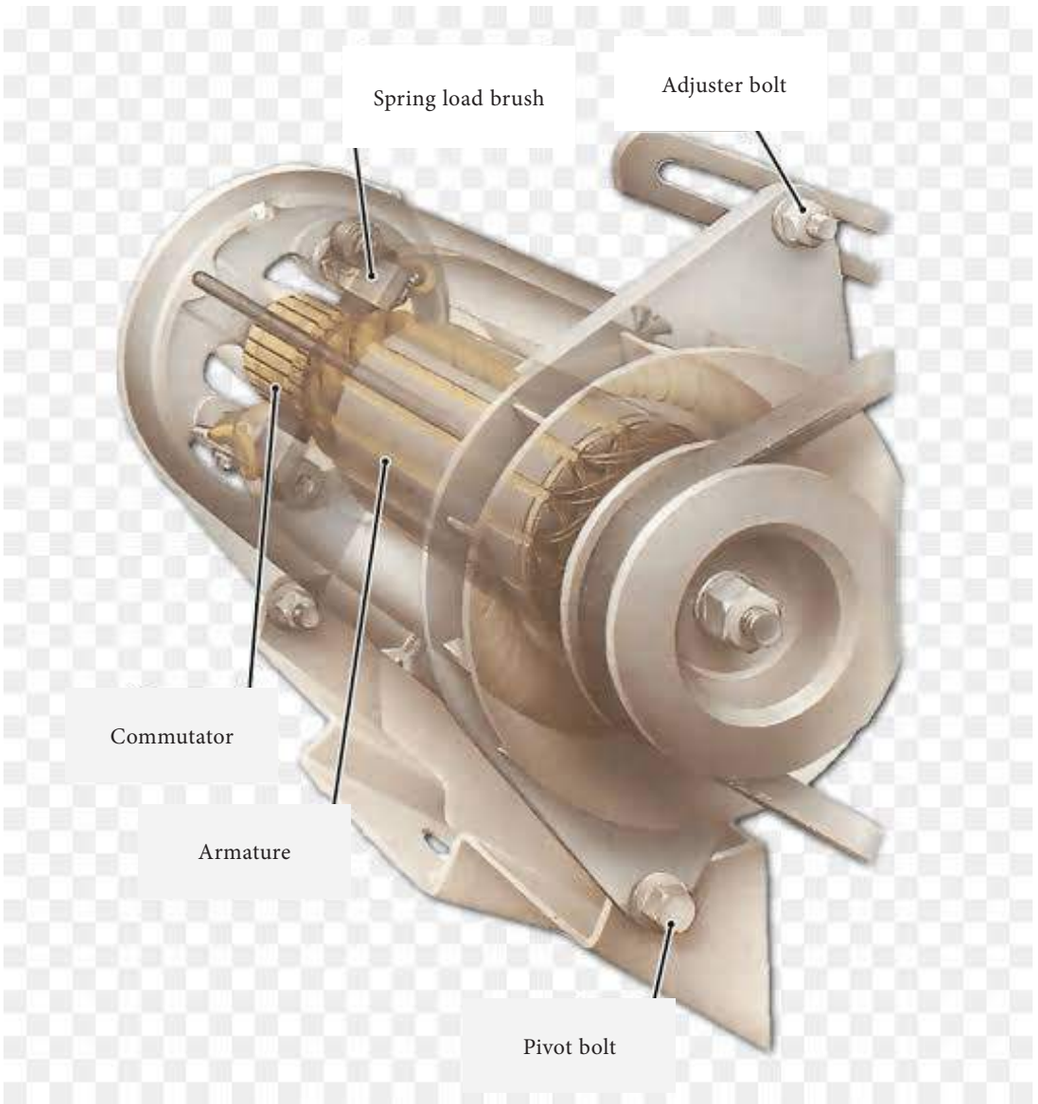
Material required

1. cotton waste
2. kerosene

Reasoning for dismantling

- No current supply through terminals
- More noise when the generator is running
- Low output current in dynamo
- Damage armature bearing
- Manufacture of POI is over





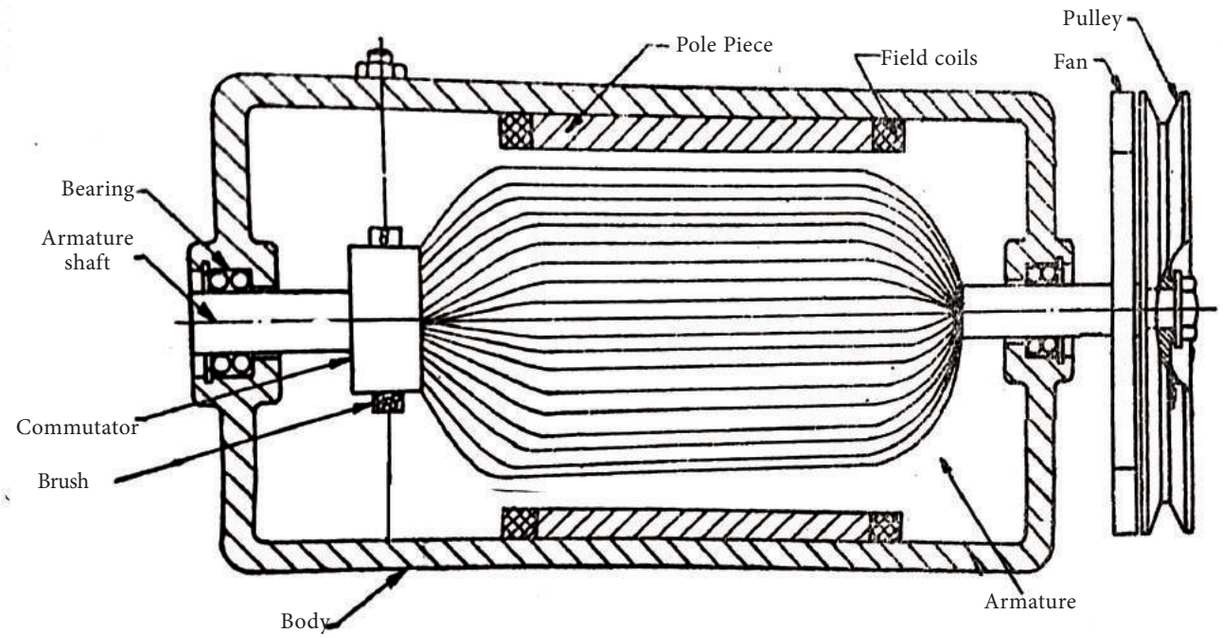
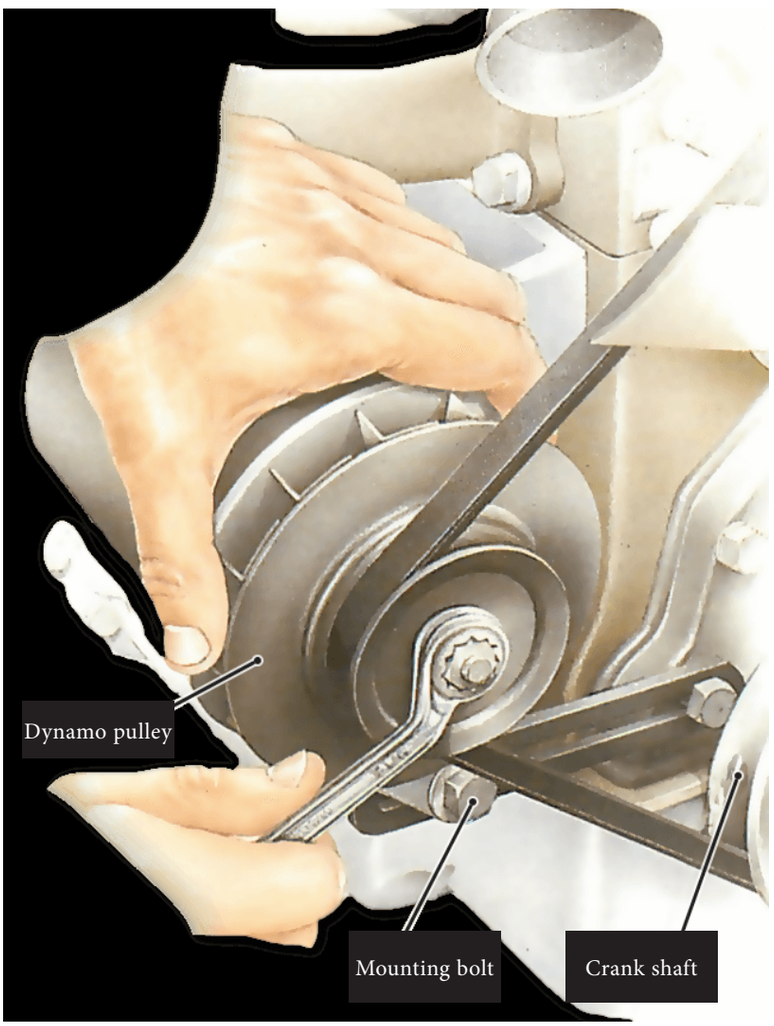


Fig Dynamo (or) D.C. Generator



Dismantling

- Disconnect the electrical connections
- Remove the belt from the dynamo pulley
- Remove the mounting bolts and nuts
- Place the generator on the work bench.
- Dismantling the following parts from the generator

1. 'V' pulley
2. End cover
3. Armature assembly
4. Commutator

Testing

Insulation test

Insulation test

- An A.C circuit containing two poles and one light switch is used for this test
- One pole is connected with the armature coil and other is with the segment
- 'ON' the light switch, if the light, glows change the brush plates.
- Connect one pole to the field terminals and other end with the wice, if the light, glows change the field

Inspections

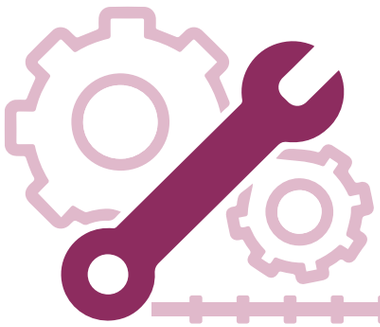
- Inspects the following parts
- Armature winding, field coils, commutator, carbon brush, bearing, spring force, fan, 'V' pulley and etc…

Assembling

Assembling is the reverse process of dismantling

Result

Thus the given dynamo was dismantled, inspected and assembled.



Practical – 10
BATTERY

Aim

To check the condition of the battery

Equipments required

Given battery

Tools required

1. Double end spanner
2. Screw driver
3. Hydrometer cell voltage tester

Material Required

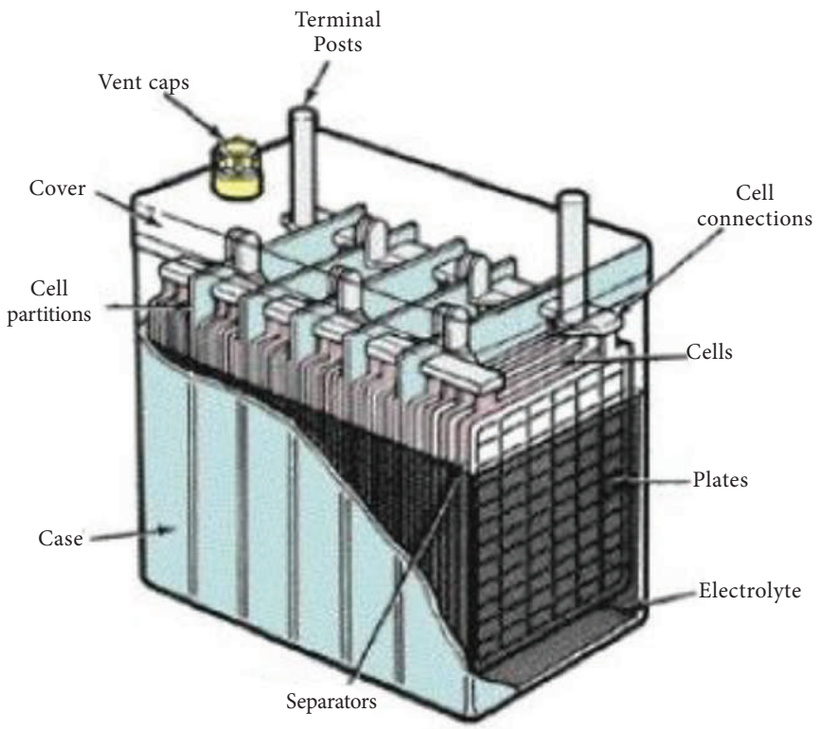
- Cotton waste
- Grease
- Distillen Water

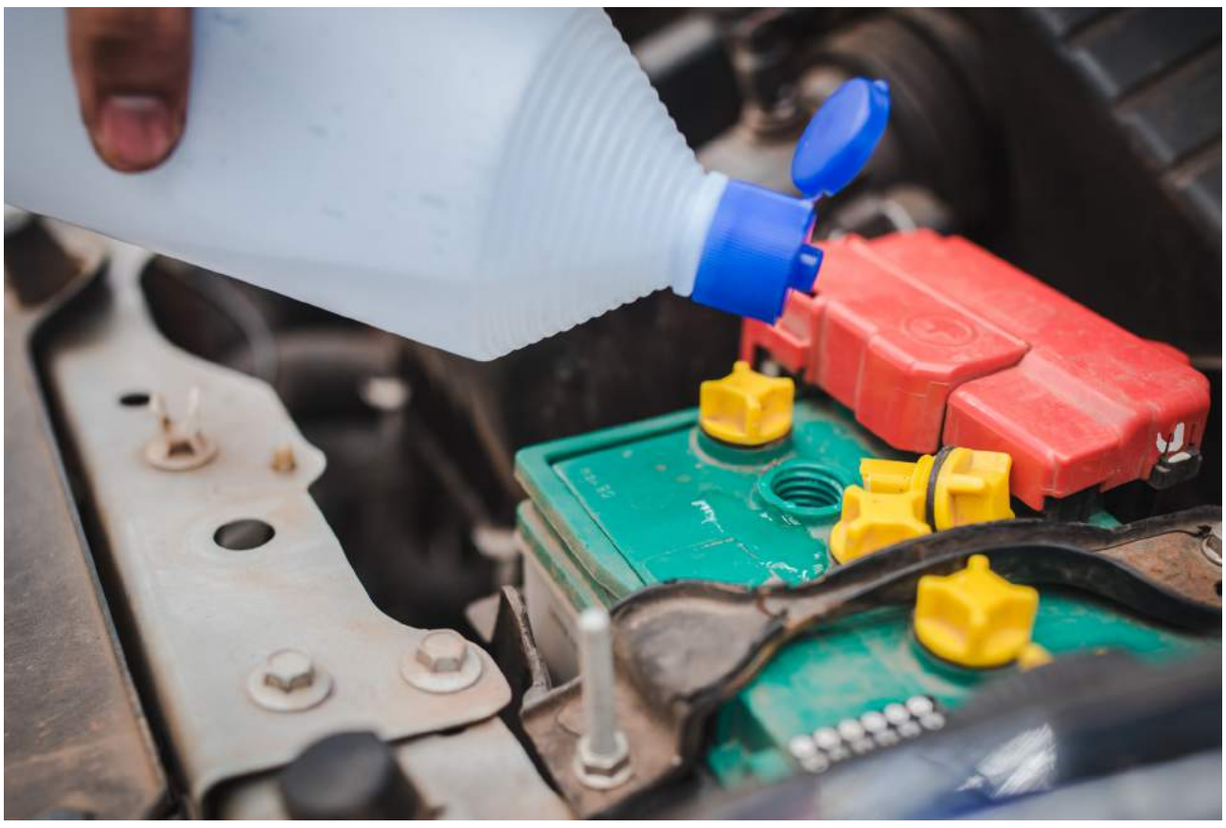
Procedure

Specific gravity test

- Hydrometer is used for this test
- Remove the vent plug and place the hydrometer hose inside the cell
- Press and release the rubber bulb
- Small amount of electrolyte is drawn into the glass tube
- Now the float is float in the electrolyte
- Note the reading on the graduate scale
- Tabulate the reading
- Repeat the same [procedure for other cells

S.no	Cell no	Specific gravity
1		
2		
3		
4		
5		
6		





Cell voltage tester

Cell voltage tester is used to check the volt for cell

Remove the vent plug and check the voltage if cell by using voltage tester.

Tabulate the following

Repeat the same procedure for other cells

Maximum cell voltage per cell is 2.1 V it depends on specific gravity of the electrolyte.

S.no	Cell no	Volt
1		
2		
3		
4		
5		
6		

Result

The charge condition of battery is checked.

Case Study

Name	Er. T. Amalan Paul Samuel M.E.
Designation	Configuration Manager
Organisation	Vestas Wind Systems A/S Denmark
School & Batch	T.V.S. Higher Secondary School, 1997–1999 batch

I thank my Creator for bringing me through with His grace and blessings. Also, I am grateful to my **T.V.S. Higher Secondary School** and my Auto mechanic teacher **Er.R.S.Muralidharan** who played a major role in my academics for what I am today. Though I took this course without an option, still he was instrumental in kindling my interest & passion towards mechanical engineering.

I sincerely thank my parents Mr. M.Thanasekaran, Retd. Sub-Divisional Engineer, BSNL and Mrs. Padma Thanasekaran, Retd. PG Asst., for their support and encouragement throughout my life.

Though vocational group is often overlooked by many, this course helped me to get my basics on engineering right. Being a vocational course, the curriculum is set in such a way that it helps to build the confidence of a young student towards equipping oneself as entrepreneur. The confidence that I gained from the subject still speaks for itself when I access any real time situations at my work.

Auto Mechanic course had set a solid foundation for my career as an engineer. The motivation given by Er.R.S.Muralidharan helped me to aim for engineering that progressed towards the completion of Master's in Engineering with specialization in CAD / CAM. He taught me the importance of looking for details, completion with perfection, team work, maintaining the equipment & tools that we use practical & systematic way of servicing components etc. I am always thankful to my school which not only helped me to grow in my academics but also instilled in me the importance of discipline and social responsibility.

Currently, I am working with **Vestas Wind Systems A/S** a Danish manufacturer, seller, installer, and servicer of wind turbines. It is the largest wind turbine company in the world.

I am proud to work in the **green energy sector** for more than a decade by giving back to the society positively. I have an **international patent - WO/2012/089214**. The invention relates to a method and assembly for aligning a wind sensor relative to a rotatable nacelle of a wind turbine.

From all these years I have understood that hard work brings positive returns. Enjoy learning and always have a superior goal to achieve and work towards it everyday by accomplishing smaller ones.

All the very best and wishes.

T. Amalan Paul Samuel

Case Study

Name	T. Dinesh Moorthi
Father Name	K. Thirumalaisamy
Organisation	Schneider Electric GmbH, Wiehl, Germany
School	Palani Gounder Higher Secondary School, Nachimuthu Polytechnic College Campus, Pollachi, Coimbatore District - 6420012

Dear friends,

I, T.DINESH MOORTHI, would like to share my opinion and how I strived to reach the highest position in my life as I choose a Auto Mechanic group in Vocational Stream at higher Secondary level.

My father worked as an Instructor in Auto Mechanic Laboratory at Nachimuthu Polytechnic College, Pollachi. After the completion of my SSLC, out of my personal interest and my father's advice I selected the vocational group and joined at **Palanigounder Higher Secondary School, Pollachi**, a school of excellence for vocational education which received the NCERT Award twice for promoting good vocational education.

These two years of study was a turning point in my career. During my school days, I had skill training in reputed car companies, where I learnt modern technologies and acquired innovative skills along with academic studies which changed my entire career. It paved way for my higher education and bright future.

I was the top rank holder in the Higher Secondary XII Standard Public Examination. I applied for B.E., admission in Anna University through single window counseling system. I got the fifth place in Anna University ranking for admission. I selected Production Engineering Course at PSG College of Engineering, Coimbatore.

The strong knowledge which I acquired in the Higher Secondary Course and the technical skill experience which I got in the industrial training helped me a lot in the engineering course and so I was awarded with the best outgoing student at PSG College of Engineering.

I was selected in the campus interview to work at Schneider Electric Company. Then I was placed in the R & D Centre, Bengaluru. Thereafter, I got promotion went to Demark and served for 1½ years. For the past 2½ years I have been working at Schneider Electric Company in Germany.

In the present Scenario, what I suggest that Vocational education is an essential one for all and the need of hour. It is the base of our life and is necessary for the growth of our economy and nation.

My suitable selection of vocational course is the basic reason for my growth and my life is an example to others.

Thanking you, all the best good luck.

All the very best and wishes.

T. Dinesh Moorthi

Case Study

Name	P. Thirumurugavel
Father	R. Prasad
Mother	P. Valli
D.O.B	04.11.1996
School	General Cariyappa Higher Secondary School, Dhasaradhapuram, Saligramam, Chennai – 93.
Residence	104/25 Annai Abirami Nagar, 3rd St., Thiruverkadu, Chennai.
Garage Address	Sri Sakthi Auto Garage 13, C.D.N Nagar 14th Street Nerkundram, Chennai.

I am proud to saying a few words about my school. **General Cariyappa Higher Secondary School** Which is a pioneer I teaching Vocational education in higher secondary level changing the life style of the students?

The name automobile engineering itself threatened me that the syllabus would be tough and hard when I joined this course but I completed it with first rank I the state at 2014. My teams project potable Battery charger won NCERT award and our team went to Bopal to receive the same with pleasure and pride and all the credit goes to my Head masters and Teachers.

Through I could not step in to the college due to family crisis and I could do my apprentice ship in major service centers since 2am the student of this school.

My vocational education in automobile engineering has given me confidence to bear my own workshop and running it successfully.

Iam an employer of right persons providing them monthly salary besides earning Rs 1, 00,000 personally.

I give complete service and repairs to various light and heavy vehicles giving the good name from many customers and all these success in my life are the byproducts of my vocational education which I remember with happy tears.

Thanking you

All the very best and wishes.

P. Thirumurugavel

Case Study

Name	Ashok S.A, S/O. S.A.Raja
Qualification	M.E., Electronic application engineer
Job	Assistant Professor, Panimalar Engineering College, Chennai
School	N.S.V.V. Boys Higher Secondary School, Pattiveeranpatti, Dindugal District

Hello Friends

I, R.Ashok have completed my higher secondary Automechanic course from **N.S,V.V. Boys higher secondary school Pattiveeranpatti** during the year 2005 and 2007.

I like to share the key turning points happened in my life. After completing my 10th standard, my father advised me to join in Auto mechanic group. Even though my interest towards teaching field, I joined in this course. After that, my teacher Mr.S.S. Suthan encouraged me and guided me that teaching is possible in this field also. Under his guidance, I studied well in 12th standard and passed out with state first rank. I take this opportunity to thank my teacher Mr.S.S. Suthan for his help and encouragement. Moreover, I could able to select the subject Electronics and communication in my Engineering degree.

At this moment, I express my sincere thanks to all the teachers of N.S.V.V Boys higher secondary school and I am grateful to the school management who helped poor student like me to change our life.

All the very best and wishes.

Ashok S.A

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Glossary

Torque Tube	முறுக்கு விசைக் குழாய்
Rear axle casing	பின் இருசு மூடி
Sliding joint (or) Slip joint	நெகிழ் இணைப்பு
Braking Torque	தடை விசை
Banjo type casing	தம்புரா வகை இருசு மூடி
Split type casing	பிரிக்கும் வகை இருசு மூடி
Hypoid gear	சுருள் பற்சக்கரம்
Worm gear	திருகு பற்சக்கரம்
Bevel gear	சரிவு பற்சக்கரம்
Coupling	இணைப்பி
Differential assembly	வேகமாற்றித் தொகுப்பு
Axle breather	அச்சுக்கூட்டின் காற்று நீக்கி
Hub	சக்கரக் குடம்
Rim	விளிம்புச் சட்டம்
Tube	காற்றுக்குழல்
Tyre	பட்டை
Tubeless tyre	குழலற்ற பட்டை
Tubed tyre	குழலுடைய பட்டை
Vulcanizing	கசிவு நீக்குதல்
Tread	மிதிப்புப் படலம்
Breakers	முறிவலைப் படலம்
Bead wires	விளிம்பிழைகள்
Ply rating	படல எண்
Cord ply	இழைநார்ப் படலம்
Inflation	காற்றழுத்தம்
Fitness certificate	தகுதிச் சான்றிதழ்
Anchor pin	ஆதார பின்

Brake band	தடை வளையம்
Dust boot	தூசு மூடி
Brake shoe adjuster	தடைக்கட்டை நகர்த்திகள்
Serrated wheel adjuster	பற்சக்கர வகை நகர்த்தி
Wedge type adjuster	ஆப்பு வகை நகர்த்தி
Snail type adjuster	நத்தை வகை நகர்த்தி
Power brake	சத்தூட்ட தடை
Booster	திறன் பெருக்கி
Air exhauster	காற்று வெளியேற்றி
Stabiliser	நிலை நிறுத்தும் கம்பி
Cambering	வளைவூட்டிதல்
Stub Axle	துண்டு அச்சு
Universal Joint	கோணம் மாறும் இணையம்
Suspension system	அதிர்வு நீக்கும் அமைப்பு
Shackle	அசைவுக் கரம்
Bushes	தேய்வுறைகள்
Clips	கவ்விகள்
Central bolt	மையத் திருகாணி
Mainleaf	பிரதான பட்டை / முக்கிய பட்டை
Helper spring	துணைப் பட்டைவில் தொகுப்பு
Forging	அடித்துருவாக்கல்
Silent block bush	சத்தமற்ற தேய்வுறை இணைப்பு
Parallel link type	இணை இணைப்பு வகை
Trailing link (or) Swing arm type	ஊசல் (அல்லது) அசைவுக்கரம் வகை
Ammeter	மின்னோட்ட அளவி
Firing order	எரிதல் வரிசை
Electric motor	மின்னோடி
Electric resistance	மின்தடை
Generator	மின்னாக்கி
Governor	கட்டுப்படுத்தி
Lead acid battery	காரீய அமில மின்கலம்
Starter motor	இயக்க முன்னோடி
Soft Iron core	தேனிருப்பு உள்ளகம்

Storage battery	சேம மின்கலம்
Transformer	மின்மாற்றி
Generating system	உற்பத்திப் பிரிவு
Separators	இடைநிறுத்திகள்
Vent holes	காற்றுத் துவாரங்கள்
Charging	மின்னேற்றம்
Discharging	மின்னிறக்கம்
Rating	தீர்வை முறை
Rectifier	மின்திருத்திக்கருவி
Horn	ஒலிப்பான்

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