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Participant Handbook

Sector
Automotive

Sub-Sector
Automotive Vehicle Service

Occupation
Technical Service & Repair

Reference ID: **ASC/Q1402, Version 6.0, NSQF Level 4**

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Four Wheeler Service Technician

Developed by

Automotive Skills Development Council (ASDC)

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"Skilling is building a better India.
If we have to move India towards development then Skill Development should be our mission."

Shri Narendra Modi
Prime Minister of India

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is hereby issued by the

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for

SKILLING CONTENT : PARTICIPANT HANDBOOK

Complying to National Occupational Standards of

Job Role/ Qualification Pack: Four Wheeler Service Technician ' QP No. ASC/Q1402, NSQF Level 4

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Authorised Signatory
Automotive Skills Development Council

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About this book

Indian Auto Industry is one of the largest in the world. The industry is expected to contribute 10% to India's GDP as per Automotive Mission Plan 2016-26 and create 65 million additional jobs. The sector offers big potential for jobs across the length and breadth of the country. In line with the rapid technological advancement in this field, there are exciting prospects for a fulfilling career in this industry.

This book is designed to enable a candidate to acquire skills that are required for employment. The content of this book is completely aligned to the National Occupation Standards QP/NOS and conform to the National Skills Qualification Framework (NSQF).

The Qualification pack of Four Wheeler Service Technician, Level 4 includes the following NOS's which have all been covered across the units:

1. ASC/N9801: Organize work and resources (Service)
2. ASC/N1402: Assist in performing diagnosis of vehicle for repair requirements
3. ASC/N1403: Carry out routine service and minor repairs
4. DGT/VSQ/N0102: Employability Skills (60 Hours)

Key Learning Objectives for the specific NOS mark the beginning of the Unit/s for that NOS. The symbols used in this book are described below.

Symbols Used

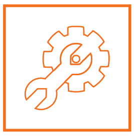
Key Learning Outcomes

Exercise

Tips

Notes

Unit Objectives



Activity

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1.Introduction to the Role of a Four Wheeler Service Technician

Unit 1.1 - Introduction to Automobile

Unit 1.2 - Job Role of Four Wheeler Service Technician

Bridge Module

Key Learning Outcomes

At the end of this module, participants should be able to:

1. Explain about automobile industry.
2. List OEMs and different products/models available.
3. Classify automobiles based on industry and other parameters.
4. Describe the role and responsibilities of a Four Wheeler Service Technician.
5. List the errands and activities with which the service technicians need to be assisted such as fetching parts, tools, gauges, etc.
6. Identify the different locations in the workshops for designated tasks, such as platforms for service, area for minor repairs, areas for routine maintenance etc.
7. Explain the organisational policies and professional code of conduct of the dealer/workshop.

Unit 1.1 - Introduction to Automobile

Unit Objectives

At the end of this unit, participants will be able to know about:

1. Explain about automobile industry.
2. List OEMs and different products/models available.
3. Classify automobiles based on industry and other parameters.

1.1.1 Introduction

We all are familiar with the word Automobile. We do also understand the meaning of automobile; it could be a car, two wheeler, bus etc. having its own engine and move using wheels for goods transport or carry passengers.

Car which is also an alternative name of automobile also seems to be taken from Latin word carrum which means wheeled vehicle or from French word cart. Most of these words seem to be taken from Gallic Chariot. Most of the definition of automobile tells us that it is designed for roads and should have seating capacity ranging from 1 to 8 people, may have minimum 2 wheels and is designed for the purpose of transporting people and goods.

1.1.2 Automobiles Categories

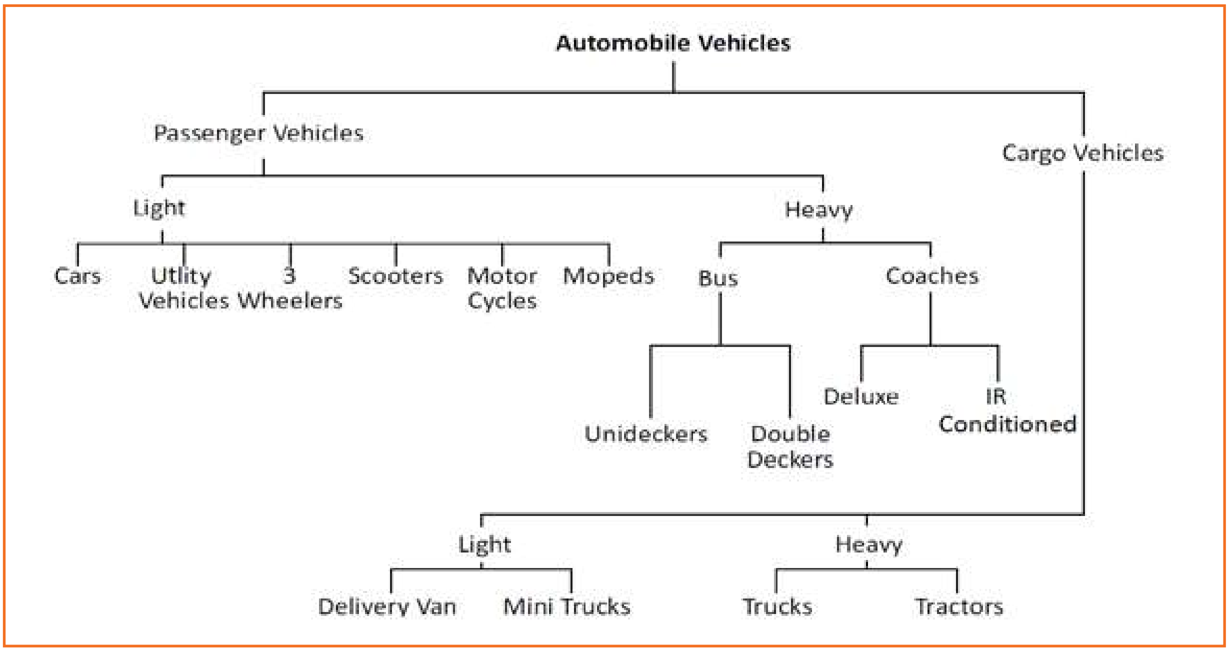

Fig 1.1.1: Automobile categories

1.1.3 Automobiles Classification

Purpose of Transportation:

1. Passenger vehicles — Car, General/Multi purpose Vehicles, Bus
2. Goods vehicles — Truck

Capacity:

1. Light motor vehicles — Car, Sports Utility Vehicles (SUVs), Multiutility Vehicles (MUVs) etc.
2. Heavy motor vehicles — Bus, Coach, Tractor, Trucks
3. Two Wheelers-Geared Motor cycles/Non-geared Two wheelers/Electric Two wheelers

Fuel used:

1. Petrol vehicles - Car, Motorcycle, Scooter
2. Diesel vehicles -Truck, Bus, Tractor, Bulldozer
3. Electric cabs - Battery truck, Forklift, Two wheelers, Cars, Buses
4. Steam carriages - Steam road rollers (Not in use now)

Number of Wheels:

1. Two-wheeler
2. Three-wheeler
3. Four-wheeler
4. Six-wheeler

Drive of the Vehicles:

1. Single-wheel drive vehicle
2. Two-wheel drive vehicle
3. Four-wheel drive vehicle
4. Six-wheel drive vehicle
5. Front wheel drive
6. Rear wheel drive

Location of Steering Wheel:

1. **LHD :** Left hand drive
2. **RHD :** Right hand drive

Normally Automobile are Specified as:

- **Type:** Car, truck, scooter, motorcycle, bus
- **Capacity:** 5 ton, 3 ton, 1 ton, 2-seater, 4-seater, 6- seater, 30-seater, 45-seater
- **Manufacturer or Make of the Vehicle:** Tata, Maruti, Suzuki, Ashok Leyland, Mahindra, Honda, Hyundai, Toyota, Ford, Fiat, Chevrolet, Audi, Mercedes, Isuzu, Skoda, Volkswagen

- **Model:** Year of manufacturing or chassis code number The vehicle identification number is the identification code (VIN) marked on each and every automobile. The VIN number is unique in nature and two vehicles cannot have same VIN as it is used as unique identification mark for the vehicle. Usually VIN have 17 alpha numeric code.

Fig 1.1.2: Automobile VIN no.

1.1.5 Invention of Automobiles

Post World War II, Automobile Industry started on rapid modernization in the 50s and 60s. Many new models of cars were introduced like Edsel, Chevrolet etc.

In USA, road network was built after the second World War. The road network was developed using modern technology having long highways to cover the country. USA has a very big land mass and vast geography. This allows open and wide roads to be built. On these types of road model of the car like the Beetle appear very small!

Three big car industries General Motors, Ford & Chrysler decided to design big fast moving cars for the American roads. During the period between 50 to 60 various cars were introduced on American highways which include Chevrolet, Edsel, Pontiac, Buick, Firebird, Impala etc. These models used large amounts of petrol or gasoline as it is called in US. But, petrol consumption was not the main issue in those happy days.

So, there was a competition between each of the car maker in making bigger & bigger designs with more luxuries added for comfort. All this made owning and maintaining a car quite costly. Still, more and more Americans were buying these models. One very popular model from FORD was named 'MUSTANG'. During 1973 situation was changed globally due to crisis of oil. Due to crisis market price of petrol became costlier because Arab nations got together in coalition. Now, suddenly even Americans started looking for more economical designs.

Meanwhile, quietly but with determination, Japan was developing cars for marketing worldwide, mainly in the USA. Post damage after WW II, many Japanese companies were introduced like Suzuki, Mitsubishi, Toyota, Mazda etc. Some of these like Mazda, were using American Technology. But, these companies were also developing their own Research capabilities. As a result when there was a oil crisis in 1973, these companies were very well positioned to roll out smaller, compact and economical models in USA.

Since then, companies like Toyota, Honda have gradually increased their market presence worldwide. Normally present era is defined as twenty five years before the present year. Presently available cars are differentiated from antiques based on technical and design aspect. Without bearing in mind car future, present approach is to focus more on the standardization, sharing of platform and computer aided design.

In 1983, Indian Government started Maruti Udyog in collaboration with Suzuki of Japan. Maruti's first model called Maruti 800 became a big success. Within 5-6 years the company reached an annual production level of nearly 1,00,000 cars per year. They launched various models like 800, Gypsy, Omni van, Esteem, Zen, Baleno etc.

During 90s end several other global multinational car makers also started manufacturing their models in India. Among them were, General Motors, Ford, Hyundai etc.

In just a few years the Indian market for cars reserved its position in global automotive activity. As we see, Indian Auto industry started with import of cars in the 20s. Then the first manufacturing started in the 40s. With continued progress many Indian companies like Maruti, Tata, Mahindra have become very big global names. Now, they are not merely manufacturing European/American or Japanese designs, but they are doing so with their own research & development capabilities. As a result, Nano model was developed by TATA Motors. Presently Nano is known as very economic car in the word with all convenient and quality features. Now India is now also exporting nearly 12% of manufactured cars to Europe, USA and elsewhere in the world.

Automotive industry in India is falling into largest industry and also it is growing globally with a rapid speed. Indian automobile manufacturing industry in car and commercial vehicle section is on 6th position in the world having annual production more than 3.7 million. As per one of the report in passenger vehicle segment India is expected to surpass Brazil to become sixth largest producer in the world with a growth of 16 to 18 percent covering over 3 million units. In passenger car segment Indian automobile industry is on 4th position after Japan, Thailand and Korea.

In passenger cars segment, during the year 2010 India became third largest exporter after Japan and Korea beating Thailand. In the year 2010 India produced more than 37 lakhs vehicle which presented a major global percentile increase and secured its position in the world as fastest growing automobile market. Indian Automobile Manufacturers Society projected sales of vehicle around 5 million by the year 2015 and by 2020 it will go more than 9 million. It is expected that by the year 2050 India became top in car volume with around 611 million cars on Indian road. In India car manufacturing industry is mainly divided into three clusters i.e. south, west and north.

Chennai which is falling in southern cluster is considered as biggest cluster sharing around 40% of the revenue. The western hub near Maharashtra is sharing 33% market. Haryana is considered in the northern cluster sharing 32%. Ford, Hyundai, Renault and Nissan having headquarter and BMW having assembly plant in Chennai and is considered as **"Detroit of India"**. Chennai exporting around 60% auto-motive and considered as largest exporter in India.

India's largest car manufacturer Maruti Suzuki is having its plant in Gurgaon and Manesar. Both these cities are part of Haryana and fall in northern cluster. Various automobile companies which includes Tata Motors, Mercedes Benz, Mahindra and Mahindra, Skoda, Volkswagen, Land Rover, Force Motors etc. are operating their assembly plant based in Chakan corridor close to Pune which falls in western cluster. Audi, Skoda and Volkswagen are based in Aurangabad which also a part of western cluster.

General Motors is based in Halol and Tata Nano at Sanand, Gujarat. Peugeot and Maruti Suzuki have their plant in Gujarat. Thus Gujarat is also now becoming a promising cluster for car manufacturing. There are other automotive manufacturers like Hindustan Motors based in Kolkatta, Honda based in Noida and Toyota based in Banglore.

Notes

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History of Automobile

Unit 1.2 - Job Role of Four Wheeler Service Technician

Unit Objectives

At the end of this unit, participants will be able to know about:

1. Describe role of four wheeler service technician
2. List key responsibilities of service technician

1.2.1 Role of an Auto Service Technician at Service Centre

Automotive service technician is responsible for inspecting, maintaining, and repairing vehicles. Automotive service technician attends to the customer and also respond to customer queries, discuss with customer about automotive problem and also give options to resolve the issues. Automotive service industry works on the repeated clients thus it become very essential for the technician to be always polite, be a good listener and should capable of answering customer's queries. The individual must be patient and have good listening ability with customer centric attitude is highly desirable to understand customer problem and also suggest preventive maintenance guidelines to customer like efficient fuel consumption, tyre life etc. (In OE authorised/organised workshops these job are performed by the Service Advisor)

Growing importance of after sales in auto industry:

- The role of the companies does not end with selling the product only. In fact, with the ever growing competitive market, it is completely important for every company to equally work hard in after sales.
- This includes product quality and sustains performance which leads to customer satisfaction.
- After sales service should ensure that customers are happy and satisfied not with the product only but also the service the organization offers.

Role of after sales in auto industry ensures:

- Product and service meet or exceed the customer's expectation;
- Customer believes and trust in the brand;
- A strong bond between the organization and the customer;
- Earn more customers through reference from old ones;
- Earn more revenues and profits in the market.

The technicians play an important role for the workshop profitably:

- A productive workforce of technically sound people will ensure / customer satisfaction and retention.
- A proper workshop has room for different work activities.
- An organization chart defines the reporting structure of the workshop.

- A well-defined service process ensures a smooth running of the workshop.

Role of four wheeler service technician:

- Courteously greet the customer with a warm welcome (In absence of Service Advisor-SA) / receive the vehicle from Supervisor/Job Scheduler
- Collect and safely handover the customer's personal belongings of customer like phone, pen, documents, water bottles etc, to the customer (In absence of Service Advisor)
- Fill in the job card after Read and understand carefully listening to the customer's problems in the vehicle recorded over Job Card. (In absence of Service Advisor). In case of any doubt get it clarified from SA
- Carefully note down on the job card, damages like dent marks, already present on the vehicle at the time of receiving the vehicle (In absence of Service Advisor).
- A four wheeler service technician has to carry out service, repairs and maintenance activities of various aggregates (including electrical and mechanical aggregates) of four wheelers
- Assist the senior technician in identifying & diagnosis of the operational fault responsible for the root cause of the vehicle trouble
- Assist in taking necessary action post the root cause analysis to repair the vehicle

The following points are important:

- Note the functioning of all the electric bulbs and see if some are fused.
- Note down the fuel level in the fuel tank.
- Note down the odometer (kms run) reading.
- **Strictly follow the SOP:** Standard Operating Procedure
- Securely park the vehicle at the proper designated place
- Place the vehicle on a suitable platform, before the repair work actually begins
- Study & understand the auto component manufacturer specifications related to the various components/ aggregates in the four wheeler vehicles
- Study & follow standard operating procedures for using workshop tools and equipment for service and minor aggregate repairs in the four wheeler vehicles
- Conduct test drives to assess need for repairs, calibration or any other adjustments in the electrical / mechanical aggregates in the four wheeler vehicles along with the senior technician.
- Review the job card and understand work to be carried out.
- Uses appropriate PPE (Personal protective Equipment) to work safely.
- Uses appropriate vehicle protective covers (Steering wheel cover, seat cover, fender cover etc.) as required.
- Ensure OEM recommended procedure and checklist is followed for routine servicing in case of non-routine service or repair, confirm tasks to be carried out with superior.
- Calibrate, align and adjust settings, alignment, pressures, tension, speeds and levels relevant to components and systems of four wheeler.

- Ensure that in routine maintenance and service, the correct spare parts and appropriate grade of lubricants, coolant, oils and grease required have been obtained.
- Ensure all dismantled components (including mechanical and electrical aggregates) are cleaned and conditioned prior to reassembly.
- Identify and change components requiring change due to continuous wear and tear.
- Ensure disposal of materials (including waste oil, scrap of failed parts/aggregates) in accordance with the organisation's policies.
- Understand the various precautions to be taken to avoid damage to the vehicle and its components while working on other aggregates.
- Record all service and repairs carried out and ensure completeness of tasks assigned before releasing vehicle for the next procedure.
- Ensure all workshop tools, equipment and workstations are adequately maintained by carrying out scheduled checks, calibration and timely repairs where necessary.
- Ensure any malfunctions observed in tools and equipment are reported to the concerned persons.
- Ensure any other repair requirements observed in the other components/aggregates systems (like engine, gear box etc.) while repairing/overhauling of braking systems are reported to supervisor/ service advisor for further inspection by other specialists.
- Measure/inspect the machining or any other repair done from an outside source/ local machining garage.
- Utilise any computer-based applications relevant to service and repairs.
- Ensure that trainings organized by the OEM from time-to-time are attended and knowledge levels are upgraded (esp. in case of newly launched products, product refreshes).

1.2.2 Service Process

- **Vehicle booking:** In this process the appointment is taken by the service advisor from the customer for the service job. When the customer calls for an appointment to service his vehicle the SA will allot time and date for him to bring his vehicle to the workshop as per the work schedule.
- **Vehicle receiving and job card opening:** The SA will receive booked vehicle and open a job order. A job order or a job card is a document which has details of the customers and the vehicle along with the job to be carried out on his vehicle. The customer has to ensure that his and his vehicle details are correctly entered and the jobs and his vehicles problems are correctly recorded on the job card before signing the JC.
- **Job allotment:** The workshop Supervisor allots the jobs to the technicians as per the schedule and priority and delivery commitments.
- **Work progress:** The technician's carries out the work as prescribed in the job order. He will intimate the supervisor if any additional job has to be done on the vehicle. An estimate of the job if required is given. On completion of the job the vehicle is sent for final inspection.

- **Final inspection:** The quality tester will perform the final inspection of the vehicle .He ensures that the job requested by the customer is carried out and the reported problems in the vehicle are solved. He sent the vehicle to washing after his inspection.

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https://www.youtube.com/watch?v=x3fgC2a2S3o

Job role of four wheeler service technician

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2. Work Effectively and Efficiently

Unit 2.1 - Safe Working Practices

Unit 2.2 - Emergency Rescue and First Aid Procedures

Unit 2.3 - Workplace Quality Standards

Unit 2.4 - Health and Hygiene During an Epidemic and Pandemic

ASC/N9801

Key Learning Outcomes

At the end of this module, participants should be able to:

1. List the potential workplace related risks and hazards, their causes and preventions.
2. Identify safety measures during work.
3. Display the correct way of wearing and removing PPE such as face masks, hand gloves, face shields, PPE suits, etc.
4. Show how to deal with a fire accident.
5. Demonstrate how to evacuate the workplace in case of an emergency.
6. Demonstrate basic first aid techniques during electric shock, burns and choking.
7. State the methods to keep the work area clean and tidy.
8. Perform routine cleaning of tools, equipment and machines.
9. Apply basic housekeeping practices to ensure that the work area is clean, such as mopping spills and leaks, cleaning grease stains etc.
10. Discuss how to complete the given work within the stipulated time period.
11. Discuss ways to maintain a proper balance between team and individual goals.
12. Discuss epidemics and pandemics and their impact on society at large.
13. Explain the significance of following prescribed rules and guidelines during an epidemic or a pandemic.
14. Discuss the significance of conforming to basic hygiene practices such as washing hands, using alcohol-based hand sanitizers.
15. Show how to sanitize and disinfect one's work area regularly.
16. Demonstrate the correct way of washing hands using soap and water.
17. Demonstrate the correct way of sanitizing hands.
18. Demonstrate appropriate social and behavioural etiquette (greeting and meeting people, spitting/coughing/sneezing, etc.).
19. Discuss the ways of dealing with stress and anxiety during an epidemic or a pandemic.

Unit 2.1 - Safe Working Practices

Unit Objectives

At the end of this unit, participants will be able to:

1. Elaborate importance of safety at workplace.
2. List the potential workplace related risks and hazards, their causes and preventions.
3. Identify safety measures during work.
4. Display the correct way of wearing and removing PPE such as face masks, hand gloves, face shields, PPE suits, etc.

2.1.1 Health, Safety and Security Procedure

Health, safety and security procedures refer to the guidelines and rules that make sure that people in the workplace, whether they are employers, employees or other visitors are safe and secure. These procedures tell employees or employers how they should carry out their tasks around the workplace in a way that ensures a minimization in accidents, incidents, contraction of diseases and security breaches.

These sorts of preventative procedures may include:

- Educating staff on manual handling, i.e. how to lift and move objects properly to avoid an injury
- Educating staff on how to minimize back and neck pain by using ergonomic furniture in an appropriate fashion
- Giving detailed instructions on how to use equipment
- Educating staff on the importance of wearing appropriate protective gear to handle certain pieces of equipment
- Instructing staff on how to keep the workplace secure, by teaching them about the security systems in place and how to use them so that cash, equipment and people are safe and secure
- Educating staff on potential hazards in the workplace
- Health, safety and security procedures also refer to what you should do when accidents or incidents do occur

2.1.2 Importance of Safe & Secure Working Place

When we feel safe and secure, we can remain motivated and feel happy at our workplace. Workplace safety play an important role in organization as it boosts the productivity. If the workers in the organization feel safe they can work with their full capabilities and potential and it also reflect positivism in the working environment. Therefore, measures needs to be taken to eliminate risks at work and ensure a safe and comfortable environment for the employees.

2.1.3 Responsibilities for Maintaining Safe Workplace

The responsibilities of the employers for maintaining safe workplace are:

- Healthy workplace should be provided
- Train the worker as per their job profile
- Maintain training records (who, what and when)
- Establish and maintain a comprehensive occupational health and safety program, including a written
- Support supervisors, safety co-ordinators and workers in their health and safety activities
- During potential hazard reporting action should be taken immediately
- During incident instant investigation should be initiated
- Provide adequate first aid facilities and services
- Ensure supply of personal protective equipment as per nature of job Worker training is usually carried out by the supervisor. However, the employer has the legal responsibility to ensure that every worker receives adequate training. The employer must follow up to see that the supervisor is carrying out all the required training. Employers should also work with supervisors to help foster positive worker attitudes to safety, health & safety policy and an incident investigation procedure.

The responsibilities of the supervisors for maintaining safe workplace are:

- Instruct workers to follow safety procedures
- Train workers on tasks assigned to them, and check that their safety at work
- Make sure that only authorized, adequately trained workers operate tools and equipment or use hazardous chemicals
- Check out that equipment and materials are handled properly, stored and maintained
- Enforce health and safety requirements
- Take corrective measures on unsafe acts and conditions
- Identify and help workers with problems who could affect safety at the worksite
- Develop health and safety rules and inspect the workplace for hazards

The responsibilities of the workers for maintaining safe workplace are:

- Know and follow health and safety requirements affecting your job
- If you don't know how to do something safely, ask for training before you begin work
- Work safely, and encourage your co-workers to do the same
- Correct any unsafe conditions or immediately report them to your supervisor
- Immediately report any injury to a first aid attendant or supervisor
- Take the initiative. Make suggestions to improve health and safety

2.1.4 Workplace Hazards

The situation which can create threat to human life, property of workplace or environment is defined as hazard. Most of the hazards are hidden in nature which reflects theoretical risk but the fact is that if it becomes active it may lead to emergency. Situation of hazard when finish it turns to be in incident. Hazard and its possibility of getting activated act together to form a risk. Identification of hazard risks is the first step in performing a risk assessment.

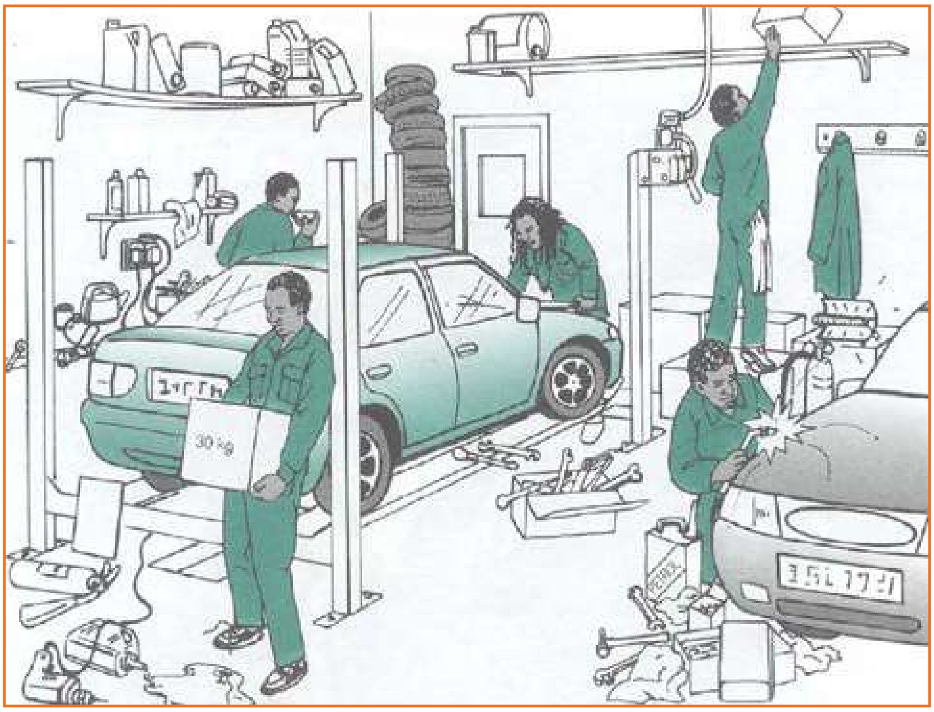

Fig: 2.1.1 Auto workshop Hazards

Hazards are generally classified into three categories:

- **Dormant:** The circumstance project a possibility of active hazard but it does not affect people, property or environment. For instance, a hillside may be unstable, with the potential for a landslide, but there is nothing below or on the hillside that could be affected.

- **Armed:** People, property or environment is in potential harm's way.
- **Active:** A dangerous occurrence in which hazard has played its role. It is sometimes referred as accident, emergency, incident or disaster not hazard.

The common types of hazard are:

- **Physical hazards -** A situation which cause physical harm to body or create extreme stress is referred as physical hazard. A physical hazard may be natural or human made also.
- **Chemical hazards** are substances which can create harm to human health, harm body parts, property or environment. Chemical hazard may be natural or human made also.
- **Biological hazards -** In this type of hazard biological agents plays a crucial role can cause harm to human health or body parts. These biological agents can be fungus, bacteria, viruses, parasites and foreign toxins.
- **Psychological hazards** usually taken place due to stressful working environment. Here potentially a person could be a hazard when affected psychological disturbance through stress or shift patterns and when a person is under the influence of alcohol, illness and lack of training.
- **Electrical hazards** are dangerous condition where a worker can or does make electrical contact with equipment or a conductor. From that contact, the person may sustain an injury from shock, and there is a potential for the worker to receive burn or blast injury.

Activity

Choose any of areas of your workplace, home, market, locality, schools, etc., and look for hazardous situations that can cause injuries to people.

For each hazard you find, write:

- Why it is dangerous?
- What would happen if the hazard wasn't rectified?
- Two options for correcting the situation
- Who should be informed of the hazard (someone in a position of responsibility)?

Submit your findings in a written form (in the form of a report) to your facilitator in the next session.

2.1.5 Auto Shop Safety

Safety at automobile workshop

Fig: 2.1.2 Wear Safety Glasses While using a Grinder

- **Personal Safety:** Observe the following general safety precautions while working in automotive workshop
- Don't indulge in horseplay
- Don't scatter the tools etc. on the operating machinery
- Don't keep sharp objects or tools in your pocket
- See that your dress is suited to the job. It should not be loose which may get caught in the moving machinery
- Never use compressed air for blowing out dirt from Tour clothes
- While chipping, grinding or using air hose or doing any other job where there is danger of flying particles, goggles must be worn.
- When car is jacked up, make sure the jack is properly centered and will not slip.

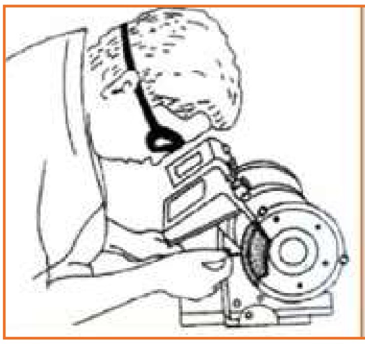

Fig: 2.1.3 Wear Safety Glasses While using a Grinder

Fig: 2.1.4 Vehicle on jacks

Safety with hand tools

- Use the correct tool for the job in hand
- Use the tool correctly
- Keep the tools clean and in good working condition
- Grease or oil on tools should be wiped off as it is difficult to hold and use such tools
- Store the tools in their proper places

Safety with power tools

There are three main dangers with the use of power tools:

- Electric shock: The safety precautions are —
  - Don't use damaged chords
  - Don't stand in water or even wear wet shoes when working with electrical equipment

- Make sure the electrical equipment is properly earthed
- Flying metal chips the safety precautions is — ALWAYS WEAR GOGGLES
- **Injuries due to unsafe use of tools:** The safety precautions are:
  - Carefully study the instructions before using any equipment
  - Keep hands and clothes away from moving parts
  - Make sure the electrical equipment is properly earthed
  - When working on devices like clutches, valves etc. which have springs, make sure the springs will not slip or jump off
  - Don’t adjust or oil moving part of a machine
- Store the tools in their proper places

2.1.6 Personal Protective Clothing

While working on shop floor every worker has to take care of several things about personal safety and also safety of its co-workers. To avoid certain accidents and hazards, person has to take different precautions for different situations.

Firstly on shop floor every person has to wear person protective equipment (PPE) for its personal safety

What is Personal Protective Equipment?

- PPE is defined as “All equipment which protects the worker from risks and hazards while working at workplace”
- Personal Protective Equipments safeguard us from work place hazards

Eye Protection: Eye protection is a must when working on cars. Eyes are so fragile. Safety glasses and goggles will help prevent foreign materials from entering your eyes. These are especially important when inspecting the underbody of a vehicle and working around chemicals. Goggles can be used over prescription glasses

Fig: 2.1.5 PPE

Gloves: Use work gloves when you are performing work on tyres or exhaust. Extremely worn tyres can have sharp steel belts poking from the tread. Exhaust systems can be hot and have rusty holes that can cut your hands. Use disposable latex gloves when you are working with chemicals, oils, and grease.

Fig: 2.1.6 Safety gloves

Head Protection: Hard hats guards from collision and penetration hazards also from burns and electrical shock hazards. Make sure that head protection is available where following risks can happen:

- Falling objects
- Contact of head with electricity sources accidently

Fig: 2.1.7 Safety hat

Foot Protection: Safety boots guard the feet from puncture wounds, injuries and slipping. Make sure that foot protection is available where following risks can happen:

- When heavy objects roll on or fall on the feet;
- Working with pointed items like nails or wires
- Risk if falling of molten metal on feet or legs;
- Working on warm, damp and greasy surfaces.

Fig: 2.1.8 Safety shoes

Ear Protection: Use earplugs or earmuffs when the work area is excessively loud. Noise with high decibel levels can damage your hearing. Earplugs are made of waxed cotton, foam, silicone rubber or fiberglass wool. They are self-forming and, when properly inserted, they work as well as most molded earplugs. Earplugs save the ears from loud noise at the workshop.

Fig: 2.1.9 Ear plugs

Body Protection: There are many varieties of protective clothing available for specific hazards. Protective clothing comes in a variety of materials, each effective against particular hazards, such as:

- Paper-like fiber used for disposable suits provide protection against dust and splashes.
- Treated wool and cotton adapts well to changing temperatures, is comfortable and fire-resistant and protects against dust, abrasions and rough and irritating surfaces.
- Leather is often used to protect against dry heat and flames.
- Rubber, rubberized fabrics, neoprene and plastics protect against certain chemicals and physical hazards.

Fig: 2.1.10 Safety dress

Notes

Scan the QR code or click on the link to watch related videos

https://www.youtube.com/watch?v=oVjYG73RFSg

Workshop safety

Unit 2.2 - Emergencies, Rescue and First Aid Procedures

Unit Objectives

At the end of this unit, participants will be able to:

1. Discuss the causes of fire at the shop floor.
2. Demonstrate steps of emergency procedures.
3. Demonstrate steps to evacuate in emergency situation.
4. Demonstrate basic first aid techniques.

2.2.1 Fire Hazards

Fire is one of the most common causes of the accidents in establishments. Fire is defined as a self-sustaining combustion process in which a substance (fuel) combines with oxygen in air to produce immense heat and light.

Fire hazards pose threats to life and property. It is, therefore, the prime object of safety systems to detect, remove or reduce the risk of fire threatened by those potential hazards.

Fig: 2.2.1 Fire

The following fire hazards are common at home, in public places, transports and work places:

- All types of flames used for any work
- Electric wires, higher loads, loose connections and old electrical equipment
- All cooking and heat generating appliances
- All works and situations where fire is essential such as welding, cutting, metal casting etc.
- Improper stowage of tools, equipment and items during and at the end of the day's work
- Smoking and personal lighters and matches
- Fireworks, pyro techniques, ammunitions and explosives
- Improper and unauthorized stowage of flammable and hazardous materials and chemicals especially the flammable ones
- Insufficient capacity and numbers of emergency exits and stairs
- Hindrance to sight or reach fire fighting equipment, markings and alarm systems
- Insufficient numbers and types of fire extinguishers
- Absence of fire detection and alarm system
- Violation of building and fire codes

2.2.2 Fire Preparedness Procedures

Follow these emergency instructions in case of fire:

- Activate the ALARM.
- Evacuate the area.
- Call the fire department.
- Fight the fire only if:
  - You know how.
  - The fire is small.
  - You are confined to the area where it started.
  - You have a way out.
  - You can work with your back to the exit.
  - You have the right type of extinguisher.
  - You feel confident that you can operate it effectively.
- DO NOT fight the fire if:
  - You have any doubts about fighting it.
  - It is spreading beyond the area where it started.
  - It could block your escape route.

Fig: 2.2.2 Fire Safety

Evacuate the building immediately

Confine a fire to the zone of origin, for a specified time, thereby preventing fire spread and leaving more time for safe evacuation of the building occupants.

If a fire breaks out, smoke containment systems prevent the movement of smoke and heat from one area to another.

2.2.3 Fire Prevention

Follow these steps for fire prevention:

- Don’t allow trash and litter to accumulate unnecessarily
- Keep the workplace areas neat and clean
- Know where fire alarm boxes and extinguishers are located
- Ensure you know the different types of fire extinguishers and how to use them
- Store hazardous materials in designated areas
- Keep exits free of obstructions
- Know location of emergency exits and procedures
- Handle flammable liquids with caution

2.2.4 Fire Extinguishers

Types of fire

There are different classes of fire and each class of fire has different properties and different mediums of extinguishing. Let's discuss this here:

Class of fire	Description	Mode of Extinguishing	Medium of Extinguishing	Type of Extinguisher
	Fire involving solid material (fuel) for combustion like wood , paper plastic that melt	Cooling	Water	• Water • Sode acid type • CO_2 gas type
	Fire involving flammable liquids like petrol, diesel, thinner, cooking oils, paints, wax and plastic	Blanketing	Foam, CO_2, Halon and DCP	• Foam • CO_2 gas type • DCP • Halon type
	Fire caused by electricity equipment	Cutting of electricity supply	Vaporising liquids, dry powder and CO_2	• CO2 • DCP • Halon • Dry sand
	Fire involving flammable metals like magnesium, titanium	Smothering	Suitable dry powder	• Special DCP extinguisher • Dry sand • Powdered graphite • Talc and asbestos • Limestone

Table 2.2.1 Types of fire

Different types of fire-extinguishers used in industry and their uses are:

Fire Extinguisher	Uses
Water	• Pressurized, pumps type • Cools Fire • Use on Class A fires • Do not use on B or C fires

Multi Purpose Dry Chemical	• Stored pressure type • Smothers fire with layer of powder • Use on Class A, B and C fire
Chemical Foam	• Aqueous film forming foam (AFFF) type • Smothers fire with foam • Use on class A and B fires
Compressed Gas	• Halon, CO_2 type • Smothers fire with gas • Use on Class B and C fies

Table 2.2.2 Types of fire extinguisher

Colour Codification of Fire Extinguishers

Type	Old Code	BS EN 3 Colour Code	Fire Class
Water	Signal Red	Signal Red	A
Water Mist	White and Red	White and Red	A (B, C, electrical if dielectrically tested)
Foam	Cream	Red with a cream panel above the operating instruments	A and B
Dry Powder	French Blue	Red with a cream panel above the operating instruments	
Carbon Dioxide		Red with a cream panel above the operating instruments	A
Halon		No longer prodiced - illegal in the UK	A
Wet Chemical	Not in use	Red with a cream panel above the operating instruments	A

Table 2.2.3 Color coding of fire extinguisher

Steps for using a fire-extinguisher

Fig: 2.2.3 Using a fire extinguisher

2.2.5 Emergency Procedures

Every workplace should have a plan for dealing with emergencies. You should be instructed in that plan within your first few days on the job and have refresher training from time to time.

Once you have been trained, you should be able to answer these questions during an emergency:

- Where the emergency phone numbers are posted?
- Where are the fire extinguishers and how and when should they be used?

- What other specialized equipment may be needed in an emergency, and how it is used?
- Where are the fire alarms and fire exits?
- What is the evacuation plan for the building?
- What should you do during an earthquake?
- In case of evacuation, where outside the building is the assembly point and who should you report to?

Emergency Service Number

Dial the service number of these departments in case of emergency:

- Fire Brigade Department
- Police Department
- Ambulance Department
- Women Safety Department
- Security Department
- Pest Control Department

Fig: 2.2.4 Emergency service number

Medical Emergency Procedures

Follow these steps for medical emergency procedures:

- An emergency medical service should be available near to your dealership
- At least one person should be trained enough to handle any medical emergency
- First-aid supplies should be available at the dealership
- Check - Call - Care route should be followed

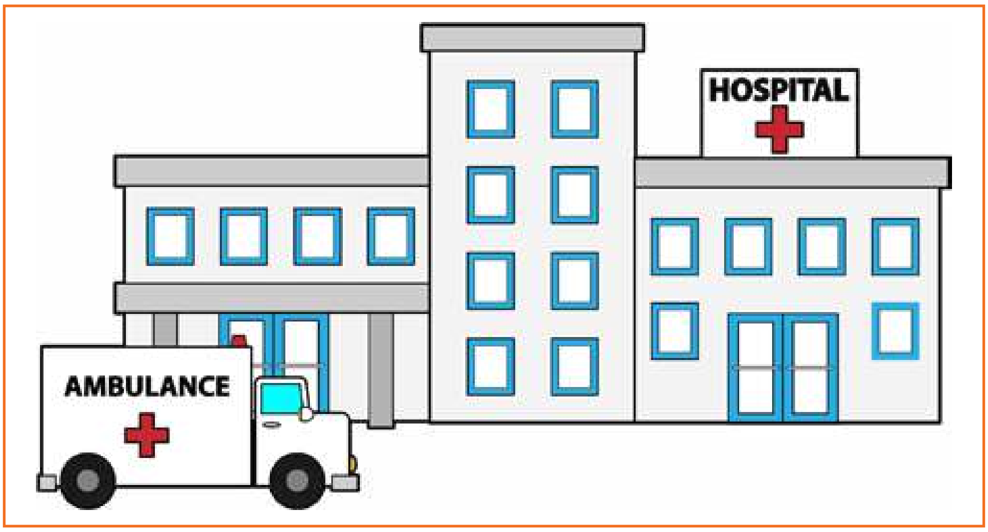

Fig: 2.2.5 Medical emergency procedure

2.2.6 Evacuation Procedures for Workers & Visitors

Let's now learn about the for evacuation procedures for workers & visitors in case of emergency.

As the first step a layout must be made of the building, including:

- Evacuation Routes
- Fire Extinguisher (locations)
- Fire Alarm Stations (locations)
- First Aid Kit (locations)

The second step for evacuation procedures for workers & visitors in case of emergency includes a map of the building, parking, area and other buildings surroundings.

This must show the Rally Point. Rally Point must be a safe distance from the building. It must be easily accessible, out of the way of emergency services, and should not be beside the fire hydrant. Both the layout and the Rally Point must be posted noticeably throughout the facility and made accessible to all employees upon request.

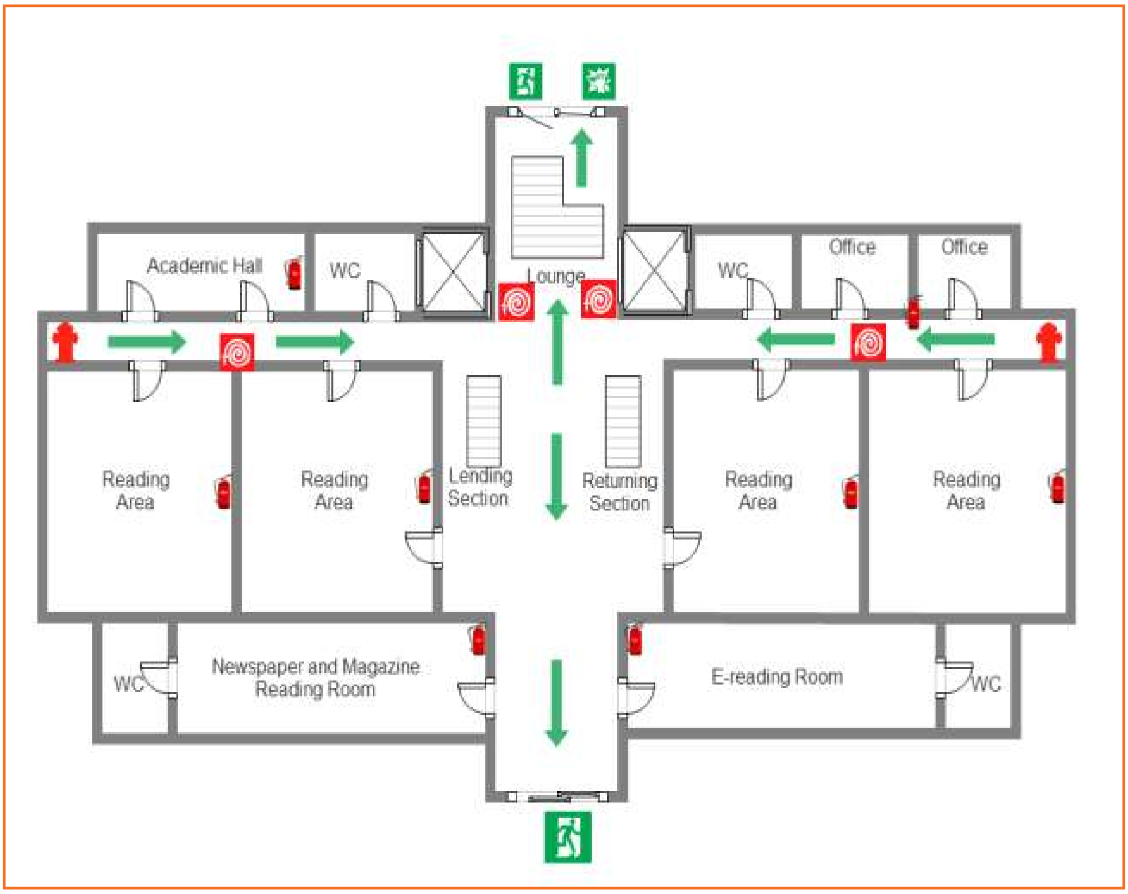

Fig: 2.2.6 Sample evacuation plan

2.2.7 Reporting of Accidents and Other Emergencies

One of the essential responsibilities of an individual is reporting hazards for electrical works. He should be aware of:

- the people responsible for health and safety at the work place;
- the name, designation and location of the person responsible to contact at the time of emergency;
- the names and location of the documents that refer to health and safety in the workplace.

Additionally, an individual should also be adept in writing accident report. An accident report needs to include all the essential information about the incident or near-miss. The report-writing process begins with facts and ends with recommendations for preventing future accidents.

Accident report involves four steps:

1. **Gathering Facts:** Collect and note all the facts, including -
    - Date, time, and location of accident
    - Names, job titles, workers and immediate supervisor involved
    - Events leading up to the accident
    - Job that a worker was handling at the time of the accident
    - Names of workers/supervisor who witnessed the accident
    - Surrounding conditions (e.g. greasy floor, insufficient lighting, noise, etc.)
    - Circumstances at the time of accident (including tasks, equipment, tools, materials, etc.)
    - PPE worn by the worker at the time of the accident
    - Injuries that occurred (name of the injured body part and characteristics and extent of injuries)
    - Type of treatment for injuries (first aid if given)
    - Damage to equipment, materials, and the worker was working on or any other equipment or material around it.
2. **Determining the Sequence:** Describe this sequence in events after gathering the facts -
    - **Events leading up to the accident:** Task the worker was performing at the time of accident. For example: bending over, climbing, lifting operating machinery, using a tool, handling hazardous materials, etc.
    - **Events involved in the accident:** Was the employee struck/caught in the machine or caught in the fire? Did the worker fall on the same level or from a height? Did he inhale hazardous fumes or get splashed with a hazardous chemical?
    - **Events immediately following the accident:** What did the employee do: started bleeding? Body caught fire? Complain about back pain? Put a hand over a bleeding wound? Response from other workers/supervisor. Did they call for help, administer first aid, shut down equipment, move the victim to the other place, etc.?

The accident should be described on the report in sufficient detail that any reader can clearly picture what happened. A picture can also be drawn, in a simple and visually effective manner, the sequence of events related to the incident and include this in your incident report. Photos can be clicked by the mobile phone of the accident scene, injury the occurred which may help reader follow the sequence of events.

3. **Analysing:** Analyse of the causes of the accident. Causes include:

   - Primary cause (e.g., a slip and fall from a ladder)
   - Secondary causes (e.g., employee not wearing appropriate goggles or helmet)
   - Other contributing factors (e.g., poor ventilation).

4. **Recommending:** Recommendations for corrective action might include immediate as well as long-term corrective actions such as -

   - Training on safe work practices
   - Preventive maintenance exercises that keep equipment in great working condition
   - Assessment of job techniques with a proposal for changes
   - Conducting a job hazard analysis to evaluate the task for any other hazards and then train employees on these hazards
   - Engineering changes that make the task safer or administrative changes that might include changing the way the task is performed

2.2.8 Basic First-aid Techniques

Free a person from electrocution

If find someone is suffering from electric shock, approach with extreme caution and following first aid steps.

Steps

1. Firstly take the suffered person away from the electricity source as fast as possible. Turning off the electric supply of machine is the best method for doing this.
2. If this seems impossible, remove the person from electricity source by using a piece of wood or

Fig: 2.2.7 Saving person from electrocution insulating material.

3. Don't touch the victim getting the electric shock because you could also get shock too.
4. After successful executing the victim from the electricity source, call the ambulance, if victim is unconscious. Give first-aid to victim till the time ambulance is coming.
5. If victim is conscious and looking well, monitor its condition, as the results of shock must not be clear immediately.

2.2.9 First-aid in Case of Bleeding, Burns, Choking, Electric Shock, Poisoning etc.

For treating shock, burns, bleeding and wounds, electric shock, choking, eye injury, heat stroke, hypothermia, fainting and unconsciousness, use following first-aid techniques:

Shock

Cold, weakness, unbalanced breathing, rapid weak pulse, pale or bluish lips and fingernails and nausea are the symptoms of shock.

Steps

1. Don't give anything for eating and drinking to victim.
2. Put down the victim on his/her back. Don't move the victim if there's any neck or back injury. If find victim is unconscious or vomiting, put down on his/her side and ensure that sufficient air is available in the room.
3. Use blankets or clothes to keep the victim warm.
4. Place the victim's legs on a pillow.

Bleeding and Wounds

Steps

1. Cover the wound by a clean cloth and gloved hand; then apply firm and steady pressure on wound for 5 mins at least.
2. Lift up the injured leg or arm above the victim's heart level.
3. Secure the wound by a bandage when bleeding stops. Ensure that bandage is not fixed too tightly—it may stops blood circulation.
4. Check the victim for shock.

Burns

Steps

Chemical or Compressed Gas Burns

1. Use a drench hose and emergency shower for at least 15 mins to rinse away all residues of chemicals.
2. Cover the burn by a clean and dry cloth or special dressing for burns.
3. Check the victim for shock.

Fig: 2.2.8 Saving from gas burns

Heat or Electrical Burns

1. Cool burning of skin by water.
2. Place the burned area under cold running water if the skin is not broken and gently compress the wound by hand. Bandage the wound by a dry and clean cloth.
3. If blister appear, don't try to break it.
4. Do not apply ointments or creams.
5. If skin is cracked, or if injuries are severe:
   - Do not clean the wound or remove embedded clothing.
   - Cover the injury insecurely with a clean, dry cloth.
   - Expect shock and treat accordingly.

Choking

The patient is talking and getting sufficient air; don't restrict it if he/she tries to cough the obstruction in the throat. If the patient can't talk or not getting enough air, make call on emergency number.

Fig: 2.2.9 Saving person from choking

Steps

1. Wrap your arms around the stomach and stand directly behind the victim.
2. Just above the navel and well below the ribs, make a fist by a hand. Place that fist with the thumb and forefinger side toward you.
3. Hold the fist by other hand and pull it rapidly towards you by a slightly upward and inward thrust. If required, repeat it.

Fig: 2.2.10 Saving person from choking

If the patient becomes insentient:

1. Put down the patient on their back.

2. If the object that is obstruct the airway is noticeable, reach a finger into the patient's mouth and try to bend the obstruction out of the patient's throat, being careful not to push the object deeper into the patient airway.
3. Even if this is not successful, attempt rescue breathing.
4. A chest compression (CPR) is more helpful if the victim is still not breathing or moving.

2.2.10 Basic Techniques of Bandaging

The key points when applying a bandage are:

1. Make sure the person is comfortable.
2. Never lean across their body and ensure that you are working from the side of the injury.
3. First clean the wound and apply the antibacterial cream over it.
4. When the bandage is on always remember keep the injured part of the body supported in the position it will be in.

Fig: 2.2.11 Bandaging injured person

5. Always use right size of bandage.
6. To check the passage easily, don't cover fingers or toes when bandaging a limb.
7. Never wrap the bandage tight, and secure the end by folding it over and binding a knot in the end. Safety pin, adhesive tape, or a bandage clip can be used.

Artificial respiration and CPR Process

- **Check the Passage -** make sure it is harmless for you to help.
- Don't become another patient.

CPR Steps

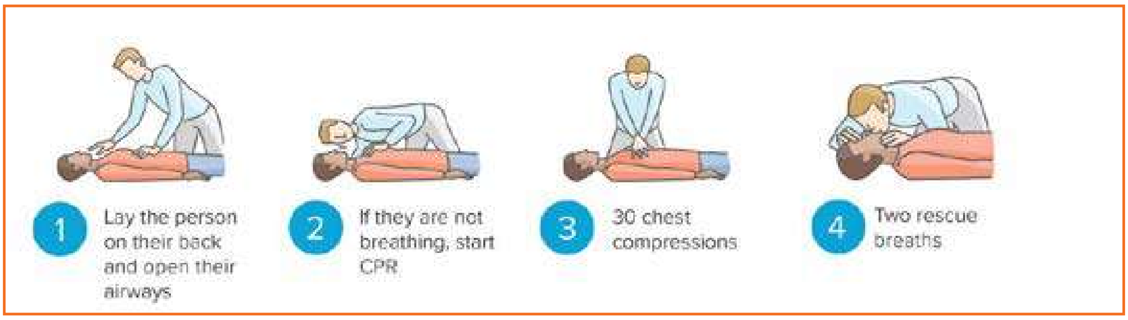

Fig: 2.2.12 CPR Process

1. **Check the Victim -** tap and shout to get response.
2. **Circulation -** pump the chest 30 times.
3. At the center of the chest put the heel of one hand and your other hand on top of it. At a rate of

100 per minute (16 compressions in 10 seconds) press chest down 2 inches.

4. Tilt head back, lift chin up to open airway.
5. **Breathing -** Tweak nose closed, take a normal breath, cover patient mouth with yours and blow out your breath until you see the chest rise. One breath per 1 second. Again open airway again if chest doesn't rise.
6. Repeat procedure until help arrives or the victim begins breathing.

2.2.11 Correct Method to Move Injured People

To carry injured people to medical help or rescue from further harm. In these cases, you must consider the condition of the patient Below discussion on several ways to carry an injured person:

Steps

1. Stand on either side of the conscious victim. Grab the victim's wrist with the hand closest to the victim's feet on your side.
2. Use your other hand to grasp the clothing on the shoulder nearest to you and pull the victim's arms to help them to a sitting position.
3. Assist the victim to his or her feet and place the arms around your shoulders, if possible.
4. Place your free hand around the person's waist and let him or her set the pace on hobbling out.
5. Help the victim for moving slowly.

Fig: 2.2.13 Moving injured people

Scan the QR code or click on the link to watch related videos

www.youtube.com/watch?v=DaYwcH1GMEg

Workplace emergency procedures

www.youtube.com/watch?v=BumbKHqXJo0

First-aid practices

Unit 2.3 - Workplace Quality Standards

Unit Objectives

At the end of this unit, participants will be able to:

1. State the methods to keep the work area clean and tidy.
2. Apply basic housekeeping practices to ensure that the work area is clean, such as mopping spills and leaks, cleaning grease stains etc.
3. Perform routine cleaning of tools, equipment and machines.
4. Discuss how to complete the given work within the stipulated time period.
5. Discuss ways to maintain a proper balance between team and individual goals.

2.3.1 Housekeeping Practices

Housekeeping in simple words means maintaining a house on a daily or long term basis or looking after its cleanliness, tidiness, upkeep and smooth running.

Cleanliness doesn't mean housekeeping. Housekeeping includes keeping work areas tidy and arranged; keep floors free of slip and trip accidents; clearing of waste materials (paper, cardboard) and other fire hazards.

Workplaces hazards can be eliminate by effective housekeeping and complete a job safely and properly. Poor housekeeping and hiding hazards can cause frequent accidents which can cause injuries.

2.3.2 Principle of Workplace Housekeeping

Housekeeping consists of the simpler aspects of care and maintenance of workplace and its associated items:

- Maintaining operational tidiness and order,
- Properly controlling waste, and
- Regulating activities such as smoking that can lead to hazardous conditions.

Good housekeeping is a vital factor in preventing accidents. The great majority of all work accidents are caused during the handling of goods or materials, and by people falling, being hit by falling objects, or striking against objects in the workplace. All these causes can be reduced by good housekeeping practices—in fact, good housekeeping is the only cure for hundreds of accidents that occur.

Here are some kinds of accidents commonly caused by poor housekeeping:

- Tripping over loose objects on floors, stairs and platforms.
- Articles dropping from above.
- Slipping on greasy, wet or dirty surfaces.
- Striking against projecting, poorly stacked, or misplaced material.
- Tearing the hands or other parts of the body on projecting nails, wire, steel strapping on bales or crates, etc.

Typical examples of poor housekeeping that lead to these accidents are:

- Excessive material, waste or chips in the working area.
- Congested aisles.
- Tools left on machines.
- Waste containers overflowing.
- Lockers and workrooms in disorder.
- Acids in open containers.
- Broken glass.
- Electric leads or air lines across aisles.
- Dirty light fittings, windows and skylights.
- Untidy or dangerous storage of materials (e.g., materials stuffed in corners, overcrowded shelves, etc.)
- Dusty, dirty floors and work surfaces
- Spills and leaks

Where housekeeping is bad, fire is a constant hazard. It can be caused by many housekeeping problems—such as oil-soaked rags and clothing igniting from spontaneous combustion; dust collectors not being properly or frequently cleaned; or piles of paper and other packing materials being allowed to accumulate.

2.3.3 Benefits of Good Housekeeping Practices

Efficient housekeeping results in:

- Decrease handling to comfort the materials flow
- Fewer slipping and tripping accidents
- Less fire hazards
- Better control of tools and materials in managing inventory and supplies
- Equipment's are more cleaned and well maintained.

- Better hygienic conditions for good health
- Space utilization is more efficient
- Reduced property damage due to improvement in preventive maintenance
- Improved efficiency because it is easy to find tools and materials.

2.3.4 Good Housekeeping Checklist

Check off your housekeeping programme against this checklist. Better still, make a more comprehensive list of your own.

Buildings

1. Walls clean.
2. Windows clean.
3. Walls free of unnecessary hangings.
4. Proper light provided.
5. Platforms in good condition.
6. Stairs clean and well lit. Handrails and steps of sound construction and well maintained.

Floors

1. Good floor surface.
2. Kept clean and free of loose material. Clean in corners, behind radiators, along walls, and around pillars or columns.
3. Free of oil, grease, etc.
4. Operating floors, or work positions free of loose scrap, metal or other materials.
5. Free of unnecessary articles.
6. Bins provided for refuse.

Fig: 2.3.1 Waste storage

Aisles

1. Free of obstructions.
2. Safe and free passage to fire-fighting equipment and fire exits.
3. Safe and free access to work positions.
4. Clearly defined.

Machinery and equipment

1. Clean and free of unnecessary material.
2. Free of unnecessary dripping of oil or grease.
3. Area around machines clean and free of rags, paper, etc.
4. Lockers and cupboards clean and free of unnecessary material both on top and inside.
5. Benches and seats clean and in good condition.
6. Drinking fountains clean.
7. Toilet facilities clean and well ventilated.
8. Proper guards provided and in good condition.
9. First-aid facilities and equipment fully stocked and in clean condition.

Fig: 2.3.2 Material handling

Fig: 2.3.3 First-aid box

Stock and material

1. Properly piled and arranged
2. Kept in storage areas.

Tools

1. Properly arranged in place.
2. Free of oil and grease.
3. Inspected and maintained in good order.
4. Tool rooms and racks in clean and orderly condition.

Fig: 2.3.4 Tools placement

Grounds

1. Yard and building surrounds free of refuse such as fruit peelings, scrap, wood, Iron, etc.
2. Grounds kept free of weeds and overgrown vegetation.
3. Wastes and refuse removed frequently.

Good housekeeping helps to create:

- Better working conditions
- Safer workplaces
- Greater efficiency.

It is not an unprofitable sideline. It is part of a good business.

Fig: 2.3.5 Floor cleaning

Waste Disposal

Fig: 2.3.6 Waste disposal

Practices the regular collection, grading and sorting of scrap leads to good housekeeping. Separate the materials from waste which can be recycled and reuse.

For systematic waste gathering and disposal, place the bin containers, near the place where waste is generated most.

2.3.5 Work In Line with Organization Policies & Procedures

Organizations will have a set of rules that direct employees' action in accordance to what is believed to be right. One should follow the policies set by the organization.

The meaning of working ethically means you should be on pre-define shift time, should take leave when you are sick, not using the telephone for personal purpose, avoid gift from customers, should not use anything belong to customer, should not indulge in gossiping about others behind them, showing support to other workers and keeping client information confidential. In the workplace it is important to always behave in an appropriate way and report any problems to your supervisor.

2.3.6 Time Management

We achieve outcome of our 24 hours period based on our enthusiasm, energy levels, ability to perform, skills and other resources

As our time is always in demand, we need to think about how to use our time and for more effective time management we need to consider certain strategies. Time management does not mean to work harder or for longer period but it help us to work smartly so that we can finish our work easily and quickly.

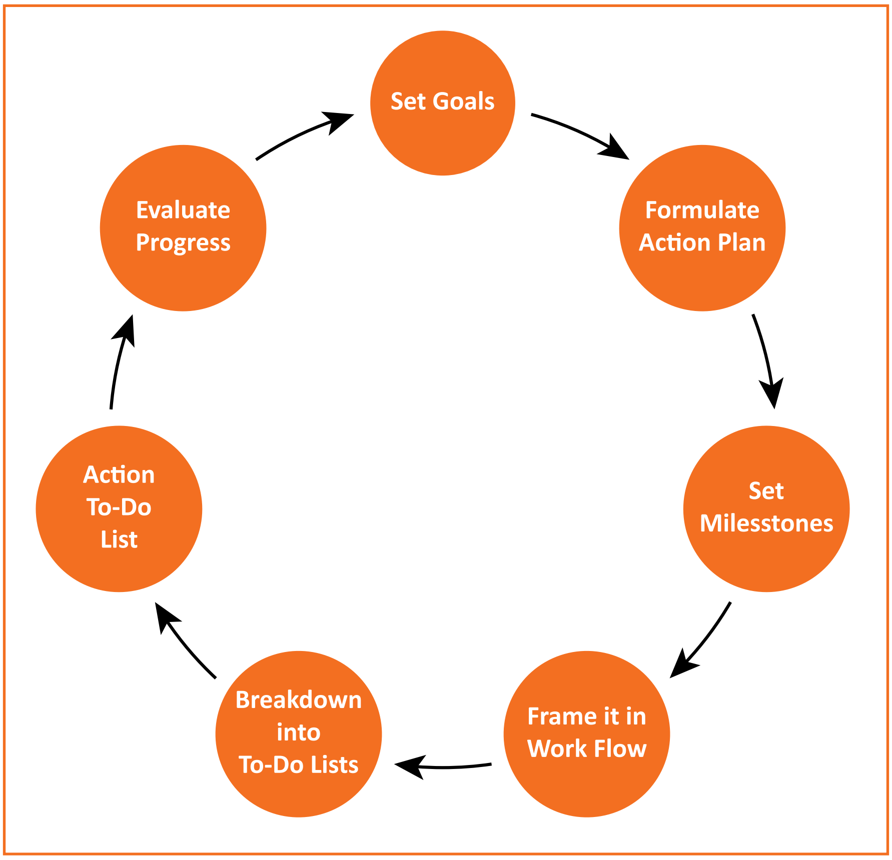

Fig: 2.3.7 Time management

If we can manage our time more effectively, we will be rewarded in a variety of ways:

- We will be more competent in our routine job and also can support others
- We can accomplish great success in every role as a leader
- On a personal level, you will certainly feel healthier, more energetic, and in a generally better mood.

2.3.7 Obstacles to Effective Time Management

There are many factors contributing to disturbance due to which it becomes for us in effective management of our time. Now think about certain common factors, and let us see does it apply to us:

- **Objective is not clear -** With closed eyes it is difficult to hit a target thus it is equally difficult to accomplish something when you aren't exactly clear about what you want to achieve.
- **Disorganization -** It's easy to see when your desk is too messy, but sometimes you have to step back and ask yourself if you are taking an organized approach in completing all of your tasks.
- **Inability to Say "No" -** We need to be helpful; towards others when they need our support, but this needs time and could result in disturbing our priorities to do something we may not have planned.

- **Interruptions -** Some time it happens that when are in the middle of accomplishing something which is very important for, we get a phone call. These calls are very disturbing as it could play an import reason to be behind the schedule as it may interrupt our though process which can lead to go back from where we started or in between somewhere.
- **More Interruptions -** Inappropriate time conversations need our time thus we need to be careful and have to stop what we are doing and focus on plans.
- **Periods of Inactivity -** As much as we think we are busy, there are times in our day when we are not really doing anything. Recognizing and making use of these times can have a positive effect on our efforts.
- **Too Many Things at Once -** Most of us work without making routine of our task as it needs our attention for detailing. When we try to do so many things simultaneously each individual task get suffer.
- **Stress and Fatigue -** We all experience stress time to time in our daily life and we perform well with a little bit stress. If the level of stress is very high, our works get suffered and also effect mental and physical situation. How to deal with stress forms an important factor of time management.
- **All Work and No Play -** Most successful people know how to balance work and play. When work takes over your life, you may end up sacrificing the really important things in life like family and friends. Therefore, give your body little time to re-energize and enjoy life.

Activity

- Collect the three pages containing 24 squares on them from your facilitator.
- Fill the squares (based on the time you spend on various activities on a regular day) and label them with routine activities like:
  - Sleeping (6 hours is equal to 6 squares), bathing, eating, travel, and TV time
  - Non-reproductive time like long tea-breaks, water cooler chats, personal telephone calls and e-mails, etc.
- Productive time like reading something useful or brainstorming on important topic
- After filling all squares, identify time wasters and time spent on routine activities.
- Come up with as many ideas as possible to handle your time wasters.
- Share your findings with your facilitator in the next session.

2.3.8 Resolving Obstacles

The obstacle we face in our day to day life is not very difficult to resolve. The most important thing is to identify existence of obstacle which is affecting our ability in time management. After identifying the obstacle we start think solution to resolve it.

2.3.9 Set Clear Goals

- You will want to accomplish many things in your time of office. The greatest favor that you can do to yourself is to define what those targets are and ensure your struggles are always absorbed toward their accomplishment.
- Effective goals share a number of characteristics in common. Effective goals are:
  - **Specific -** When a goal is too vague, you may never know how to grasp it or even when you have reached it. Ensure that you know exactly what you hope to achieve.
  - **Measurable -** When you have a goal that is measurable, you will know how far you have to go to reach the goal, and when you will get there.
  - **Achievable -** It is worthy to set your vision high, but sometimes we try to achieve more than we can actually do. Your goals should be such that, if you "extend yourself" you can just reach them. For example, if a person weighing 100 kilos decides to lose 30 kilos in a month its absurd. Rather if he set a goal to lose 5 kilos each month that's achievable.
  - **Realistic -** Your goal has to be real. Saying I will fetch the moon for you, as in many Bollywood movies is fictious. So set your goal that is realistic. You can refer to the same example of a person weighing 100 kilos. If he wants to build body like John Abraham or Hritik Roshan in a month it's unrealistic.
  - **Time-based -** It is important to set time guidelines for your goals, so that you can keep track of your development as you are along and can be aware to when you are falling behind the schedule.

Fig: 2.3.8 SMART Goals

2.3.10 Prioritize

As a part of organization, you will be assigned many tasks. It is always good and safe to clarify that you cannot do everything, thus it is important to make a list of tasks periodically that confront you and prioritize them. Below mentioned technique may help in prioritizing:

- **Do -** Choose most important task from the list which you consider as important for your organization. These are the task you need to do yourself.
- **Delegate -** There could be many persons in an organization who possess various skills and experience to carryout variety of task. A real leader understand it very clearly that they cannot accomplish everything by themselves. Thus they recognize someone who can better handle the task. Delegating not only helps to free up your time so that we can do other works but also ensures resources applied can be used more effectively through certain degree of motivation.
- **Delay Until another Time -** As a regular process we think something can wait and applying same thinking on too many things close to the dead line which creates a dangerous situation. It is always good to consider when things are due, how long it will take to accomplish and your current workload. Suppose you have to pay for your policy but still have time you can delay it but when it comes to deadline it may hamper your working process.
- **Delete -** If we set our goals as explained earlier, we will experience that some of these goals are not achievable or realistic, or that they are just not important. A good leader knows when to concentrate on the important and eliminate the rest.

When you prioritized your task it is important for you to:

- **Address the Urgent -** Things having short-term consequences should be tackled first.
- **Accomplish What You can Early -** Reports, registrations and requests that can be handled early should come next. Don't put off until tomorrow what you can do today.
- **Attach Deadlines to Things You Delay -** Attaching deadlines to things we delayed - When we are very sure that things can definitely wait be careful in taking such decision by adding a deadline for that task in our schedule and should also make a note to remind our self about when we should start working on that.

Fig: 2.3.9 Prioritizing work

2.3.11 Organize

As you prioritize tasks and set deadlines, you will want to organize your plans and actions. Some time we are using paper and pencil to organize our plans, but it is important for you in today's environment to use planner as it includes calendar and enough space to make notes. Most of the planners are equipped with calendar space, space to note down daily activities, contact information, and "to do" lists. Look for the planner which satisfy your need and start using it. You will feel like it is an essential tool for you to manage your time.

We can also consider device like computer to help in organizing our time. The modern computers are equipped with necessary features such as calendars, task lists, reminder, and contact details using software programs. In case you do not have these features in your computer you get it installed very easily.

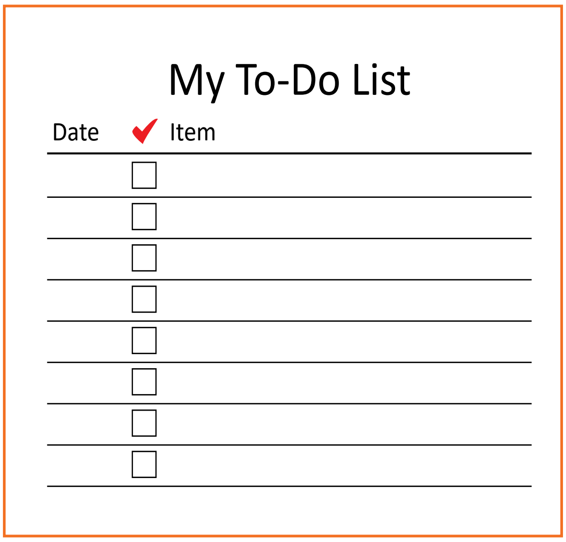

Fig: 2.3.10 To-do list

You may also consider a small personal digital assistant, or PDA. These devices are small enough to fit in your hand, and use the same software your home computer uses. When we do not have computer access PDAs plays important role specially during travelling to keep you updated with your pending task.

Whatever method you choose, make sure you organize your tasks so that you can stay on track.

2.3.12 Focus on the Task

When you serve as a leader you are managing many activities and we cannot cut ourselves from this fact. There is no way around this fact. But, one important strategy to keep in mind is to concentrate completely on the current task. Concentration can be difficult when you have a lot on your mind. Your time will be better spent if you are able to:

- **Focus on Your Goal -** Everybody has various set of commitments and concerns, but for better accomplishment focus on the task at a moment is very much required.
- **Avoid Interruptions -** When need to set our specific time in day time in which we should not talk on phone or attend visitor meeting because this is the time we can pay highest level of attention to our task. We cannot separate all of our time but definitely avoid interruption during specific period of time and this way we can successfully complete task in less time than it was expected. When you must respond to phone calls, be assertive in minimizing interruptions by asking if you can call back at another time or meet another day.

2.3.13 Working in Team

Lessons from the Geese :

Teams are much more effective than individuals for work. Let's look at an example from Mother Nature to learn how an effective team works.

The geese actually fly in a group on their long flight of migration.

The flapping of the geese that are in front of the formation creates a draft for the geese at the rear reducing air resistance. This indicates their true sense of responsibility towards the fellow beings.

When the leader goose is tired, it goes back and another goose then comes in the front to lead the group of Geese. So, these Geese have no fixed leadership or hierarchy. No goose likes to fly out of formation because it would get tired easily. Even if it does fly out of formation, it quickly comes back to its place. So, Geese have amazing team sense!

Geese also make a lot of noise while they fly. But it's interesting to note that the noise is not made by the geese leading the formation, but by the Geese in the back of the formation, which serve to support and keep everyone going. Isn't that the unique vocal support?

If one goose is ill and falls out of formation, a few of others stay with it, to be with it until it gets well or dies. Now, that's what we call team spirit!

Geese are unique as a team. The team works on a common goal and are cohesive in nature to reach their destination. Team members help each other since they can collectively achieve much more than they can alone.

As explained about the Geese, being a human if we are sharing common set of direction and have consider our community can move fast and reach to our goal in shorter period because we move with trust on each other.

Considering the Geese if we follow their footsteps we will be connected with the persons who could lead us to reach our destination.

We willing accept help from others and offer our help to others.

It pays to take turns in doing the hard tasks and share the leadership. As with Geese, people are interdependent on each other's skills, capabilities and unique arrangements of gifts, talents and resources.

We need to ensure we are encouraging each other in the team. In teams where there is encouragement, the production is much higher.

If we have to learn from Geese, it is to stand by each other in tuff times as well as good times. Now, what do you say to that!!!

You need to be a good team player to work in a team.

Commitment & Task Sharing Based on Individual's Skills :

A committed team treats the work like their own garden or pet - they obsess over it, they care for it, they own it. If a leader is trying to build a team who can give commitment to finish the assigned task, then it is important to align team member's personal visions to that of the organization.

2.3.14 Resolving Conflict

Conflict - It can be defined as a serious disagreement or argument. Conflict exist in almost all organization and some time it is also consider positive as it helps in healthy exchange of ideas and creativity. If the conflicts became counter conflict it may leads dissatisfaction to employee, productivity reduction

Importance of Resolving Conflict:

You must avoid conflict at the work place as it brings negativity all around.

By deciding not to say something that would make you sound aggressive or frustrated, you can avoid unnecessary conflicts.

Conflicts take place when people are rigid and are not willing to cooperate with each other. Let's look at some ways through which you can prevent and resolve conflicts.

Best Practices Resolving Conflict:
To resolve conflicts in a team, you should use these steps:

- Examine what is causing trouble
- Discuss the issue with the conflicting party
- Clarify expectations and roles
- Find an option which benefits all
- Utilize constructive feedback
- Reach agreements

You should always maintain a positive relationship while trying to reach an agreement.

Depersonalizing Conflicts:
You should always depersonalize conflicts by adopting these steps:

- Focus on issues not personalities
- Encourage both sides to be objective
- Evaluate concerns of both sides
- Encourage people to listen to other's view
- Encourage points of agreement
- Don't dwell on anger

When individuals find it difficult to adjust with each other, the best way is to sit together and discuss among themselves to reach the middle path. Instead of fighting with each other, it is better to discuss things and come to a solution which benefits all. For example, when the boss sets the timeline for completing a given task and the team member finds it unachievable, the team member should negotiate with his boss to slightly extend the timeline to make it practically achievable. Through discussion they can then reach the timeline that suits all.

Resolving Complaints:

Use the following do's to resolve complaints:

- Be warm to the others
- Show empathy
- Acknowledge the other's feelings
- Listen actively
- Isolate the core problem
- Provide a satisfactory resolution and an alternative
- Follow-up after the resolution

Avoid the following don'ts to resolve complaints.

Don't:

- Take a confrontational attitude
- Make assumptions
- Use technical or professional jargon
- Pass the blame
- Make unrealistic commitments
- Exceed your authority
- Sacrifice your company's interest

Responding to a Transactional Crisis:

Use the following do's to respond to a Transactional Crisis:

- **Tell the whole story:**
  - Openly
  - Completely
  - Honestly
- Apologize, if you are at fault
- **Show your concern with:**
  - Words
  - Actions

Avoid the following don’ts to respond to a Transactional Crisis.

Don’t:

- Blame others
- Speculate in public
- Refuse to answer questions
- Release confidential information without permission
- Use the crisis to promote yourself

Scan the QR code or click on the link to watch related videos

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Workplace quality standards

Unit 2.4 - Health and Hygiene During an Epidemic and Pandemic

Unit Objectives

At the end of this unit, participants will be able to:

1. Discuss epidemics and pandemics and their impact on society at large.
2. Elaborate the significance of following prescribed rules and guidelines during an epidemic or a pandemic.
3. Discuss the significance of conforming to basic hygiene practices such as washing hands, using alcohol-based hand sanitizers.
4. Show how to sanitize and disinfect one's work area regularly.
5. Demonstrate the correct way of washing hands using soap and water.
6. Demonstrate the correct way of sanitizing hands.
7. Demonstrate appropriate social and behavioural etiquette (greeting and meeting people, spitting/coughing/sneezing, etc.).
8. Discuss the ways of dealing with stress and anxiety during an epidemic or a pandemic.

2.4.1 Safety During Epidemics and Pandemics

Difference between epidemic and pandemic

- An epidemic is a disease that affects a large number of people within a community, population, or region.
- A pandemic is an epidemic that's spread over multiple countries or continents.

An epidemic can provoked social stigma and discriminatory behaviours against people of certain ethnic backgrounds as well as anyone perceived to have been in contact with the virus.

The level of stigma associated with an epidemic is based on three main factors:

1. it is a disease that's new and for which there are still many unknowns;
2. we are often afraid of the unknown; and
3. it is easy to associate that fear with 'others'.

It is understandable that there is confusion, anxiety, and fear among the public. Unfortunately, these factors are also fueling harmful stereotypes.

WHAT IS THE IMPACT?

Stigma can undermine social cohesion and prompt possible social isolation of groups, which might contribute to a situation where the virus is more, not less, likely to spread. This can result in more severe health problems and difficulties controlling a disease outbreak.

Stigma can:

- Drive people to hide the illness to avoid discrimination
- Prevent people from seeking health care immediately
- Discourage them from adopting healthy behaviours

2.4.2 Safety Protocols During Epidemics and Pandemics

Follow these safety protocols during an epidemic to keep yourself and others safe:

1. Wash your hands often with soap and water, especially after being in a public place, or after blowing your nose, coughing or sneezing.

Fig: 2.4.1 Safety protocols during epidemic

- If soap and water are not readily available, use a hand sanitizer with alcohol.
- Avoid touching your eyes, nose and mouth with unwashed hands.

2. Avoid close contact with people who are sick. Some people without symptoms may be able to spread the virus.

- Stay home as much as possible and avoid non-essential travel.

- Practice social distancing by keeping at least 2 meter — about two arm lengths — away from others.

3. Cover your mouth and nose with a cloth face cover when around others. The cloth face cover is meant to protect other people in case you are infected.
4. Cover your coughs and sneezes. Use a tissue to cover your nose and mouth, and throw used tissues in a lined trash can. If a tissue isn't available, cough or sneeze into your elbow — not your hands. Wash your hands immediately.
5. Clean and disinfect frequently touched surfaces daily. This includes tables, tools, machines switches, countertops, handles, desks, phones, keyboards, toilets, faucets and sinks.

IF YOU ARE SICK

- Stay home and call doctor for medical advice.
- Separate or isolate yourself from other people in your home.
- Avoid sharing personal items, with others.
- Clean and disinfect high-touch surfaces daily.
- Wear acloth face cover if you are around other people.

2.4.3 Workplace Hygiene

All workplace environments need to be hygienic and safe for both employees and visitors. This applies to all, not just workplaces involved in handling food and personal products.

A solid workplace hygiene policy is the best way to ensure employees maintain a clean workplace.

Each workplace will require different hygiene requirements. Certain tasks, or industries may also create risks which require additional protection than those discussed below. However, below are some key areas all workplaces should consider for their workplace hygiene policy.

Why Is Hygiene Important in the Workplace?

Hygiene is important in the workplace because it contributes to a healthy workforce. A healthy workforce is happier and more productive. A healthy workplace also means workers take less sick leave. Which will reduce the huge cost that sick leave places on small business.

How do you maintain hygiene in the workplace?

Implement a hygiene policy

Provide staff with a written hygiene policy. Inform them of your intentions and expectations of a clean workplace. This helps communicate to staff that you also take workplace hygiene seriously.

Provide a clean bathroom

It is pivotal for a hygienic workplace to have a clean bathroom. Also ensure that the bathroom is well stocked with soap, toilet paper and hand towels.

Provide clean wipes, sanitiser and tissues

Provide items such as these to help your staff maintain a clean and hygienic workspace. Employees are more likely to use such items if they are readily available.

Regular cleaning

Make sure your workplace is regularly cleaned. This helps prevent the spread of infection, and a cleaned workplace also maintains morale and a sense of professionalism.

What Is the Basic Hygiene in a Workplace?

Basic hygiene in the workplace can be put down to four different things: personal hygiene; work area cleanliness; clean restroom facilities; and a clean kitchen.

Why Is Personal Hygiene Important in the Workplace?

Personal hygiene refers to the cleanliness, appearance and habits of employees. Personal hygiene of employees, for obvious reasons, can be a sensitive issue for business owners.

A well-groomed personality projects a good image and speaks well of hygiene and efficiency. As far as possible, personnel should —

Fig: 2.4.2 Personal hygiene

- be fresh, well-groomed and clean, not half asleep or unkempt in appearance while reporting on duty
- have their hair neatly cut and tied properly
- have nails neatly trimmed
- dress in simple, clean and well ironed clothes

- avoid rings or other jewellery
- use light makeup, in case of women
- use footwear that is light, without heels and noiseless
- be healthy and not suffer from any skin disease, colds, etc.
- avoid bad habits such as nail biting, nose picking, leg shaking, sitting on work table, spitting, chewing pan, smoking, etc.
- bathe daily.

2.4.4 Workplace Sanitization

Cleaning and disinfecting are part of a broad approach to preventing infectious diseases in the workplace. To help slow the spread, cover coughs and sneezes with your elbow or tissue; wash your hands, and keep sick people away from others. It is important to make employees aware that if they feel ill, stay home from work. Below are tips on how to slow the spread of germs specifically through cleaning and disinfecting.

1. **Know the difference between cleaning, disinfecting, and sanitizing:** Cleaning removes germs, dirt, and impurities from surfaces or objects. Cleaning works by using soap (or detergent) and water to physically remove germs from surfaces. This process does not necessarily kill germs, but by removing them, it lowers their numbers and the risk of spreading infection.

   Disinfecting kills germs on surfaces or objects. Disinfecting works by using chemicals to kill germs on surfaces or objects. This process does not necessarily clean dirty surfaces or remove germs, but by killing germs on a surface after cleaning, it can further lower the risk of spreading infection.

   Sanitizing lowers the number of germs on surfaces or objects to a safe level, as judged by public health standards or requirements. This process works by either cleaning or disinfecting surfaces or objects to lower the risk of spreading infection.

2. **Clean and disinfect surfaces and objects that are touched often:** Follow organization's standard procedures for routine cleaning and disinfecting. Typically, this means daily sanitizing surfaces and objects that are touched often, such as desks, countertops, doorknobs, computer keyboards, faucet handles, and phones. Standard procedures often call for disinfecting specific areas, like bathrooms.

   Immediately clean surfaces and objects that are visibly soiled. If surfaces or objects are soiled with body fluids or blood, use gloves and other standard precautions to avoid coming into contact with the fluid. Remove the spill, and then clean and disinfect the surface.

3. **Simply do routine cleaning and disinfecting:** It's important to match your cleaning and disinfecting

activities to the types of germs you want to remove or kill. Most studies have shown that some viruses can live and potentially infect a person for only 2 to 8 hours after being deposited on a surface. Therefore, it is not necessary to close organizations to clean or disinfect every surface in the building to slow the spread of germs. Also, if employees are dismissed because the organization cannot function normally (e.g., high absenteeism during a flu outbreak), it is not necessary to do extra cleaning and disinfecting.

Some viruses are relatively fragile, so standard cleaning and disinfecting practices are sufficient to remove or kill them. Special cleaning and disinfecting processes, including wiping down walls and ceilings, frequently using room air deodorizers, and fumigating, are not necessary or recommended. These processes can irritate eyes, noses, throats, and skin; aggravate asthma; and cause other serious side effects.

4. **Clean and disinfect correctly:** Always follow label directions on cleaning products and disinfectants. Wash surfaces with a general household cleaner to remove germs. Rinse with water, and follow with an EPA-registered disinfectant to kill germs. Read the label to make sure it states that EPA has approved the product for effectiveness against specific viruses.

   If a surface is not visibly dirty, you can clean it with an EPA-registered product that both cleans (removes germs) and disinfects (kills germs) instead. Be sure to read the label directions carefully, as there may be a separate procedure for using the product as a cleaner or as a disinfectant. Disinfection usually requires the product to remain on the surface for a certain period of time.

   Routinely wash eating utensils in a dishwasher or by hand with soap and water. Wash and dry bed sheets, towels, and other linens as you normally do with household laundry soap, according to the fabric labels. Eating utensils, dishes, and linens used by sick persons do not need to be cleaned separately, but they should not be shared unless they've been washed thoroughly. Wash your hands with soap and water after handling soiled dishes and laundry items.

5. **Handle waste properly:** Follow standard procedures for handling waste, which may include wearing gloves. Place no-touch waste baskets where they are easy to use. Throw disposable items used to clean surfaces and items in the trash immediately after use. Avoid touching used tissues and other waste when emptying waste baskets. Wash hands with soap and water after emptying waste baskets and touching used tissues and similar waste.

Ways to maintain personal sanitization

Maintain social distancing, staying six feet away from others. Reduce sharing of common spaces and frequently touched objects.

- Wear disposable gloves to clean and disinfect and discard after use or use reusable gloves that are dedicated only for cleaning and disinfecting. Always wash hands after removing gloves.
- Clean any dirty surfaces using soap and water first, then use disinfectant.

- Cleaning with soap and water reduces the number of germs, dirt, and impurities on the surface. Disinfecting kills any remaining germs on surfaces, which further reduces any risk of spreading infection.
  - Practice routine cleaning and disinfection of frequently touched surfaces. More frequent cleaning and disinfection may be required based on level of use.
  - Surfaces and objects in public places, such as shopping carts, point of sale keypads, pens, counters, vending machines, and ATMs should be cleaned and disinfected before each use or as much as possible.
  - **Other high touch surfaces include:** Tables, doorknobs, light switches, countertops, handles, desks, phones, keyboards, toilets, faucets, sinks.

When cleaning

- Wear disposable gloves and gowns for all tasks in the cleaning process, including handling trash.
  - Additional personal protective equipment (PPE) might be required based on the cleaning/disinfectant products being used and whether there is a risk of splash.
  - Gloves and gowns should be removed carefully to avoid contamination of the wearer and the surrounding area.

Fig: 2.4.3 Hand wash

- Wash your hands often with soap and water for 20 seconds.
  - Wash your hands immediately after removing gloves and after contact with a person who is sick.
- Follow normal preventive actions while at work and home, including washing hands often for at least 20 seconds and avoiding touching eyes, nose, or mouth with unwashed hands. It is especially important to wash hands:
  - After blowing one's nose, coughing, or sneezing.
  - Before touching one's face.
  - After using the restroom.
  - After leaving a public place.
  - After handling one's mask.
  - After changing a diaper.
  - Before eating or preparing food.
  - After touching animals or pets.
  - After caring for an ill person.

Fig: 2.4.4 Using hand sanitizer

Hand sanitizer: If soap and water are not available and hands are not visibly dirty, an alcohol-based hand sanitizer that contains at least 60% alcohol may be used. However, if hands are visibly dirty, always wash hands with soap and water for at least 20 seconds.

2.4.5 Stress Management During An Epidemic

Stress during an infectious disease outbreak can sometimes cause the following:

- Fear and worry about your own health and the health of your loved ones, r financial situation or job, or loss of support services you rely on.
- Changes in sleep or eating patterns.
- Difficulty sleeping or concentrating.
- Worsening of chronic health problems.
- Worsening of mental health conditions.
- Increased use of tobacco, and/or alcohol and other substances.

Healthy ways to handle stress

- Know what to do if you are sick
- Know where and how to get treatment and other support services and resources
- Take care of your emotional health. This will help you think clearly and react to the urgent needs to protect yourself and your family.
- Take breaks from watching, reading, or listening to news stories, including those on social media. Hearing about the pandemic repeatedly can be upsetting.
- Take care of your body.
  - Take deep breaths, stretch, or meditateexternal icon.
  - Try to eat healthy, well-balanced meals.
  - Exercise regularly.
  - Get plenty of sleep.
  - Avoid excessive alcohol and drug use.
- Make time to unwind. Try to do some other activities you enjoy.
- Connect with others. Talk with people you trust about your concerns and how you are feeling.
- **Connect with your community -** or faith-based organizations. While social distancing measures are in place, consider connecting online, through social media, or by phone or mail.

Fig: 2.4.5 Tips for stress management

Exercise

Multiple Choice Questions

1. In health and safety context, a hazard is

a. Anything with the potential to result in an injury or illness.
b. The likelihood of someone being injured in the workplace.
c. Anything that could result in a physical injury.
d. Anything that could result in a psychological injury.

2. Once you have spotted a hazard you must

a. Report it to your boss
b. Leave it as someone else will fix it eventually
c. Bring your own toolbox to work and fix it yourself
d. None of the above

3. From the following options, what is the best way to control hazards in the workplace?

a. Replace the hazard for a less risky option
b. Eliminate the hazard completely from the workplace
c. Use personal protective equipment (PPE)
d. Have rules to help people avoid hurting themselves

4. The safe way of working is

a. An effective and right way of working

b. An ancient way of working

c. A way of handling the work in a hurry

d. A way of normal working

5. The best way of avoiding accident is by

a. Doing work in ancient way

b. Doing work in one's own way

c. Observing safety rules related to job, machine and workplace

d. Using safety equipment

6. Employers have to provide a safe and healthy place for

a. Employees only

b. Workers only

c. Employees and Workers only

d. Employees & Workers

7. You have been given a dust mask to protect against hazardous fumes. What should you do?

a. Do the job but work quickly

b. Do not start work until you have the correct Respiratory Protective Equipment

c. Start work but take a break now and again

d. Wear a second dust mask on top of the first one

8. If you drop your safety helmet from height on to a hard surface, you should

a. Repair any cracks then carry on wearing it

b. Make sure there are no cracks then carry on wearing it

c. Work without a safety helmet until you can get a new one

d. Stop work and get a new safety helmet

9. What type of breathing protection do you use in a space with little oxygen?

a. A disposable mask

b. Self-contained breathing apparatus.

c. A filter mask with the correct filter cartridge.

d. None of these

10. The risk of manual task injuries are increased by

a. The length of time spent handling the load

b. Twisting sideways, bending and stretching

c. Using trolleys and hoists

d. Wearing a back brace

11. What is a frequent cause of stumbling, slipping or tripping?

a. Failure to wear safety footwear
b. The lack of barrier tape along a footpath
c. The presence of cables and pipes lying across a footpath
d. None of these

12. What should bbe your first action, when treating an electrical burn?

a. Ensure that the casualty is still breathing
b. Wash the burn with cold water
c. Check for danger and ensure that contact with the electrical source is broken
d. Check for level of response

13. What is a faint?

a. A response to fear
b. An unexpected collapse
c. A brief loss of consciousness
d. A sign of flu

14. The best treatment for all heart attack victims is immediate CPR

TRUE FALSE

Answer the Following Questions:

15. What are the benefits of organization policies and procedure?

....

....

16. What are the obstacles to effective time management?

....

....

Summary

This module covers how to maintain health and safety at workplace by adhering to organisational policies and guidelines. It also covers potential hazards, risks and threats, organisational emergency procedures for different emergency situations, health and hygiene practices, reporting procedures and importance of following the same.

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Skill Development
Corporation
Transforming the skill landscape

AUTOMOTIVE SKILLS DEVELOPMENT COUNCIL

3. Optimize Resource Utilization

ASC/N9801

Key Learning Outcomes

At the end of this module, participants should be able to:

1. List the ways to optimize usage of resources.
2. Employ ways for efficient utilization of material and water.
3. Use energy efficient electrical appliances and devices to ensure energy conservation.
4. Discuss various methods of waste management and its disposal.
5. List the different categories of waste for the purpose of segregation.
6. Differentiate between recyclable and non-recyclable waste.
7. State the importance of using appropriate colour dustbins for different types of waste.
8. Demonstrate different disposal techniques depending upon different types of waste.

Unit 3.1 - Resource Optimization

Unit Objectives

At the end of this unit, participants will be able to:

1. List the ways to optimize usage of resources.
2. Employ ways for efficient utilization of material and water.
3. Use energy efficient electrical appliances and devices to ensure energy conservation.

3.1.1 Energy Conservation

In today's world, the automotive industry continuously explores new opportunities for energy efficiency options. The company aims to reduce production costs and yet maintaining the quality of the product, customer satisfaction and safety of the passengers in their automobiles. Energy efficiency is crucial to reduce the pollutant emissions into the atmosphere and the automakers find it challenging to increase the output of the products and adhering to energy efficiency practices.

- **Energy management programs and systems:** As the technology of saving energy on equipment is becoming more complex and advanced, so do the impact and changes in employees' attitudes and behaviours.
  - For the employees to adopt the energy management practices in their daily work life, they must undergo energy management training programs and adapt to such changes in their routine tasks.
  - Every level of management from top to bottom of the authority levels must work together to attain the company objectives and missions of energy efficiency and become aware and conscious of their energy consumption.
  - Conducting regular feedbacks and suggestions between all employees and employers in the programs and introducing incentives such as the reward system may motivate participants at all levels.
  - Although employees take small steps and only saves a small amount of energy by switching off the electronic devices, etc. but when they continuously do those small little steps, in the long run, the company saves a huge amount of energy consumption costs and shows greater impact than investing in technology development.
- **Efficient HVAC (heating, ventilating and air conditioning) measures:** HVAC consumes the largest amount of electricity in the automotive assembly plants during operations; it's ventilating the system when the fuel operates with high energy for drying and heating in painting.
  - Therefore, a great way to save energy from the HVAC system is by setting the temperature

of the premises lesser during non-operating days such as weekends and public holidays. It can be evidenced just as simple as turning off the electronic air conditioning controls after operating hours during these periods.

Fig: 3.1.1 HVAC system

- Adjusting the fans by using different shape or size of the sheaves of a fan helps to control the airflow and fan speed which eventually saves energy in the vehicle plant facility.
- Reducing the usage of air conditioning by planting trees that give shades and cool down the building temperatures especially in hot climate areas is warranted immensely.

The bigger is the area of the facility plant, the higher is the ventilation system usage and energy used. The proper distribution of the HVAC system rightly plays an important role that helps save energy throughout the plant facility.

- **Maintenance and control check:** In the long run, the painting lines start to function less efficiently and the other machinery parts also become more deteriorated. The more care of your car, the greater it will perform and saves the environment.
- **The following list shall be considered as maintenance checks:**
    - Install only well- functioned airlocks, windows, entry and exit doors which cause heat losses in the plant facility.
    - Monitor the air exhaust from the ovens so as not to be excessive in the plant facility. Ovens help to heat up the automobiles so to ensure that the hot air transmission from ovens is not too high.
    - Examine the assembly line system that handles coordination between the material parts and check any errors to avoid undesirable failure that cause slowdowns the automobile production process.
    - Install the direct air conditioning towers rather than overhead tubes in the facility and maintained the air conditioner regularly.
    - Regularly record of performance parameters such as OEE or KPI (Overall Equipment Efficiency or Key performance indicator) to measure the efficiency of implemented facility

management services.

- **Design environmentally automobile and structure:** Electric cars are the latest trend in the automotive industry nowadays which relate to energy efficiency. Most car companies manufacture eco-friendlier electric cars and start to increase the numbers of car charging points whether at parking areas, shopping malls, gas stations or office buildings, etc. Weight or load is also another factor that determines the cars' energy usage. If the car is transporting heavy weights, it is highly likely that the car should consume more fuel to travel. Most people leave old or unnecessary items in their car trunks. Every item increases more weight that will use up more fuels while driving which eventually incur more costs and destroying the environment as well. Thus, automakers should produce automobiles with lightweight materials for the components and parts which help the drivers to owning lightweight automobiles which save up on fuel usage.
- **Prevent leaks in equipment, compressor and pipes:** Leaks can be a major source of wasted energy, and correcting them can provide significant immediate savings. Reports indicate that leaks can lead to a 20 to 30 percent loss of a compressor's output. They can also diminish the effectiveness of your equipment.

  There are various ways to determine leaks in system like undertaking an air leak survey. Ultrasonic detection equipment is available for finding smaller leaks as well. Common causes for leaks include missing seals or welds, loose tubes and hoses and worn materials. Leaks can cause delayed the production downtime, increase facility maintenance and shorten its life expectancy. Depending on the cause, rectifying leaks may be as simple as tightening up fittings or replacing minor parts. Repairing and fixing the leaking pipes or equipment reduced the electricity bills. To detect the leakage, identify the high hissing sound from the air leakage. Another way is to use soapy water to detect large leaks. Reduce the pressure to improve the energy efficiency of your compressed air systems. Turn off the compressor when not in use especially after operating hours, night time or during tea breaks to save electricity.

- **Upgrading equipment:** Keeping equipment in good working condition is vital to becoming more energy efficient. Retro-commissioning systematically looks for equipment in facility operating below optimal standards. Retro-fitting involves replacing outdated or inefficient equipment.
- **Install energy-efficient lighting:** Manufacturing facilities need to be well-lit, so it's critical that energy-efficient lighting is properly installed. Industrial compact fluorescent light bulbs (CFLs) or light-emitting diodes (LEDs) can help businesses use less energy.

  Another consideration is to turn off or remove lights in non-essential areas. For example, many manufacturers have vending machines in their facilities. Placing vending machines in well-lit areas, but removing their individual light bulbs can help you reduce some of your electrical usage.

- **Power down the equipment:** Virtually every piece of technology in facility runs on electricity. Shutting down equipment at the end of the day seems to be a no brainer, but it can be overlooked. When your employees are not in their offices, whether it is overnight or for an extended vacation, remind them to shut down their computers and other equipment, or place them into sleep mode. And if you have networked computers, your administrator might be able to adjust power settings for more efficient usage.

- **Improve process heating:** Process heating is required to make most consumer and industrial goods, and it can be responsible for more than one-third of a facility's energy usage. Manufacturers can save energy within this area by installing waste heat recovery systems, leveraging alternative fuels with higher combustion efficiency, installing automatic blowdown control systems, affirming proper furnace installation and controlling exhaust gases.

3.1.2 Water Conservation

We can save water in industries by creating awareness in employees, measuring water consumption, optimum use of water, recycling of waste water, installing water saving equipment, routine checks for pipes etc.

Only 3% of water on Earth is pure and can be used for daily routine. Out of 3% water 5-10% (as of 1999) water is consumed for industrial purpose. As world population will grow water consumption also will grow. By 2030 it can go upto 15-20%, so there is need to spread awareness on ways to save water in industries by reducing its consumption

Ways to conserve water in industry.

- **Educate employees:** Build understanding in employees why water is important and let them innovate ways to water conservation.
- **What is current water consumption:** Know current water consumption to set target for next cycle. It can be month or quarter or year. It will help to identify peaks times, locations which are using more water, leaks and equipment.

Fig: 3.1.2 Noting water consumption reading

- **Routine Checks:** Installation on monitoring, water pressure meter and water flow meter will help to identify leakage in pipes, joints or valves.
- **Minimal use in Cleaning:** To avoid high water consumption, shift to electric brooms, vacuum cleaner or other cleaning devices (like squeegees etc.) in initial process. Wash equipment as and when required than regularly. Reduce the uses of water sprinkler.
- **Retrofit existing equipment and fixtures:** Setting appliance parameters to meet the minimum water requirement for usage; installing automatic shut-off nozzles to hoses; switching to high-

Fig: 3.1.3 Water wastage

pressure, low-volume hose nozzles; and installing water efficient sink faucets, shower heads, and toilets are several ways to retrofit existing equipment to save water.

- **Install water saving equipment:** There are plenty of water conservation equipment are available. Consider using them. Such as toilet systems, tap aerators, also replace tap from high volume to high pressure and low volume.

Fig: 3.1.4 Water saving equipment

- **Reduce the amount of blowdown water from cooling towers by carefully maximizing cycles of concentration:** Cooling towers are often the greatest consumers in industrial operations, providing considerable opportunity for advancement. Each cooling tower cycle, wastewater high in dissolved solids leaves the tower and is replaced by fresh water. If monitored carefully, industries can significantly reduce their fresh water usage.
- **Water recycling:** It is wrong assumption that all processes require pure drinking water in business. We can reuse water (Non-Potable) in plant wherever possible. Installation of cooling tower to recycle water with efficient refrigeration loop can save upto 25% of total water consumption.

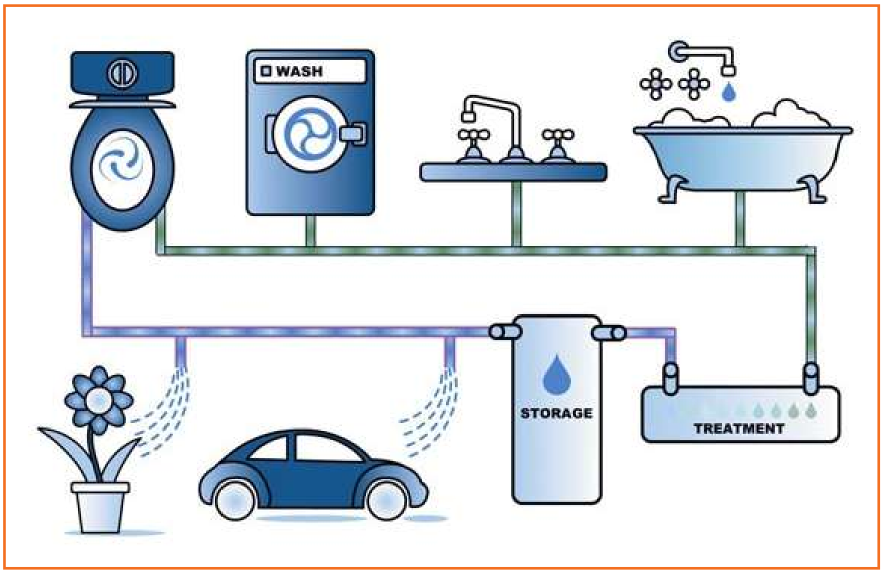

Fig: 3.1.5 Water recycling process

- **Ways to reuse water:** Save water in Industries by Reuse Uhle-box seal water. Centrifugal pump seal water, vacuum pump seal water and condenser water for steam makeup can be reuse to save water.
- **Reverse Osmosis:** Industries can consider reverse osmosis unit to treat water. Although energy consumed by this plant is much higher but it worth it.
- **Effluent and sewage water treatment plant:** Industries can use ETP (effluent treatment plant) and STP (sewage treatment plant) to treat waste water, so that it can be recycled for flush in toilet

and floor cleaning.

- **Replace outdated equipment with energy-efficient alternatives:** Water usage is also cut by investing in equipment with water-saving technology or “dry” equipment that doesn’t require water. One example is using air-cooled equipment (such as an air-cooled compressor), in place of water-cooled equipment whenever possible.
- Reuse non-potable water for other operations. Water leftover from one sector of an operation can be reused for another purpose. For example, water used for cleaning can be filtered and reused for landscaping, or for cooling equipment. Another example is taking otherwise wasted condensate water from cooling towers and reusing it as “make up” water, or water that is used to replace water lost by evaporation.

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Unit 3.2 - Waste Management

Unit Objectives

At the end of this unit, participants will be able to:

1. Discuss various methods of waste management and its disposal.
2. List the different categories of waste for the purpose of segregation.
3. Differentiate between recyclable and non-recyclable waste.
4. State the importance of using appropriate colour dustbins for different types of waste.
5. Demonstrate different disposal techniques depending upon different types of waste.

3.2.1 Waste Management

Waste management is gathering, transport, recycling, processing and disposal of waste materials. Waste management is carried by recovering resources from waste materials.

It involves waste substances (i.e. gaseous, solid, liquid or radioactive), expert personnel and different methods of management.

Classification of wastes typically as follows:

- Garbage i.e. decomposable waste
- **Rubbish:** paper, wood, cloth i.e. combustible in nature and metal, glass, ceramics i.e. non-combustible in nature and non-decomposable wastes
- Ashes
- **Sewage-treatment solids:** material reserved on settled solids, biomass sludge and sewage-treatment screens
- **Industrial wastes:** like chemicals, paints etc.
- **Mining wastes:** slag heaps and coal refuse piles

3.2.2 Types of Waste in Industry

Generally five types of waste are identified in industry, these are:

1. **Liquid Waste:** Liquid waste is commonly found both in households as well as in industries. This waste includes dirty water, organic liquids, wash water, waste detergents and even rainwater.

Fig:. 3.2.1 Liquid Waste

2. **Solid Rubbish:** Solid rubbish can include a variety of items found in commercial and industrial locations. Solid rubbish is commonly broken down into the following types:

    - **Plastic waste** - This consists of bags, containers, jars, bottles and many other products that can be found. Plastic is not biodegradable, but many types of plastic can be recycled. Plastic should not be mix in with regular waste, it should be sorted and placed in recycling bin.
    - **Paper/card waste -** This includes packaging materials, newspapers, cardboards and other products. Paper can easily be recycled and reused so make sure to place them in recycling bin.

Fig:. 3.2.2 Solid Rubbish

    - **Tins and metals -** This can be found in various forms throughout in industry. Most metals can be recycled. Consider taking these items to a scrap yard to dispose of this waste type properly.
    - **Ceramics and glass -** These items can easily be recycled. Look for special glass recycling bins and bottle banks to dispose them correctly.

3. **Organic Waste:** Organic waste is another common type of waste. All food waste, garden waste, manure and rotten meat are classified as organic waste. Over time, organic waste is turned into manure by microorganisms. However, this does not mean that you can dispose them anywhere.

   Organic waste in landfills causes the production of methane, so it must never be simply discarded with general waste.

Fig:. 3.2.3 Organic Waste

4. **Recyclable Rubbish:** Recyclable rubbish includes products that can be used again. Solid items such can all be recycled.

5. **Hazardous Waste:** Hazardous waste includes all types of rubbish that are flammable, toxic, corrosive and reactive.

Fig:. 3.2.4 Recyclable Waste

Fig:. 3.2.5 Hazardous Waste

3.2.3 Elements of Waste Management Strategy

Good waste management practices involve much more than that disposing of waste legally and properly. Strategy for the management of industrial waste can include the subsequent elements:

- Current waste management procedures and primary audit of wastes produced.
- Risk assessment to find that stowage and handling procedures does not possess any health or environmental risk.
- Identification of options for reuse, waste reduction, recovery assessment and recycling of waste.
- Identification of best practicable environment! There should be an option for dumping of waste and residues.
- Selection of the contractor offering the best service and audit of potential waste management contractors.

3.2.4 Methods of Waste Management

1. **Segregation**

   Why waste separation using container unit is so necessary because plastics, building materials, glass and waste from the site work could take a really long time period to decompose. This is the reason, thus, it is required to maintain green practices so waste management should be done with proper segregation. Thus we make sure to support you in removing hazardous waste from compostable non-hazardous solid waste, organic waste, recyclable materials and other regulated material.

Fig: 3.2.6 Waste segregation

2. **Composting**

   This waste management process turns waste into organic compounds that you can use to feed plants. In terms of the environment advantages this is actually beneficial technique. Making use of this method, it's easy to turn unsafe organic products into safe compost.

Fig: 3.2.7 Waste composting

3. **Landfill**

   One of the most popularly used methods of waste disposal. This process buries the waste in the land, but there is more to it. When it comes to proper landfill management, it is important to sort out all the waste first and send only the waste that you cannot recycle or compost. There is also a method that eliminates the odour and dangers of rubbish before placing them on the ground.

4. **Recycling**

   Products like PVC, LDEP, PP and PS are recyclable though they are not collected for recycling. The material, which is composed of a single type, is recyclables and is much easy to work with. However, complex products are difficult to treat and so are complex for recycling.

Fig: 3.2.8 Waste recycling

Exercise

Multiple Choice Questions

1. **Which is not the element of effective housekeeping**
   a. Waste disposal
   b. Cleaning
   c. Machining
   d. Spill control

2. **The most serious environmental effect posed by hazardous wastes is**
   a. air pollution
   b. contamination of groundwater
   c. increased use of land for landfills
   d. destruction of habitat

3. **Which of the following is not a primary contributor to the greenhouse effect?**
   a. carbon dioxide
   b. carbon monoxide
   c. chlorofluorocarbons
   d. methane gas

4. **In health and safety context, a hazard is**
   a. Anything that could result in a psychological injury.
   b. Anything with the potential to result in an injury or illness.
   c. The likelihood of someone being injured in the workplace.
   d. Anything that could result in a physical injury.

5. **Spilled oil can be the cause of an accident.**
   a. True b. False

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Waste management

Summary

This module covers how to dispose different types of waste as per organisational and environmental policies and guidelines. It also covers how to reduce wastage of water, electricity etc. and save them by using effective conservation practices.

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4.Assist in Diagnosing Repair Requirements

Unit 4.1 - About Four Wheeler Vehicle

Unit 4.2 - Tools and Equipment Required

Unit 4.3 - Diagnosing Four Wheeler Vehicle

ASC/N1402

Key Learning Outcomes

At the end of this module, participants should be able to:

1. Identify four wheeler aggregates and parts.
2. Describe functioning of four wheeler vehicle, its aggregates and parts.
3. List tools and measuring instruments required for servicing and repairing work;
4. Demonstrate use of tools and measuring instruments required.
5. Analyse the job card to plan diagnostic activities as per the complaints mentioned in the job card.
6. Demonstrate how to do a test drive of the vehicle.
7. Employ appropriate techniques to park the vehicle in the workshop's designated service/repair area as instructed by lead technician.
8. Apply basic techniques to diagnose faults in the sub-assemblies of the vehicle.
9. Demonstrate how to check the vehicle for the service and repair requirements based on the job card.
10. Demonstrate how to use tools and equipment required for diagnosis as per standard operating procedures.
11. Employ various precautions and safety measures to ensure that no damage is caused to the vehicle during diagnosis.
12. Prepare documents required for diagnosis/troubleshooting of common issues.

Unit 4.1 - About Four Wheeler Vehicle

Unit Objectives

At the end of this unit, participants will be able to know about:

1. Identify four wheeler aggregates and parts.
2. Describe functioning of four wheeler vehicle, its aggregates and parts.

4.1.1 Introduction

Automobiles are made up of several components, assemblies and systems. The growing auto industry has given rise to a growing auto component manufacturing industry also. India has now become outsourcing hub for manufacturing of various automobile components. Many reputed automobile brands like Hyundai, Volvo, Renault, Toyota and many other companies are now obtaining their automotive spare parts from Indian manufacturers.

The auto components industry is predominantly divided into five segments:

- Engine parts
- Drive line- Transmission
- Steering, Suspension & Brake Parts
- Electrical Parts
- Body and chassis

India is now being seen as manufacturing hub by global manufacturers of automobiles due to:

- Raw material availability and labour force at low cost thus it is cost competitive
- Very good setup of manufacturing base
- Several internationally known auto components manufacturers like Bosch, Visteon, Meritor just to name a few have already did their operational setup in India
- Automobile manufacturers and auto component manufacturers have set up International Purchasing Offices (IPOs) in India.
- Fine-quality components are manufactured in India.
- **India is a global hub for R&D:** GM, Daimler Chrysler, Bosch, Suzuki, Johnson Controls etc. All have their research centres in India.

In this unit, you will learn about various components and systems that makeup a complete automobile. Therefore, you will be introduced to engine and its part, Body and chassis, Drive Transmission & Steering Parts, Suspension & Brake Parts, Electrical Parts and other systems that make it possible for running of an automobile.

4.1.2: Anatomy (Aggregates) of Four wheeler

The main critical parts and aggregates of a typical automobile are shown in the schematic diagram given below -

Let us understand the vehicle parts & their nomenclature:

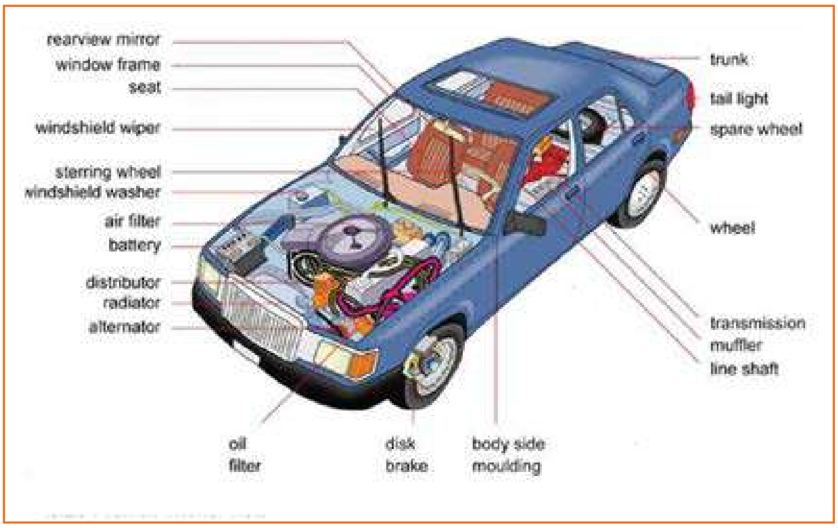

Fig 4.1.1: Vehicle interior view

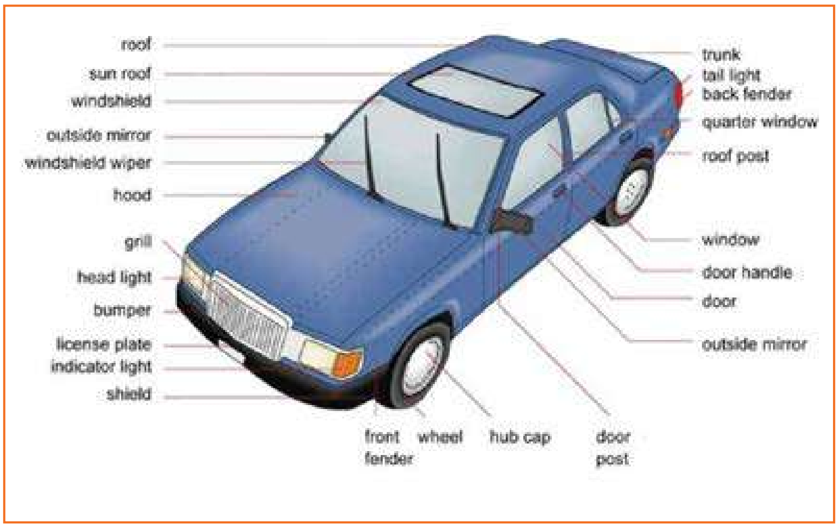

Fig 4.1.2: Vehicle exterior view

Frame or body shell: It forms the skeleton of the Vehicle

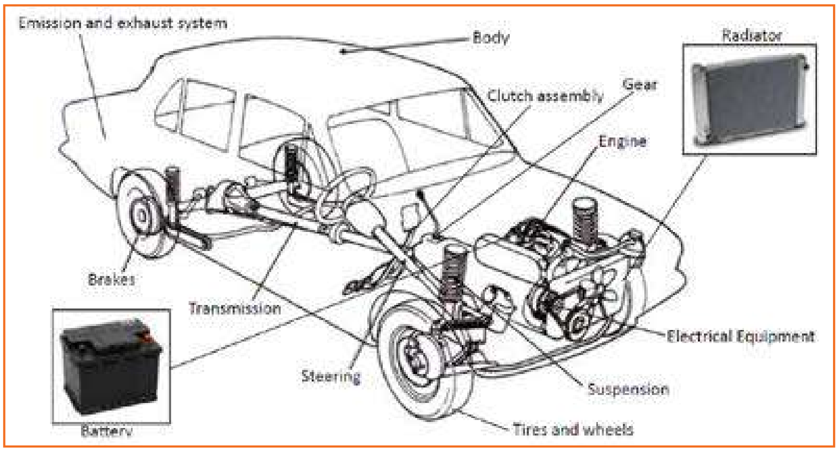

Fig 4.1.3: Vehicle frame

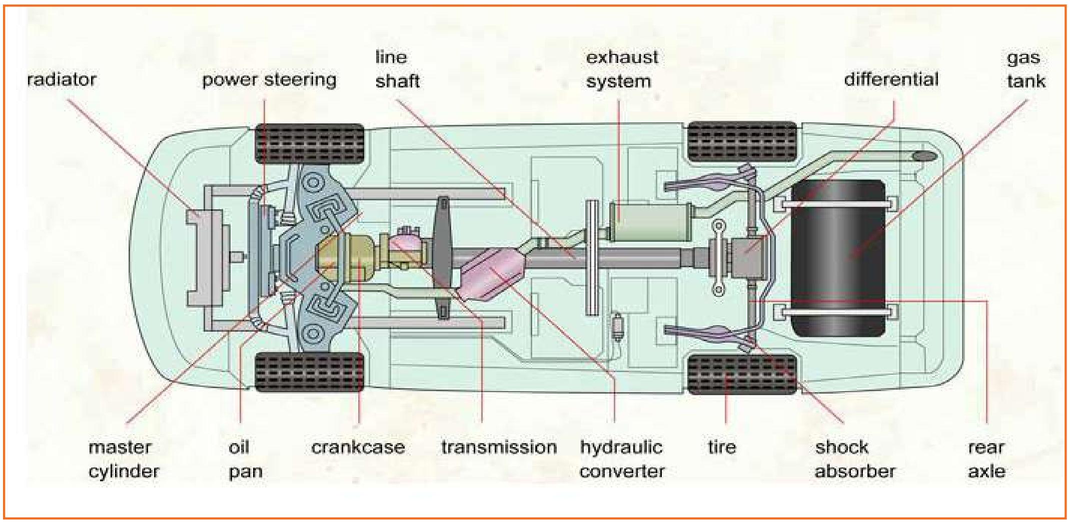

Fig 4.1.4: Vehicle view from the bottom

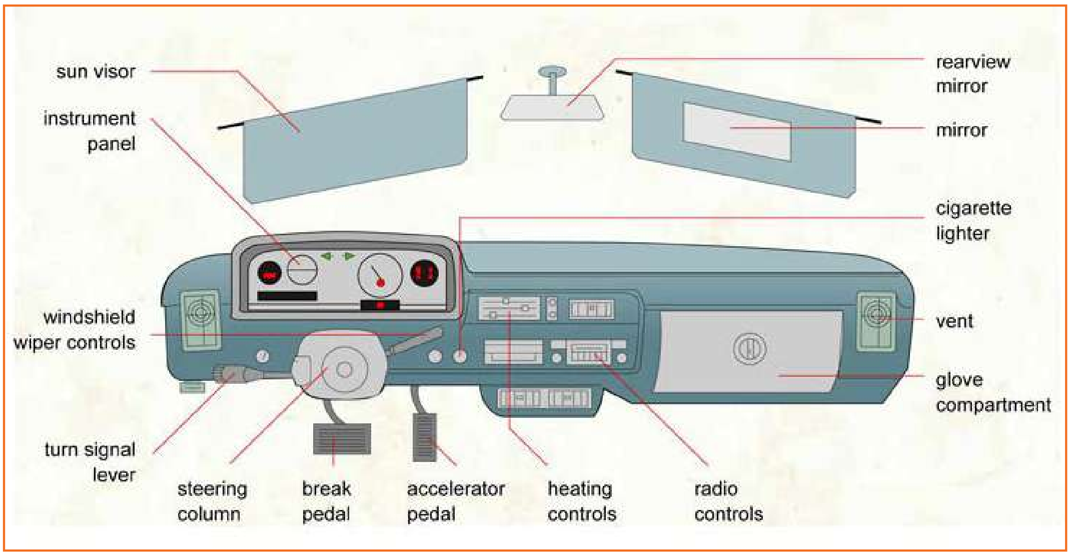

Fig 4.1.5: Vehicle dash board

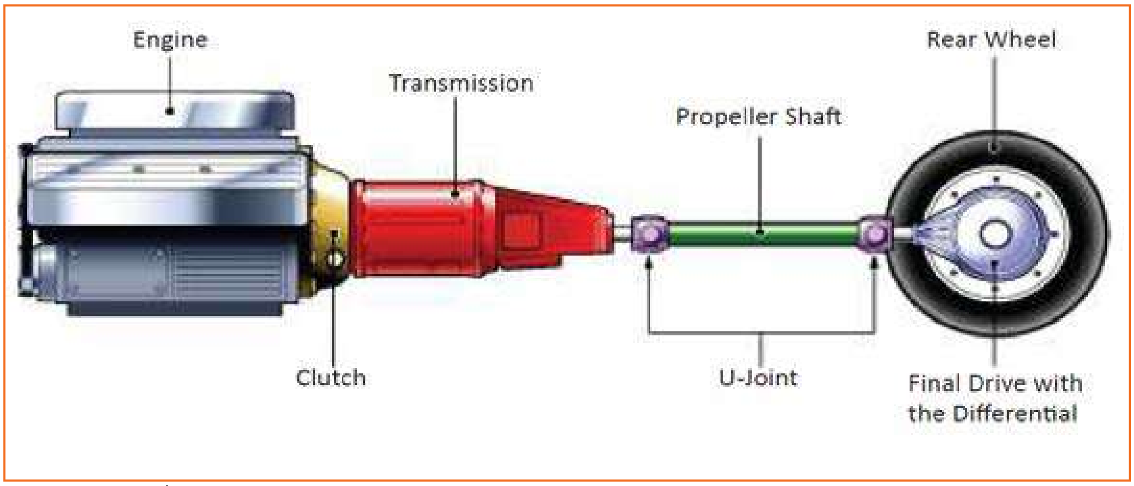

Fig 4.1.6: Complete power train

4.1.2 Major Systems and Sub-systems in an Automobile

1. Engine (Power Generation)
    - Air Induction
    - Fuel system
    - Ignition system
    - Exhaust system
    - Lubrication system
2. Driveline
    - Clutch
    - Gearbox/Transmission
    - Transfer case
    - Differential
    - Driveshaft
    - Wheels and Tyres
3. Running Gear
    - Suspension
    - Steering
4. Brake System
    - Drum Brake, Disc Brake and Parking Brake
5. Electrical, Comfort, Convenience and Safety
    - Horn, lighting, wiper, instrument cluster, controls
    - HVAC, seating, power window, central locking, etc.
    - SRS Airbag, ABS etc.

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Anatomy (Aggregates) of Four wheeler

Unit 4.2 - Tools and Measuring Instruments Required

Unit Objectives

At the end of this unit, participants will be able to know about:

1. List tools and measuring instruments required for servicing and repairing work;
2. Demonstrate use of tools and measuring instruments required.

4.2.1 Tool and Equipment

Workshop tools may be divided in three types:

- Manually used tools
- Electrically operated tools
- Pneumatically operated tools
- Special service tools

4.2.2 Manually Used Tools

Workshop tools may be divided in three types

Wrenches:

The objective of a wrench is to tighten or loosen bolt or nut. Based on fastener's design and size, appropriate wrench needs to be selected. It can also depend on how difficult the fastener is to reach.

Tip:- When using a wrench, pull it toward you rather than pushing it away as it provide better control and injury can be avoided during slip process.

Different types of wrenches are available: Box end, Open end, Combination, Adjustable, Socket and Allen.

Fig 4.2.1: Wrenches

Screwdriver:

Screwdriver is manly used for tightening or losing screws by inserting it into the screw head. It helps in amplifying user's hand motion to its tip. There are various types of screwdriver tips based on specific requirement out which two most common head of screwdriver are straight or minus one and x shaped

Fig 4.2.2: Screw drivers

which is also called start tip. Handle of screwdriver made up of either plastic or wooden. For having better grip on handle rubber cover is also used on it. Some other tips are also used for various purposes like hourglass shape, square shape, six slots tips etc.

Pliers:

Fig 4.2.3: Plier

The primary purpose of the tool known as pliers is to grip objects firmly. The objects can then be turned, bent, or otherwise manipulated. Pliers have parallel handles, a pivot where the handles join, and parallel jaws that grasp the object. Special-use pliers may have additional components and purposes, such as cutting pliers. Types of pliers include engineer's pliers for gripping metal, flat-nosed pliers for grasping smaller objects, electrician's pliers for gripping electrical wires, and round-nosed pliers for bending wire into loops. The most common are slip-joint and plumber's pliers, both with slip-joint adjustments to change the width of the jaw grip. In addition, locking pliers, sometimes known by the Vice-Grip brand name, are popular for firmly holding objects.

Socket-Set:

Fig 4.2.4: Socket set

Socket set is having a number of different size detachable sockets used with socket wrench. It is basically a type of wrench having facility to attach a required size of socket at the end to turn a fastener.

The most common type of socket wrench is ratcheting socket wrench which is also called ratchet.

Extension bar-set:

Fig 4.2.5: Extension bar set

It has number of bars in sets. Use extension bars to prevent over-tightening of lug nuts, distortion of wheels, drums and rotors. It helps to reach the bolt that are out of reach, so it make easier for mechanic to take off the part deep in engine bay.

Torque-Wrench:

Fig 4.2.6: Torque wrench

It is a tool which is used to exactly apply specific torque to a fastener like nut or bolts. Basically it is a socket wrench having special internal mechanism.

Vice:

Fig 4.2.7: Bench vice

A vice is an apparatus used to hold an object so that required work can be carried out on object. Vice consists of parallel jaws. One of the jaws is fixed on the structure whereas another one is movable having a liver to move the jaws. Vices can be used to hold metal in place to be cut or modified.

Hacksaw:

A hacksaw is a metal-framed saw used primarily for cutting plastic and metal pipes and other small household materials. It is basically a U shaped bended frame which can hold a thin wide metallic blade between its clip having a handle at one end made up of plastic or wood. Some hacksaw is also having facility for adjustment so that it can accommodate wide variety and size of blades as per requirement. As per the requirement of cut the metallic blades will have varied number of teeth per inches like 14, 18, 24 or 32. For cutting smaller objects dense teeth will be required. There are two types of hacksaw blades namely high carbon steel blades and high speed steel blades used for various types of cutting job.

Fig 4.2.8: Hacksaw

Chisels/Punches chisels:

Type of tool is having a typical shaped cutting of blade at one end used for carving or hard material cutting like wood, stone or even metal using hand and further struck with a mallet or mechanical power. In some chisel handle and blade are made up of metal or wood having a sharp edge. Chisels are various uses in service and maintenance.

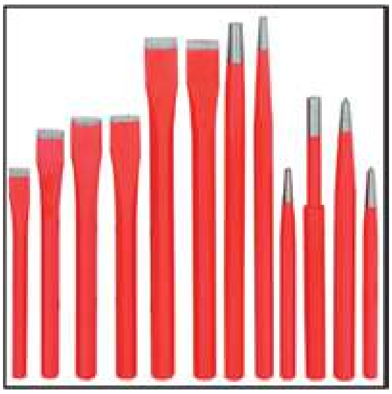


Fig 4.2.9: Chisel

Punches:

There are two distinct types of punches either hollow or solid one.

- Hollow punches are manly used puncturing surface to create a hole of metal sheet or leather. We can identify hollow punches by looking towards the working end where we can find its exit hole which helps in removing and discarding punch material. Shape and size of working edge can vary and depends on the hole required and the material being pierced.
- Solid punches are made of metal and looks like a road, designed to be struck by a hammer. It is mainly used to move objects such as pins or to form impressions on a work piece. Solid punches can vary in diameter, length and tip depending on the job to be performed.

Ball-Peen hammers:

The ball peen hammer is a type of peening hammer having 2 ends. Shape of the first end is like an ordinary hammer head while the other is ball shaped. It has a handle that is like that of a regular hammer and the material can vary, which includes wood, metal or fibre glass. This type of hammer is also called machinist's or engineer's hammer. It is the tool that is utilized to form the general shape of the material in metal fabrication. It is also used for hitting chisels and punches.

Fig 4.2.10: Ball peen hammer

Hand-Sledge:

In this type of tool a large flat metal head is attached to a handle which is also called lever. The advantage of sledge hammer is that its head size applies more force compare to other hammer of same size. It distributes force over a wide area along with mallet and basically the alternative of other types of hammer which apply force on relatively smaller area.

Fig 4.2.11: Hand sledge

Rubber-Mallet:

Rubber mallets are much lighter and cheaper than metal mallets and are much safer to use. A rubber mallet is the basically used to produce the effect of hitting on another object. Sometime it is also used metal dent removal process because they don't leave any marks. They are also used in construction to force tight fitting parts together.

Fig 4.2.12: Rubber mallet

Threader-Kit:

Threader - kit has a number of threading tools. It is use to threading the bolt. If your threads are not completely destroyed, you can try **"chasing"** the threads with a thread chasing tap. This may realign the threads so that the bolt can be threaded in place. A thread chaser is essentially a slightly undersized tap that will clean threads without removing any metal. When thread damage is too severe to be saved with a thread chaser, they can completely restore the threads with new coil-type thread inserts. They will provide a completely new threaded hole (with strong steel threads) that accepts the original size bolt. They are installed by drilling the damaged thread hole slightly oversize, tapping it with a larger tap, and screwing in the new thread insert coil.

Fig 4.2.13: Threader kit

4.2.3 Electrically Operated Tools

These tools are operated by electrical power

Drill:

It is a tool which is getting attached with cutting tool or driving tool. It is basically used for boring holes in various types of materials or also in fastening various materials by the use of fasteners using a drill bit or drive bit.

Fig 4.2.14: Drill

Drills are mainly used for boring holes in wooden, metal job and also in construction and some basic requirement at home. For drilling holes in various types of work like wooden, plastic or metal we use drilling machine. For safe drilling of such material bench drill is bolted down. There are also some larger versions of drill called pillar drill having longer column which help them to stand on the floor. It functions the same as the bench drill but can drill larger pieces of material.

Drill-Bits:

Drill bits are cutting tools used to remove material to create holes, almost always of circular cross-section. Drill bits are available in various shapes which can be used to create different types of hole in various types of materials. For making a hole, drill bits has to be attached with drill machine. Drill machine provide power to drill bits so that it can cut through the work piece by rotation. Upper end of the drill which is also called shank is grasped in the chuck.

Fig 4.2.15: Drill bits

Reamers:

It is a type of rotating cutting tool used in metal work. It is designed to enlarge pre-existing hole dimension or further deepening by a small amount but with very high level of accuracy. Various types of reamers are available based on material used, style of flute styles and size.

Fig 4.2.16: Reamers

The typical reamer is a rotary cutting tools designed to machine a previously formed hole to an exact diameter with a smooth finish. But other types are used to remove burrs from the inside of pipes & drilled holes and to enlarge and align holes for fasteners.

Soldering-Iron:

Soldering iron is a handheld tool used for soldering purpose. It melts the solder by applying heat so that solder can flow in-between joints of two work piece so that it can be joined.

A soldering iron consists of metal tip having heating facility and insulated handle. Metal tip heating is done by the use of electric current which is supplied using and electric cable through the heating element. Soldering irons are mainly used in electronics assembly during installation and repair work.

Fig 4.2.17: Soldering iron

Soldering gun:

Soldering gun is tool which work on electricity. It is used for metal soldering by using tin-based material so that strong mechanical bond with good electrical contact can be achieved. Shape of soldering gun is similar to the shape of pistol.

Fig 4.2.18: Soldering gun

4.2.4 Pneumatically Operated Tools

These tools are operated by compresses air

Impact-Wrench:

Impact wrench is also called by various names such as impact gun, air gun, rattle gun, torque gun etc. Impact wrench is a socket wrench power tool used to deliver high output torque with minimum effort by user as it stores the energy in rotating mass and deliver it suddenly to the output shaft.

Fig 4.2.19: Impact wrench

4.2.5 Measuring Tools

Gauge:

Gauge is a measuring tool used for measurement to display certain information like time, pressure, dimension etc. Based on the use of gauge it can be generally defined as a physical quantity measuring device for example deciding the thickness, space gap, material diameter or flow pressure.

Fig 4.2.20: Gauge

Feeler-gauge:

A feeler gauge is a tool used to measure gap widths. Feeler gauges are mostly used to measure the clearance between two parts. They consist of a number of small lengths of steel of different thicknesses with measurements marked on each piece. To use it, hold the feeler gauge the same way you would hold a pen knife or a multi-tool, between your thumb and forefinger. If needed, feeler gauge blades can be stacked together to obtain the correct size for measuring.

Fig 4.2.21: Feeler gauge

Calipers:

Caliper is a measuring tool used to measure the distance between two opposite sides of an object. It is as simple as compass with inward and outward facing points. To use it, slide the jaws open, place the caliper over the object to be measured, and slide the jaws until they contact the workpiece. Read the measurement.

Fig 4.2.22: Caliper

Dividers:

Divider is a measuring tool used primarily to measure distance particularly in maps. It is very similar to drawing compass except that compass is having one metallic point and one pencils whereas divider is having two metallic points.

Fig 4.2.22: Divider

Vernier caliper:

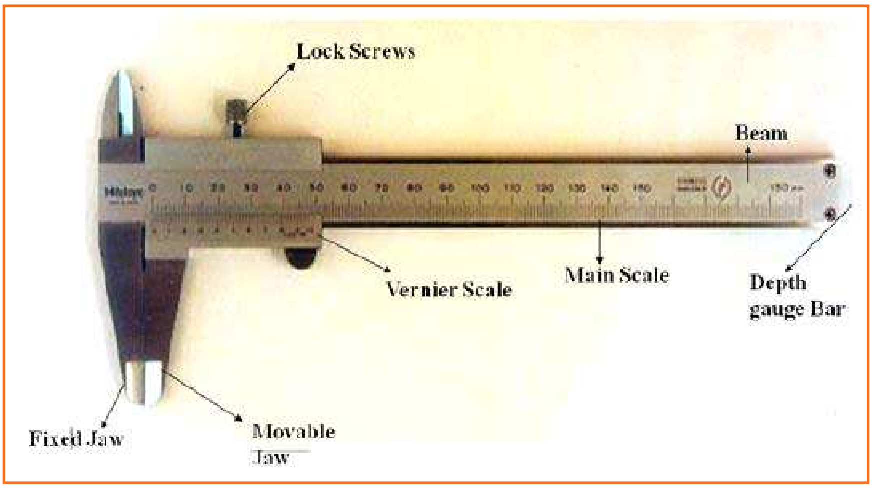


Fig 4.2.23: Vernier caliper

It is widely used for precision measurement of length, thickness and depth apart from inside and outside diameter. A vernier caliper has a main scale (in millimetres) and a sliding or rotating vernier scale. In figure 1 below, the vernier scale (below) is divided into 10 equal divisions and thus the least count of the instrument is 0.1 mm. Both the main scale and the vernier scale readings are taken into account while making a measurement. The main scale reading is the first reading on the main scale immediately to the left of the zero of the vernier scale (3 mm), while the vernier scale reading is the mark on the vernier scale which exactly coincides with a mark on the main scale (0.7 mm). The reading is therefore 3.7 mm.

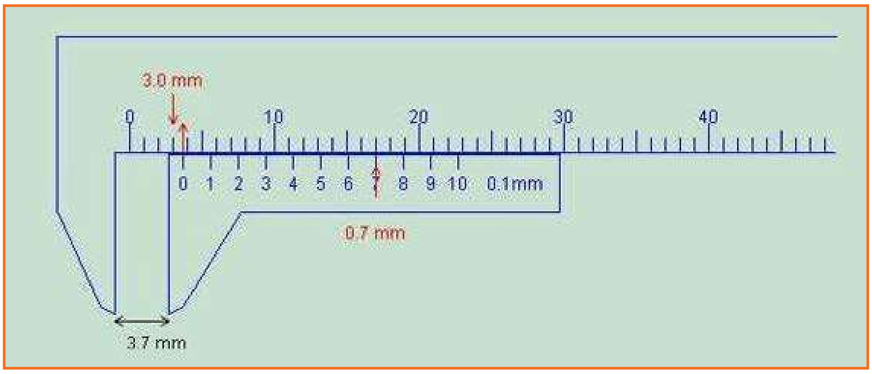


Fig 4.2.24: Reading vernier caliper

Least Count: The smallest reading which can be accurately measured with a vernier caliper is called its least count (L.C), it is also known as vernier constant.

Calculation = Smallest division over main scale/Division over Vernier scale

=1/20 = .05 mm (It may be different in different in different calipers)

Vernier Calipers are available for measuring accuracy of 0.01- 0.02 or 0.5.

Zero error

Close the jaws to check the Zero error and calculate the zero correction. It is positive if showing some reading and to be deducted from the calculated value. If reading is less than zero it is negative and to be added.

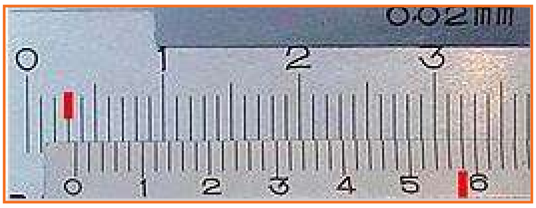


Fig 4.2.25: Reading Vernier scale

Measurement=Main scale reading + Vernier reading x Least count (adjust zero error in calculated value to find out final reading)

Reading Vernier (mm)

Least count -1/50 = 0.02 mm

Main scale reading - 3.00 mm

Vernier scale reading -(5 X 5 + 4 = 29) x 0.02 = 0.58

Total reading = Main scale + Vernier = 3.00 + 0.58 = 3.58 mm

Micrometer:

Micrometer is basically a measuring tool used to measure block thickness, depth of slot, inner and outer diameter of shaft with high level of accuracy. It incorporates a calibrated screw widely used for accurate measurement of components.

A micrometer reading is not accurate if the thimble is over- or under-torqued. A useful feature of many micrometers is the inclusion of a torque-limiting device on the thimble—either a spring-loaded ratchet or a friction sleeve.

To take a measurement on the micrometer the object is gently pinched between the anvil and spindle. Once a very gentle pinch has occurred the user twists the ratchet until it clicks once or twice. This ensures that the right amount of tension is applied. The object should be held firm enough to not fall out of the micrometer under its own weight yet gentle enough that it can easily slip away if grasped. If necessary the user can apply the lock nut to prevent the spindle from tightening or loosening while interpreting the measurement.

The user then looks at the lines on the spindle and finds which markings are aligned with the datum line. This line, highlighted with the red arrow in Figure, is the measurement.

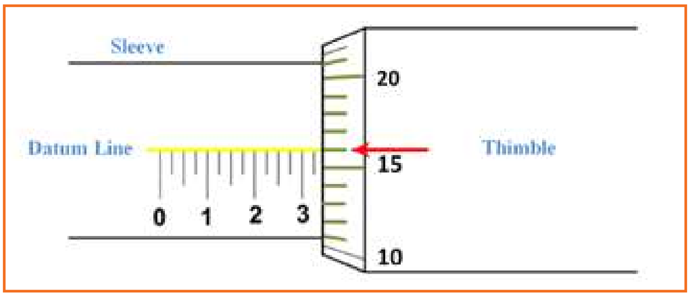


Fig 4.2.26: MIcrometer scale

Least Count of Micrometer:

LC = Pitch / Number of vernier scale division

LC = 0.5 mm / 50 or 1 mm / 100 = 0.01 mm

Zero error: When the anvil and spindle are touching the 0 line of sleeve (main scale) and the 0 line of thimble (rotating scale) must be aligned. If these are not aligned, the micro-meter is having zero error

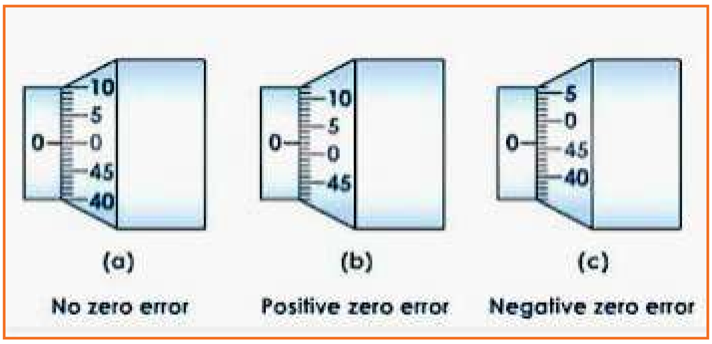


Fig 4.2.27: Micrometer errors

Dial indicator:

Dial indicator is mainly used in monitoring the readings as it helps in displaying small measurement changes in amplified form. The gradations measured with a dial indicator are small, typically 0.01 mm.

Fig 4.2.28: Dial indocator

Dial indicator helps in checking the difference in tolerance thus very helpful in the process of inspection of mechanical part, measuring beam deflection or also in various other situations where a small measurement needs to be recorded.

To use it, rotate the outer dial to position the zero mark directly opposite the needle regardless of where it is pointing. Once the indicator is zeroed you can take the measurement by moving the part in question. The indicator will show movement either positive or negative.

The least count of dial indicator is 0.01 mm with a range of 0.80 mm or up to 2 mm.
But some special type of lever dial gauge has the least count of 0.001mm with a range of 0 to 1 mm.

Zero out a dial indicator: Rotate the face of the indicator until the **"0"** marking aligns with the dial. Tighten the knob afterward to lock the face in position. Twist the zero adjustment knob if your dial indicator does not feature a rotating face. Continue twisting the knob until the dial aligns with the **"0"** marking.

4.2.6 Pressure / Vacuum Gauges

It is used to measure the pressure or the vacuum of liquid, gas, air etc.

Pressure Gauge:

A compression gauge or compression tester is a tool inserted into the spark plug hole on an engine while the flywheel is rotated. This will result in a pressure reading that can be used to judge the condition of a cylinder, piston and rings.

Fig 4.2.29: Pressure gauge

Compression Gauge:

A compression gauge or compression tester is a tool inserted into the spark plug hole on an engine while the flywheel is rotated. This will result in a pressure reading that can be used to judge the condition of a cylinder, piston and rings.

Fig 4.2.30: Compression gauge

4.2.7 Electrical Quantity Measuring Devices

Voltmeter:

Voltmeter is a measuring instrument used to measure potential difference or voltage between two points in either electrical or electronic circuit. It is often called voltage meter. There are two types of voltmeter i.e.

- Analog which is using needle type of pointer to show the reading whereas
- Another type is digital which shows reading as numerical display.

Fig 4.2.31: Voltmeter

A voltmeter in a circuit diagram is represented by the letter V in a circle.

Multimeter:

Multimeter is an electronic measuring instrument which is also called as multi tester. It is equipped with the facility of measuring several functions within one unit. Multimeter is a hand held device used to measure current, voltage both type AC and DC and resistance with high degree of accuracy and mainly used for fault finding during maintenance and service process. It is very helpful in electrical or electronic problem troubleshooting in a wide range of industrial and household devices such as electronic equipment, domestic appliances, power supplies and wiring systems.

Fig 4.2.32: Multimeter

It used to measure DC/AC- Voltage, Current, Resistance, continuity and diode etc.

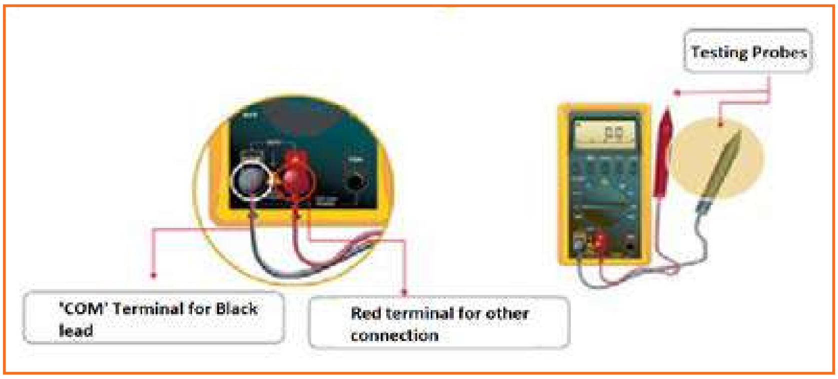


Fig 4.2.33: Reading multimeter

Selection fields

- **Direct voltage:** Set the switch to V
- **Resistance:** Set the switch to Ω
- **Direct current:** Set the switch to A

Fig 4.2.34: Multimeter selection fields

Caution

Incorrect Connection may blow multi-meter fuse.

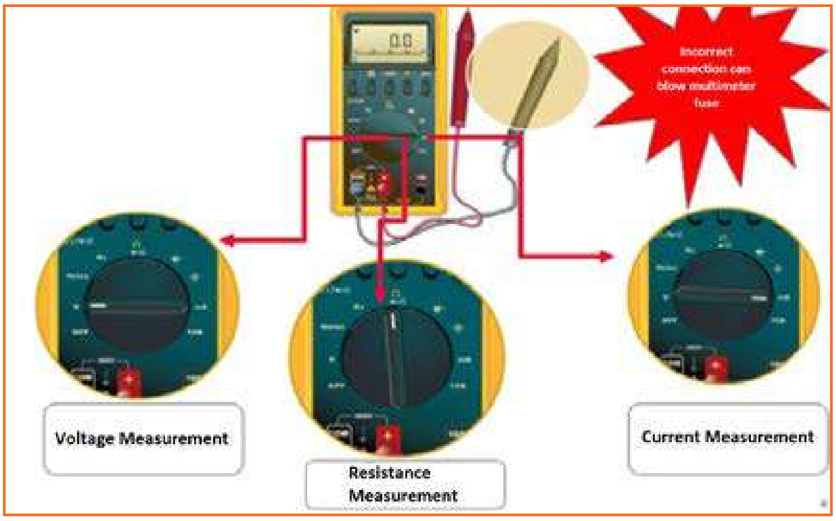


Fig 4.2.35: Multimeter incorrect connection

Checking Voltage: When circuit is **"ON"**, multi-meter probes parallel to the load

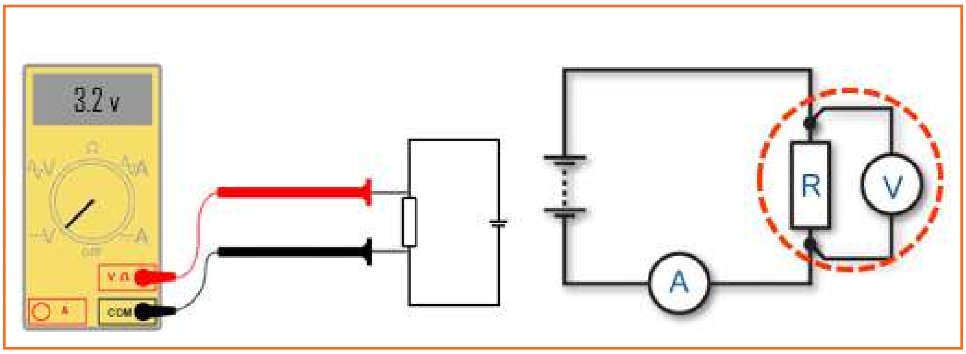


Fig 4.2.36: Checking voltage

Current measurement: ensure always in series with the load checking. We must not check more than 10 Amp current by multi-meter as common multi-meters are up to the range of 10 Amp.

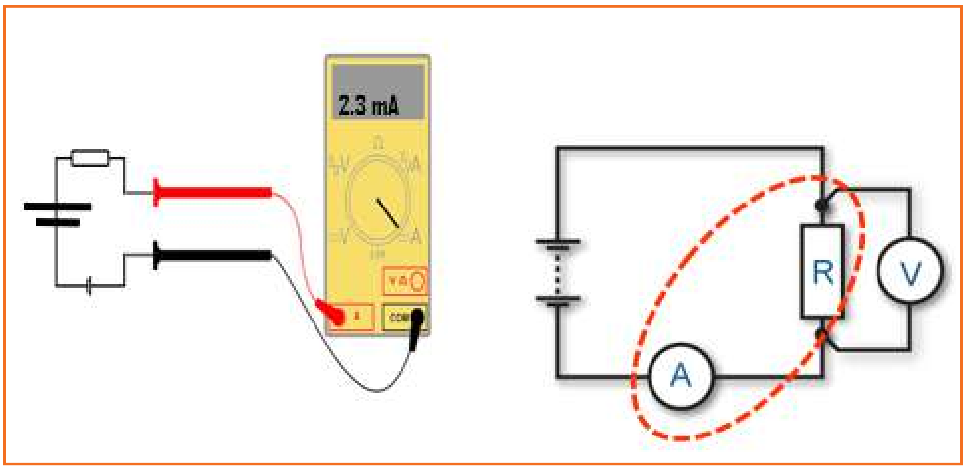


Fig 4.2.37: Current measurement

Resistance: Opposition to the flow of current or electrons in any electrical closed circuit is known as Resistor Symbol is R and unit is Ohm. It's checked after removing it from the circuit

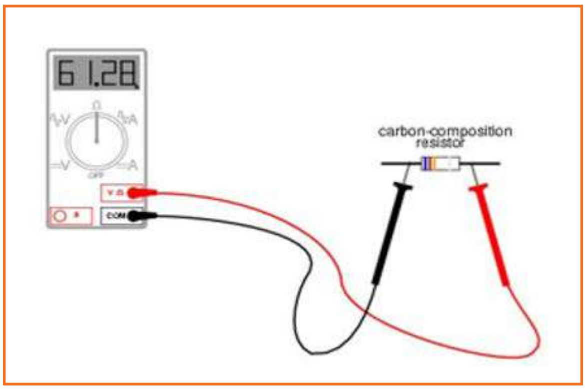


Fig 4.2.38: Resistance measurement

Caution: Multi-meter can be used to measure current level below the limit mentioned over it (generally 10 A). For higher current measurement, use clamp meters.

Don't use multi-meter for checking resistance/continuity of air bag. In doing so, small amount of voltage is applied by the probes of the multi-meter which may deploy the air bag/pretensioner.

Fig 4.2.39: Using multimeter

4.2.8 Diagnostic Tools and Equipment

These tools are used for diagnostic purpose or for doing some settings

Test light: Test light is electronic test equipment also known as test lamp, voltage tester. It is basically used for establishing the presence or absence of alternating current in a piece of equipment under test condition.	
Tachometer: Tachometer is a measuring tool used to measure rotation speed of instrument shaft or disk in a motor or other such machine.	
Scan-Tool: Scan tool used in automotive is often called as scanner. This is basically an electronic tool which can be interfaced with vehicle for diagnostic purpose. It also helps to reprogram control module of vehicle.	
Oscilloscope: The oscilloscope helps us find the problem quicker and easier. Shows the electrical activity in the vehicles ignition system and other electrical systems.	
Exhaust gas analyzer: Vehicle's exhaust is having various chemicals and to measure the amount of chemical exhaust gas analyzer is use. To measure the fuel-air ratio of the fuel mixture of an engine a carbon dioxide sensitive element device is placed in the exhaust manifold. It is also known as fuel-mixture indicator or smoke feeler.	

Table 4.2.1: Diagnostic tools required

4.2.9 Special Service Tools

Bearing puller

A bearing puller is a tool used to remove bearing sets from a rotating machine shaft or from a blind bearing hole. These tools are made of tool grade steel, so they are harder than the parts they are used on. They are usually hand-powered with a handle on the turn screw. Some bearing pullers are hydraulically powered, using a hydraulically powered piston to press against the end of the shaft the bearing is on.

There are arms with extensions that allow the user to pull in the inner race as well. It is preferable to drive from the inner race since it is firmly set on the shaft, while the outer race is not very well secured to the rest of the bearing assembly.

Types

- **Bearing Splitter Plates:** Bearing splitter plates are the safest type of bearing pullers to use. Technically these are not pullers, but pushers, since they use wedges to push and pop the bearings off of the shaft. These consist of two half plates held together by two long, wide diameter, heavy duty screws with nuts on all four ends. The plates have a hole in the middle and are ground downwards towards the hole in the center, so as you tighten the two plates together on the outside, the tool wedges into and applies upward thrust on the inner race of the bearing. These work best if there is a gear or hub directly behind the bearing, so that the tool is held in place on one end as the upward thrust pushes on the inner bearing race.

Fig 4.2.40: Bearing splitter plates

- **Two and Three Arm Bearing Pullers:** These are the most common types of bearing pullers and can be used for pulling gears or bearings. The arms have fingers on the end that bend in to get behind the bearing to its race. The center screw of the puller is torqued so it pushes on the top of the shaft and upward thrust is applied to the bearing's race. Arms and fingers are interchangeable so the same puller can accommodate a wide variety of bearing and shaft sizes and lengths.

Fig 4.2.41: Bearing pullers

- **Internal Bearing Puller:** Internal bearing pullers are made to extract a bearing set, a bushing, or a simple bronze sleeve from a blind hole. Blind holes preclude using a punch to drive out the sleeve or bearing. Internal bearing pullers usually resemble small dent pullers since they have a slide hammer along the shaft to apply upward thrust and shock to the bearing. The collet, the part that goes into the bearing at the tip of the puller shaft, is expandable. The user can lock the collet inside the bearing or bushing, usually by spinning the collet tighter on the puller shaft. By working the slide hammer away from the bearing and up towards the user, the tool's hammer will transmit the upward thrust to the bushing and pull it out of its hole.

Fig 4.2.42: Bearing puller

Clutch holder

Clutch holder is used to hold the inner clutch hub, which is necessary for removal and installation of the clutch hub and clutch basket of the vehicle. To use it place the jaws on the clutch hub so the ends fit into the square grooves where the drive plates (steel plates) would usually rest. Using the adjusting bolt on the back of the tool, adjust the tension so the tool can apply light pressure on the hub when clamped down. With the clutch hub held in place the center nut can be removed with the appropriate wrench.

Fig 4.2.43: Clutch holder

The tool can also be used to hold flywheels, gears, sprockets, and other parts with the appropriate sized **"holding holes"** for easier removal. The pins on the back of the jaws are used to fit into the **"holding holes"**. Simply use the jaw adjusting bolt to set the tool to fit the object you are holding. Once again there should only be light pressure used to clamp the tool to the object. Once in place you can hold the object and more easily remove or tighten the nut or bolt.

Tappet Adjuster

The hand tool allows micro adjustment without disturbing the locknut which can be tightened when the correct clearance is achieved. Use a knurled handle to ensure a secure grip and 12mm wrench to hold the locknut socket while using square type driver to loosen or tighten the valve adjustment screw.

Loosen the nut just enough to allow adjustment of the tappet. Turning the tappet clockwise with the screwdriver will decrease the clearance (counter-clockwise to increase clearance if clearance is too small).

Fig 4.2.44: Tappet adjuster

Notes

Scan the QR code or click on the link to watch related videos

www.youtube.com/watch?v=rddQmcNk1w4

Measuring Tools

www.youtube.com/watch?v=kIadaxekWNI

Special Service Tools

Unit 4.3 - Diagnosis of Four Wheeler Vehicle

Unit Objectives

At the end of this unit, participants will be able to know about:

1. Identify faults and repairing requirements in the four wheeler vehicle;
2. Perform servicing and repairing of four wheeler vehicle.

4.3.1 Test Drive of Vehicle

Automobiles are made up of several components, assemblies and systems. The growing auto industry has given rise to a growing auto component manufacturing industry also. Standard Operating Procedures for servicing and minor repair of vehicles as prescribed by the OEM/ dealership.

To start the servicing and repairing process, firstlyl technician has to identify the faults, place and cause of fault in the vehicle. The first step to identify faults in vehicle is taking a tesy drive of vehicle.

A test drive is critical in spotting loss of engine power, function of clutch and gearbox, worn suspension and brake components on vehicles. Unlike older vehicles, shocks and struts are shielded by a lot of plastic.

This can make looking for a leak more difficult. Even if there is not a leak, a lot of the wear on a modern shock and strut happens internally. The oil and valving inside a strut can wear out. Also, the gas chamber can leak and mix with the fluid.

Another issue test drives can help diagnose is problems with the bushings. Modern vehicles have larger bushings that are designed to isolate vibration and harshness. While they may look fine to the naked eye, deflection due to wear may only be experienced on the test drive.

So firstly, take the test drive of vehicle and diagnose it for the problems.

4.3.2 Job Card

A job card is a sheet that contains details about the customer, vehicle, customer repairs requests, and instructions by service advisors, time and cost estimate, vehicle inventory and vehicle handover.

Company Name: **Address:** **Tel:** **Fax:** **GST No:**	**Vehicle Job Card** 0002	
Technician	Customer	
Work Order	Reg No.	
Defect Number	Trailer/Vehicle ID	
Job Date	Mileage	
Damage/Wear & Tear	MOT Due	
Protected Defect	Completed Action	
Parts used	Cost	Labour
	Total Cost	

Table 4.3.1: Job card

Check the vehicle as per the checklist and fill the job card according to that.

Check List			
Sl	**Description**	**Not Ok**	**Remark**
1	Transit Damages		
1.1	Front fender		
1.2	Head lamp/ Housing front/Visor		
1.3	TSL Indicators LH & RH		
1.4	Clutch & brake levers position & scratch		
1.5	Damper handlebar scratches		
1.6	Fuel tank assembly		
1.7	Fuel tank covers		
1.8	Cover frames/Tail covers		
1.9	Pillion handle		
1.10	2 Seat		
1.11	Silencer guard (Front & Rear)		
1.12	Saree guard		
1.13	Others (if any specify)		
2	2 Missing items if any		
2.1	Split pins		
2.2	Rider/Pillion footrest rubber		
2.3	Any other items		
3	3Fasteners Tightness		
3.1	Front axle nut		
3.2	Rear axle nut		
3.3	Reat shock absorber mounting nut		
3.4	Swing arm nut		
3.5	Engine mounting bolts		
3.6	Footrest mounting bolts		
3.7	Damper handle bar screw		
4	4Standard checks		
4.1	Front & rear wheel for free rotation		
4.2	Front & rear wheel for any noise		
4.3	Key function - ignition, tank steering, cover frame		
4.4	Digital speedometer - self check		

Check List			
Sl	**Description**	**Not Ok**	**Remark**
4.5	Mode and set switch operation/function (Check Odo, trip meter A&B and digital clock)		
4.6	Fuel gauge and warning light function		
4.7	Clutch cable operation / free play		
4.8	Centre / Side stand operation		
4.9	Drive chain slackness		
4.10	Rear fender alignment		
4.11	Steering operation		
4.12	front & Rear brake play		
4.13	Front & Rear Tyre pressure		
4.14	Engine/gear box oil level - dipstick		
4.15	Gear level & brake pedal position w.r.t. rider footrest		
5	**Start the engine after petrol in tank**		
5.1	Startability		
5.2	Kick/Self starter functioning		
5.3	Ignition cut off/kill switch function		
5.4	Cold recovery - Throttle response		
5.5	Tachometer function		
5.6	Oil/Fuel leak if any		
5.7	Any abnormal noise		
6	**Electric check - Engine running**		
6.1	Head lamp & parking lamp On/Of		
6.2	High beam low beam & focus		
6.3	Rear combination lamp - break & tail (LED)		
6.4	Speedo panel bulbs (LED)		
6.5	Turn signal lamp (Front & Rear)		
6.6	Battery terminal jelly application		
7	**Road Trail**		
7.1	Gear Shifting		
7.2	Front & Rear brake effectiveness		
7.3	Speedo/Odo/Trip meter display and function		
7.4	Suspension - front - rear		

Check List			
Sl	**Description**	**Not Ok**	**Remark**
7.5	Steering shake - on braking		
7.6	Idling Shake - on braking		
7.7	Any other abnormality		
8	**Accessories Fitment**		
8.1	Mirrors alignment		
8.2	Tool Kit		
9	**Any other observation (Specify)**		

Table 4.3.2: Service checklist

4.3.3 Four Wheeler Aggregates and diagnosing problems

This section describes the functions, checking/testing and important settings of different systems of four wheelers.

4.3.4 Engine

Mostly internal combustion is used in four wheelers. It converts energy from the heat of burning fuel into mechanical work, or torque. That torque is applied to the wheels to make the car move.

The function of an Automobile is mainly dependent on its engine performance. The engine performance is determined by measuring various parameters related to its components. These parameters have definite tersminologies and are measured in specific units. The following session covers all the important terminologies – their units of measurement and the ideal way of calculating them.

Main components of engine are:

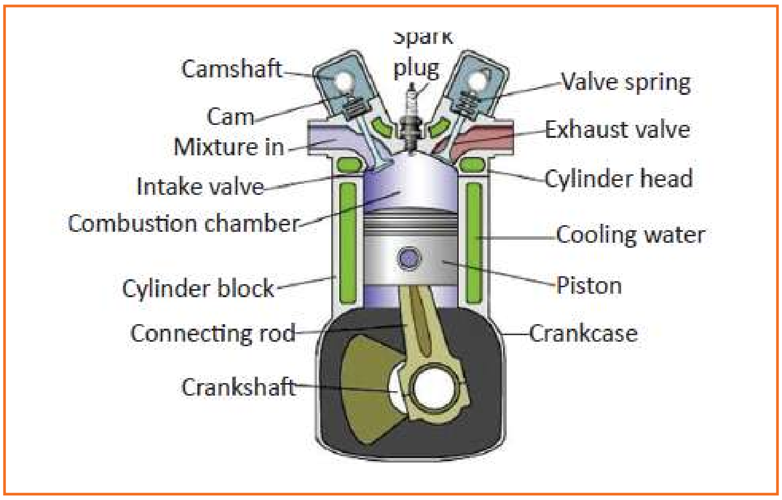


Fig 4.3.1: Components of an Engine

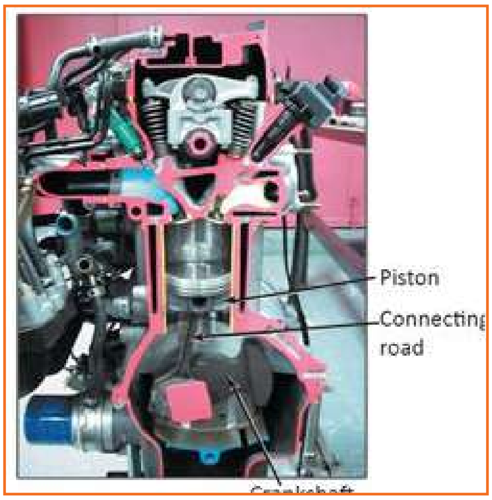


Fig 4.3.2: Engine cut section

How engine works

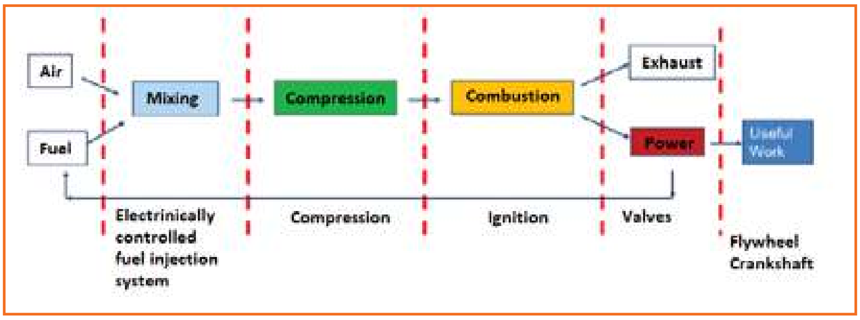


Fig 4.3.3: Working of an engine

Technical terms used in engine:

Number of basic terms are used to describe and compare engines. A few commonly used terms are described here.

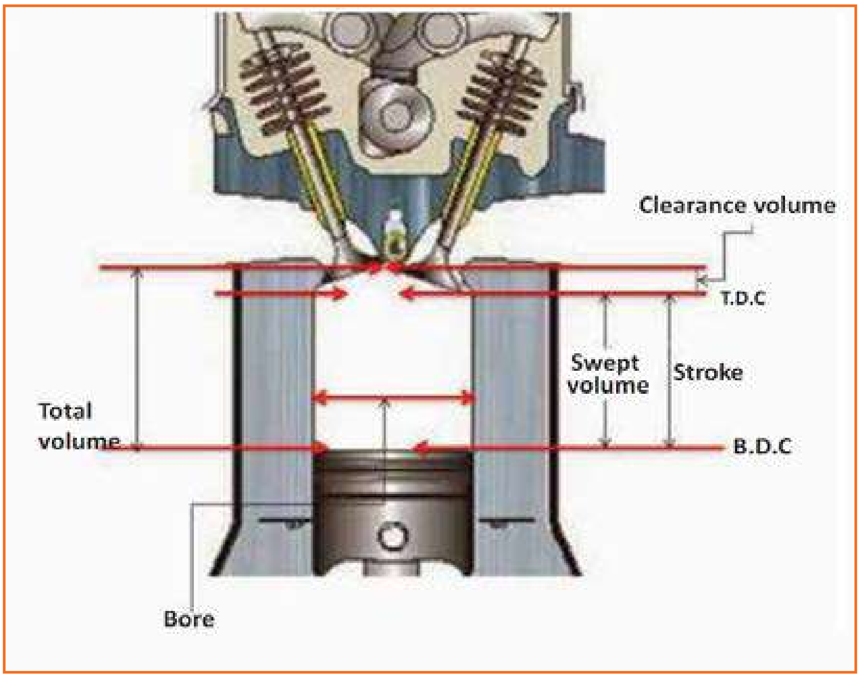


Fig 4.3.4: Engine Terminology

- **Top Dead Centre (T.D.C):** Extreme position of the piston at the top of the cylinder is referred as TDC.
- **Bottom Dead Centre (B.D.C):** Extreme position of the piston at the bottom of the cylinder is referred as BDC.
- **Bore:** Engine cylinder diameter is called as bore and measured in mm.
- **Stroke:** When the piston moves from TDC to BDC, the distance travelled by piston is referred to stroke. Measured in mm.
- **Swept volume:** Volume between TDC & BDC.
- **Clearance Volume:** Volume available above the piston, with the piston in top most position is referred as 'clearance volume' (Vc).
- **Piston Displacement:** The volume covered by piston while moving from TDC to BDC is called piston displacement, It is also referred as swept volume (Vs).
- **Engine Capacity:** It is the total displacement of piston or all the cylinders Swept volume. Measured in cubic centi-meter
- **Compression Ratio:** The degree to which the charge in the engine is compressed is indicated by compression ratio. The calculation of compression ratio is based the volume above the piston at BDC to the volume above the piston at T.D.C. If 'Y' is the compression ratio, then Y = (Vs + Vc)/Vc
- **For petrol engines, compression ratios are about 8 to 9.5 : 1, whereas for diesel engines, these vary from 16 to 22:**1
- **Power:** It is the work done in a given period of time. Doing the same amount of work in a lesser time would require more power. The units of power are Kilo Watts (KW), HP, PS (Pferde Starke or the Metric HP unit)

  1 KW = 1.34 HP or 1 HP = 0.746 KW

  1 KW = 1.36 PS

- **Horse Power (H.P.):** This is the amount of energy required to do 4500kgm. of work in one minute.
- **Indicated Horse Power (I.H.P):** The power developed within the engine cylinders is called indicated horse power. This is calculated from the area of the engine indicator diagram.
- **Brake Horse Power (B.H.P):** This is the actual power delivered at the crankshaft. It is obtained by deducting various power losses in the engine from the indicated Horse Power.
- **Friction Horse Power (F.H.P.):** This is the power lost due to friction present between different mating components.

  F.H.P = I.H.P – B.H.P

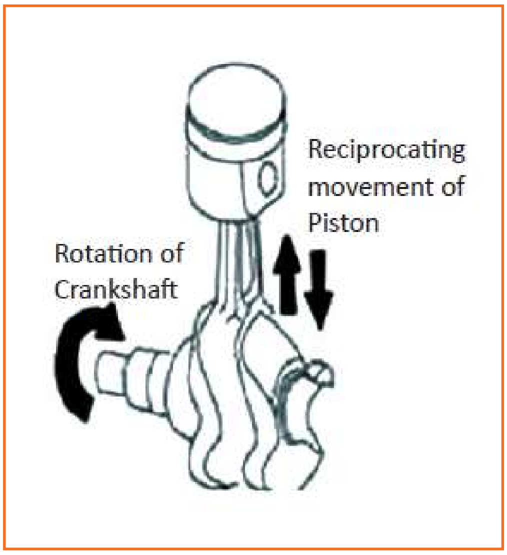


Fig 4.3.5: Torque developed at crank shaft by reciprocating motion of piston

- **Engine Torque:** Is the turning force required to turn or twist any object. It is the force of rotation acting about the crankshaft axis at any given instant of time.

For example, the effort that is required to tighten bolt with a spanner is called torque.

Torque = Force x Radial Distance

It is expressed in Newton - meter (Nm).

1Kgf-m = 9.8 N-m

1Kg-m = 7 Lb-f (Pound-foot)

4.3.5 Types of Four Wheeler Engine

Types of engines:

Engines can be various types, namely:

1. Two stroke engine
2. Four stroke engine
3. Air-cooled engines or water-cooled engines
4. Number of cylinders and arrangements of cylinders like Single Cylinder, Multi Cylinder, In-line Cylinder, V-type Cylinder, Opposed Pistons and Radial Piston Cylinder

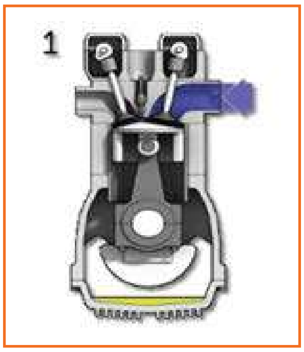


Fig 4.3.6: Four stroke engine

Let us see types of engine in little more details

1. **Two stroke engine:** Two-stroke, two-cycle, or 2-cycle engine is an example of IC engine. Power cycle in a two stroke engine is completed in one crankshaft revolution with two strokes or piston movement in up and down direction.
2. **Four stroke engine:** A four stroke engine is also acknowledged as four cycle engine. In four-stroke engine four separate strokes are completed which we are calling as compression, power and exhaust which take place between revolutions of engine's crankshaft. It produces one single power stroke.
3. **Spark ignition engines:** In spark-ignition engine, mixture of air and fuel is ignited using spark plug. The compression ratio of Spark Ignition engine is between six and ten. The Spark Ignition engine requires carburetor and an ignition system.

Fig 4.3.7: Spark ignition engine

4. **Compression ignition engine:** In this type of engine, air alone is compressed and self-ignition takes place when hot air mixed up with a spray of a fuel with high pressure and high temperature. Example is diesel engine.

   The compression ratio of diesel is from 10 to 25. Diesel engine requires fuel injection pump and injectors.

4.3.6 Diesel Engine

Diesel engines are special type of internal-combustion engine. The main distinguishing characteristic of diesel engines is the method of fuel ignition. In diesel engine the injection of fuel into the cylinder have highly compressed air. During air compression in the engine cylinder air temperature goes up so fine spray fuel, is mixed with hot air, gets ignited and as a result no other external means of ignition is essential. Due to this diesel engines are also called compression-ignition engines.

Four-Stroke diesel (Compression-Ignition) Engine cycle

- **Induction:** The piston descends, drawing only air into the cylinder.
  - ❑ **Compression:** The piston rises, compressing the air to a temperature well above the ignition temperature of the fuel, and the fuel ignites as it is sprayed in just before T.D.C.
  - ❑ **Power:** The high temperature of the burning fuel causes high gas pressures, which force the piston downward.
- **Exhaust:** Exhaust gases are barred as the piston rises.

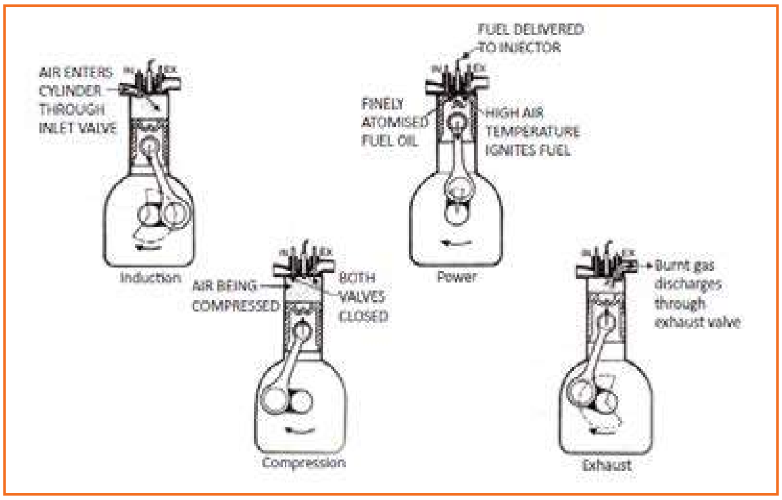


Fig 4.3.8: Four-Stroke compression-ignition engine

Diesel and petrol engines difference

As compared to petrol engine, the diesel engine differs in following respects:

- In diesel engine, air alone enters the cylinder during intake stroke and compressed during compression stroke.
- Diesel engines use higher compression ratio. Typical compression ratio for petrol engine is 9:1 and for diesel engine is 16:1 or more.
- In diesel engine, fuel is injected or sprayed into the combustion chamber with very pressure. In petrol engine mixture of air and fuel is supplied by the carburetor or injectors.
- Diesel engines have no ignition system. High temperature of the compressed air is sufficient to ignite the fuel.
- Diesel engines run on less volatile, heavier liquid fuel than that of petrol engine.
- For the same power output, diesel engines are heavier than petrol engines.

Classification of diesel engines

Diesel engines can be categorized as:

- **Two-stroke cycle diesel engine :** Piston moves 2 times in the cylinder in one cycle
- **Four-stroke cycle diesel engine:** Piston moves 4 times in the cylinder in one cycle

Fuel injection in diesel engine

In diesel engine the method used for introduction and burning of fuel is totally different from that of petrol engine. The fuel is injected into the highly compressed hot air where it burns. Fuel injection system major requirements are as follows

- It must meter the fuel accurately i.e. the fuel quantity supplied should be in accordance with engine load and also the fuel should be supplied to each cylinder in same amount for each power stroke
- It must time the fuel injection properly i.e., fuel injection should begin at the required moment
- It must atomize the fuel properly i.e. it should break up the fuel stream into mist like sprays
- It must dispense the fuel in the combustion space properly

Method of fuel injection

Mechanical injection: In this system, the fuel is forced in, from a mechanical fuel injection pump through injectors. This consists of

1. Low Pressure Fuel Supply System
2. Metering and high pressure injection system

Types of fuel injection in diesel engine

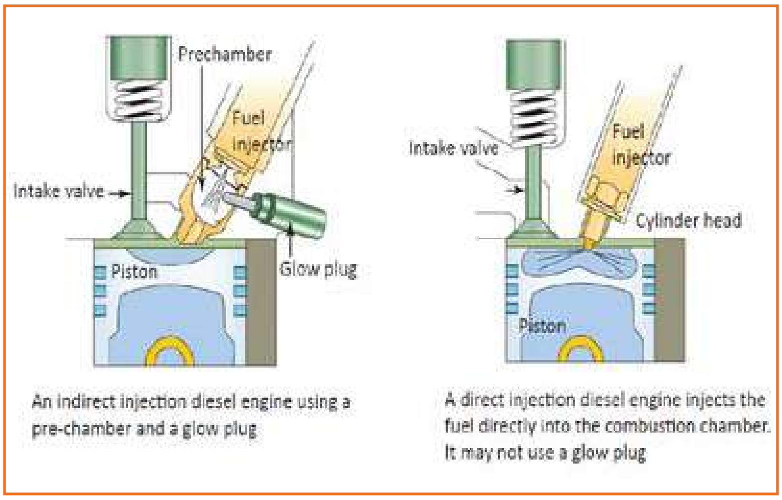


Fig 4.3.9: Diesel engine – Fuel injection

Direct Injection Engine (DI)

On direct injection diesel engines, fuel is sprayed directly on top of the piston.

- Highly fuel efficient
- Noisy
- Easy cold starting ability

Indirect Injection Engine (IDI)

On indirect injection diesel engines, fuel is sprayed on to a separate pre-chamber.

- Less fuel efficient
- Less Noisy/smoother
- Requires pre-heating for starting.

4.3.7 Petrol Engine

Principle: All petrol engines are based on the same principle. If you mix petrol and air and then compress the mixture, a tiny spark will cause it to explode; the power of this explosion is used to work an engine.

- The pre mixing was earlier done in a carburetor. Now a days, fuel injection system is controlled electronically.
- **In modern vehicles, MPFI:** Fuel injection system is having multi point, this assures suitable Air / Fuel ratio to the engine
- In this system, one fuel injector is installed near intake valve of each cylinder.

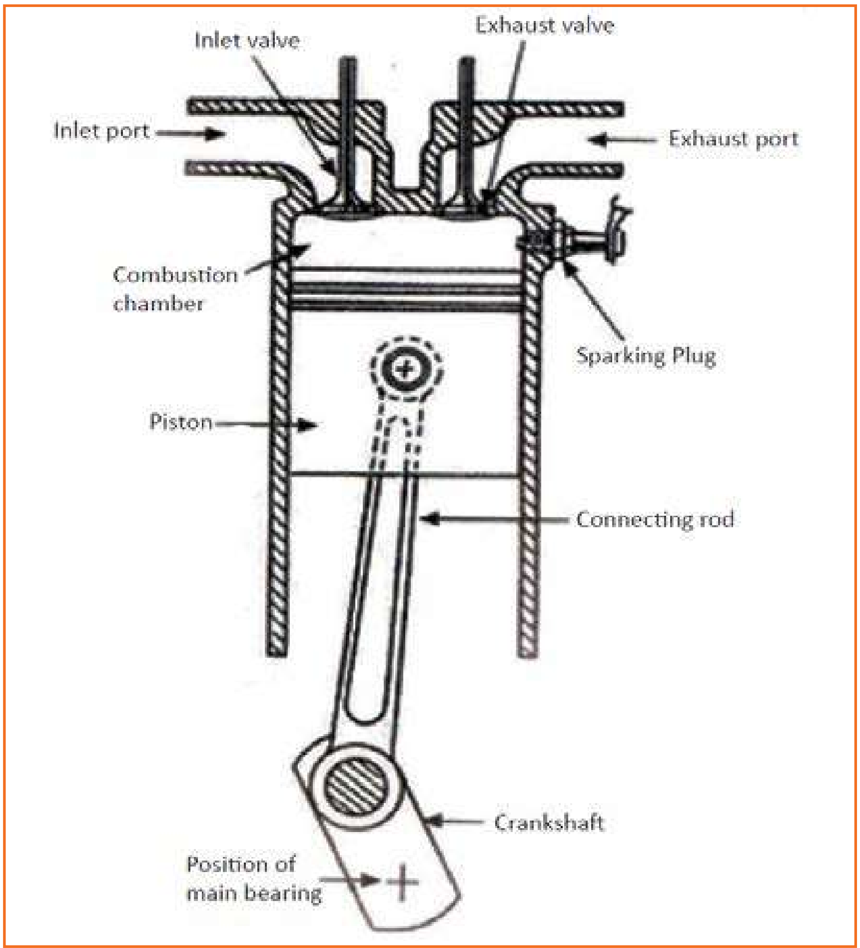


Fig 4.3.10: Components of basic engine

Basic Design: The basic petrol-engine design contains a hollow metal cylinder, in which a close-fitting piston is free to move in up and down direction. The piston is joined to a rod, which is pivoted where it joins the piston. On other end of the rod, called the connecting rod, is a bearing which allows it to rotate on the crankshaft, which itself is free to rotate.

Cycles of operation

Cycle is the process of an action, which repeats in a regular order. There are two ways in which an engine can be designed to operate:

- Four-stroke
- Two-stroke

Four-stroke spark-ignition engine: The cycle of operation is spread over four strokes.

- **Induction stroke:** Piston moves downwards by the crankshaft. Inlet valve is in open state and air and fuel mixture is absorbed into the combustion chamber.
- **Compression stroke:** When piston moves up again, mixture in the combustion chamber is compressed. Both the valves are in close position
- **Power stroke:** The sparking plug ignites the compressed petrol / air mixture, which explodes and forces the piston down.
- **Exhaust stroke:** The piston starts to move upwards again, exhaust valve comes in opens position, the piston pushes the gas left over after the explosion out of combustion chamber. piston begins to move down again, the inlet valve re-opens and the next cycle starts again.

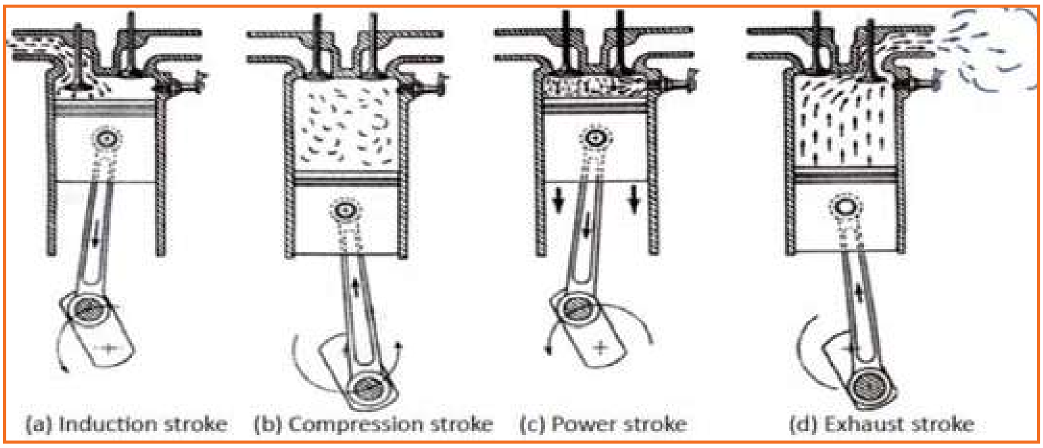


Fig 4.3.11: Four stroke engine

A power stroke occurs every 720° or two revolutions of the crank shaft.

Two-stroke Engine:

Two-stroke cycle engine employs the same sequence of operation as the four-stroke cycle. Completion of the cycle is given below in one revolution of the crankshaft so that a power stroke occurs every 360°

- **First stroke (piston moves upwards):** Piston moves from B.D.C. to T.D.C. Vacuum is generated under the piston on clearing the inlet port, fresh fuel-air mixture is admitted into the crankcase (suction). Pre-combustion mixture rushes above the piston in the combustion chamber via the transfer port. Burnt gases are expelled out via the exhaust port. Compression starts when the ports are closed.

- **Second stroke (piston moves downwards):** Compressed mixture on top of piston is ignited and burnt. High pressure and expansion of gases perform work till exhaust port clears. Below the piston the fuel and air mixture is pre-compressed after covering of the inlet port. When the transfer port opens, the mixture rushes over in the combustion chamber.

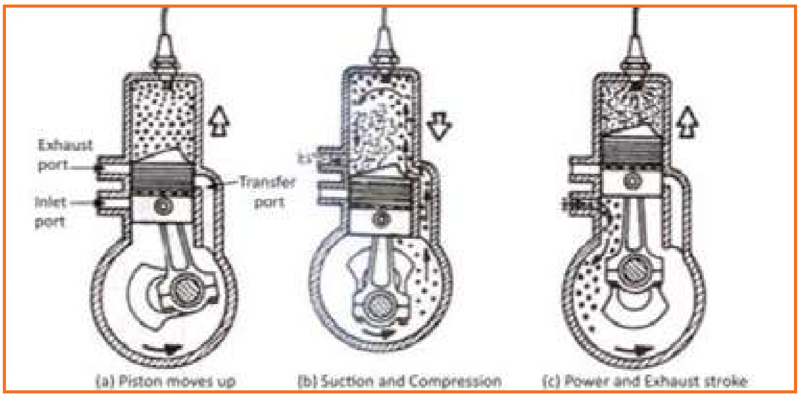


Fig 4.3.12: Two stroke engine

Two-stroke cycle engine differs from four-stroke cycle engine as mentioned below:

- Cycle completion is in two strokes instead of four.
- When piston reaches the highest level of its stroke, It fires every time
- It has no valves
- Its crankcase is sealed

Multi-cylinder engines:

A smoother flow of power from the crankshaft is obtained when more than one cylinder is used. The multi-cylinder engines by cylinder arrangement are classified as follows:

- **In-line type:** Cylinders are positioned in a straight line, one cylinder behind the other
- **Horizontally opposed type:** Cylinders are positioned in two flat banks. The crankshaft is between them
- **Vee-type:** Two rows of cylinders are set in the form of a vee. In V6, two banks of three cylinders are set at 60°. In V8, two banks of four cylinders are set at 90°
- **Radial type:** In this type, the cylinders are arranged radially. This type of engine is shorter, lighter and more rigid. The radial engines are used mostly in airplanes.

4.3.8 Engine Compression Testing

A compression test reveals the condition of engine's valves, valve seats and piston rings and whether these parts are wearing evenly. Healthy engines should have compression over 100 psi per cylinder, with no more than 10 percent variation between the highest and lowest readings.

1. Remove the fuel pump and fuel-injection fuses.
2. Disconnect the main wire to the coil and spark plug wires and remove spark plugs.
3. Start the threaded end of the compression gauge in a spark plug hole by hand.
4. Turn the ignition on, depress the throttle and crank the engine four revolutions. This should result in a stable reading; if not, crank up to 10 revolutions, but do the same with all cylinders.
5. Mark the pressure reading for each cylinder on the valve cover in chalk, then move to the next cylinder.

Fig 4.3.13: Engine compression testing

4.3.9 Modern Day Engines

Modern day engines are:

- **MPFI (Multi Port or Multi Point Fuel Injection):** Modern day PETROL Engine
- **CRDI (Common Rail Direct Injection):** Modern day DIESEL Engine

MPFI Engines

Main components of MPFI system

- System for air intake
- System for fuel delivery
- System for electronic control

Fuel injection systems:

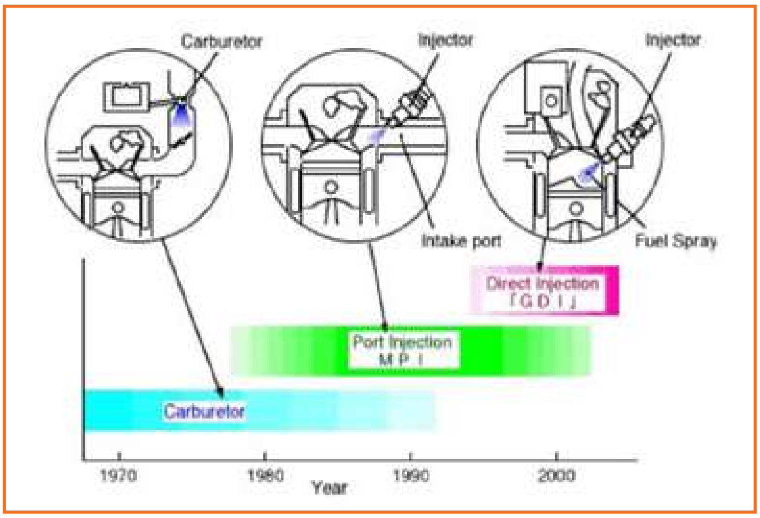


Fig 4.3.14: Fuel injector

Working of MPFI system:

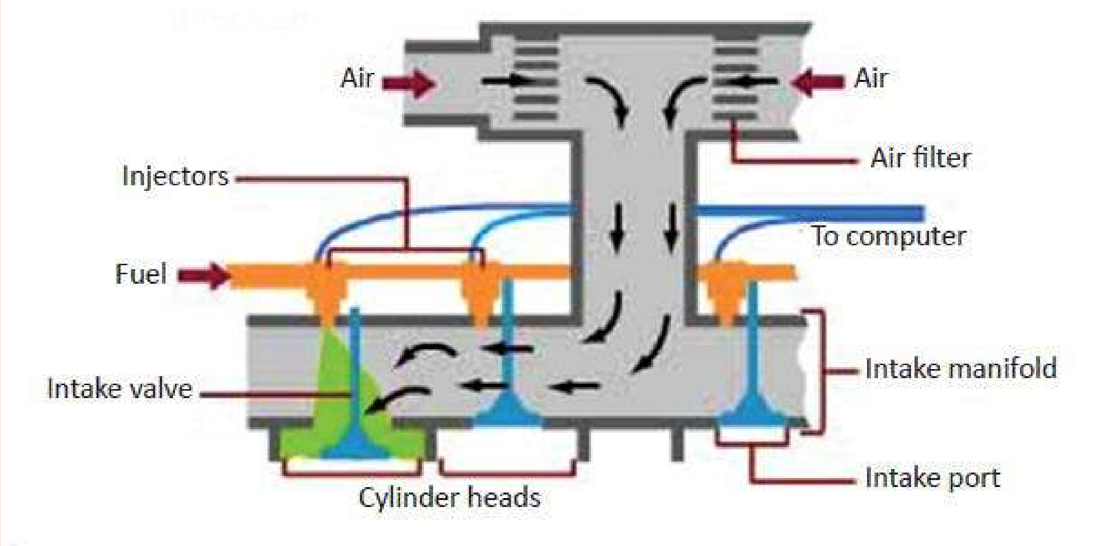


Fig 4.3.15: Multi-point fuel injector

MPFI – Advantages

- Since more uniform Air / Fuel mixture is provided to each cylinder in MPFI system, resulting complete combustion & less emission.
- Less vibration leading to improved life of engine components.
- In cold starting it does not require multi cranking of engine
- Immediate response during unexpected acceleration / deceleration.
- Improved mileage.
- Improved Combustion – better fuel atomization
- Improved fuel distribution – fuel is mixed inside the manifold
- Decreased Emission level – idle air fuel mixture.
- Improved cold Drivability – prevent fuel pudding inside the intake manifold.
- Enhanced air- flow – better volumetric efficiency.
- Comfortable smooth driving –
    1. Engine output is high (no venturi restriction)
    2. Acceleration response is high
    3. Good cold starting

Do's & Don'ts of MPFI engine:

- While washing the engine room, ensure that pressure is not more than 3 kg/cm2 on sensors or any other coupler and water jet is not sprayed directly on these components.
- Never push start a MPFI vehicle, it will damage a catalytic converter.
- Never disconnect a battery terminal when the engine is in running state or even ignition is ON.

- Never short circuit or connect any two terminal of ECM using service wire or bulb.
- Never touch any ECM connecter pins. The static current flowing from body might cause harm to ECM.
- Never remove or connect any coupler with ignition switch ON or vehicle start.
- Check that battery voltage more than 11 volt when working on MPFI vehicle.
- Don't push accelerator pedal when starting the vehicle.
- Always use unleaded petrol.
- Don't ground the power circuit of TP and MAP sensor. This could damage to ECM.
- While checking voltage in ECM circuit, connect one probe of multimeter to ground and the other probe to ECM point.
- While checking resistance in the wiring harness, the resistance should be measured using the digital multimeter, with the coupler removed to the ECM. The multimeter probe should be connected from the side of wiring harness of the coupler. The ignition switch has to be in the off position for this check.
- Don't connect or disconnect Tech-1 coupler to cartridge of Tech-1 during running stage of engine or ignition is switched on.

Engine control system:

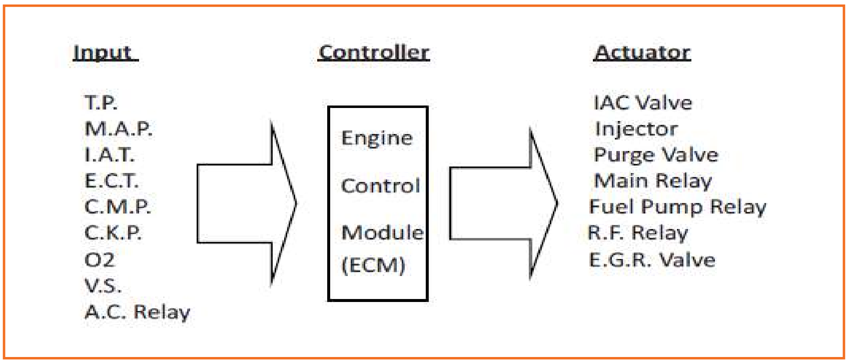


Fig 4.3.16: Engine control system

TP : Throttle Position	**CMP :** Camshaft Position
MAP : Manifold Absolute Pressure	**CKP :** Crankshaft Position
IAT : Intake Air Temperature	**O2 :** Oxygen
ECT : Engine Coolant Temperature	**VS :** Vehicle Speed

TP (Throttle Position) Sensor:

- **Location:** On throttle body.
- **Function:** To measure the degree of opening of throttle valve and sends the signal to ECM.

- **Working Principle:** Potentiometer (resistance changes as degree of throttle valve opening changes).

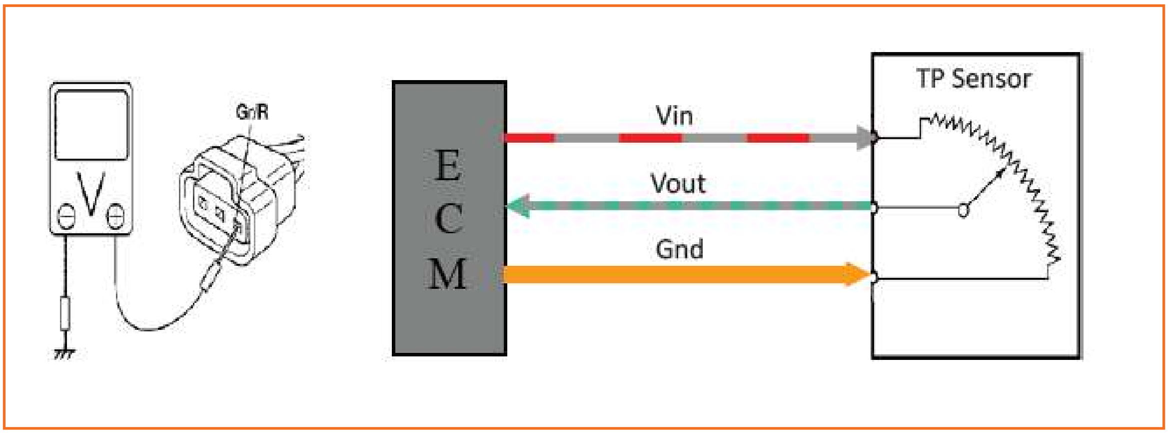


Fig 4.3.17: TP Sensor

Manifold absolute pressure sensor:

- **Location:** On the intake manifold.
- **Function:** To measure the vacuum present into the cylinder and to send signal to the ECM.
- **Working Principle:** Pressure converting element which converts pressure changes into voltage changes.

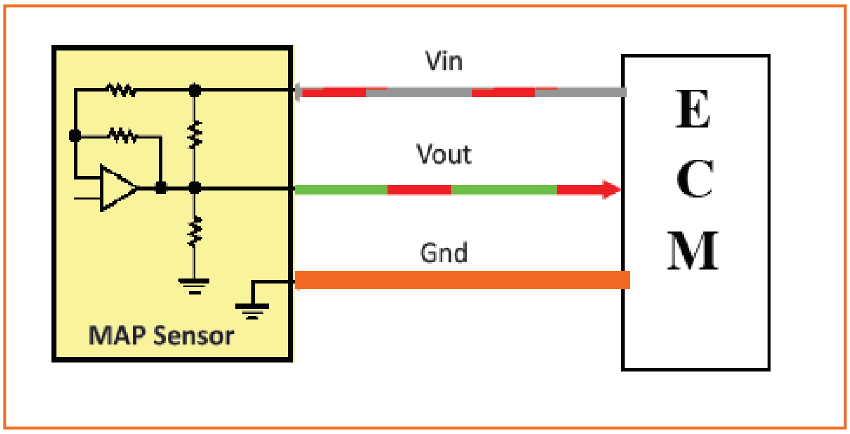


Fig 4.3.18: Manifold absolute pressure sensor

Intake air temperature:

- **Location:** On the air cleaner.
- **Function:** To determine air temperature intake and signal to ECM
- **Working Principle:** It works on thermistor.

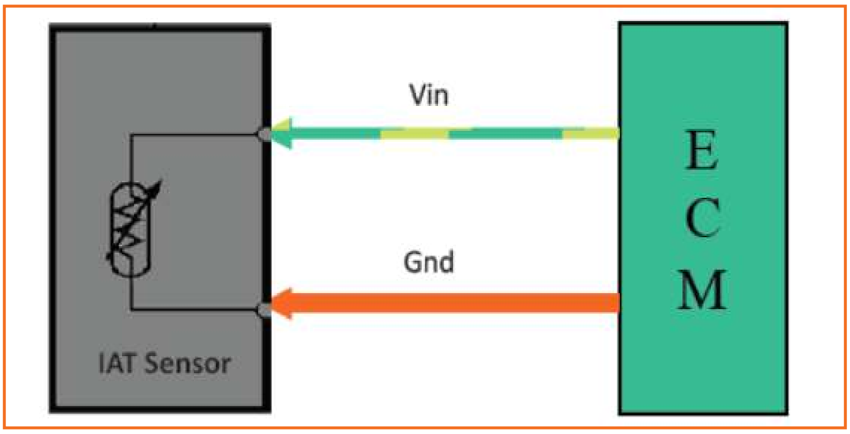


Fig 4.3.19: Intake air temperature

Engine coolant temperature sensor:

- **Location:** On the thermostat case.
- **Function:** To measure engine coolant temperature and sends signal to ECM.
- **Working Principle:** Thermistor (resistance changes as the temperature changes).

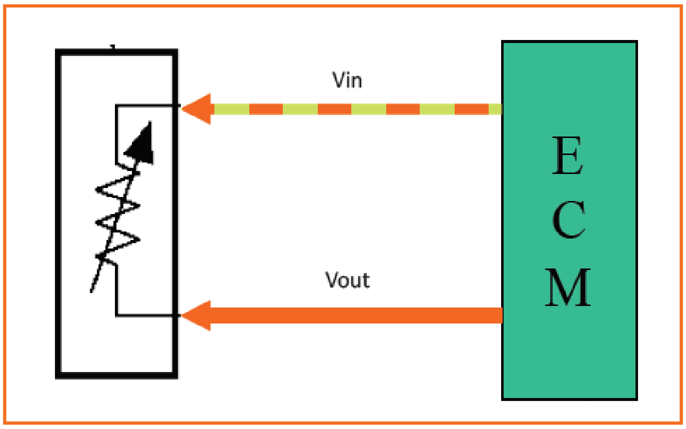


Fig 4.3.20: Engine coolant temperature sensor

Vehicle Speed Sensor:

- **Location:** On transmission or inside speedometer.
- **Function:** Detects vehicle speed and feeds the information to ECM.
- **Working principle:** Generates signal in to proportion of vehicle speed and sends signal to ECM.

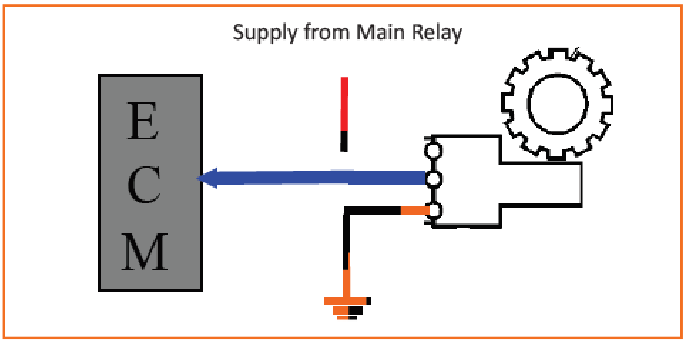


Fig 4.3.21: Vehicle speed sensor

Cam Shaft Position Sensor:

- **Location:** Mostly on sensor case on camshaft side.
- **Function:** Sends electrical pulse signal on the rotation of camshaft.

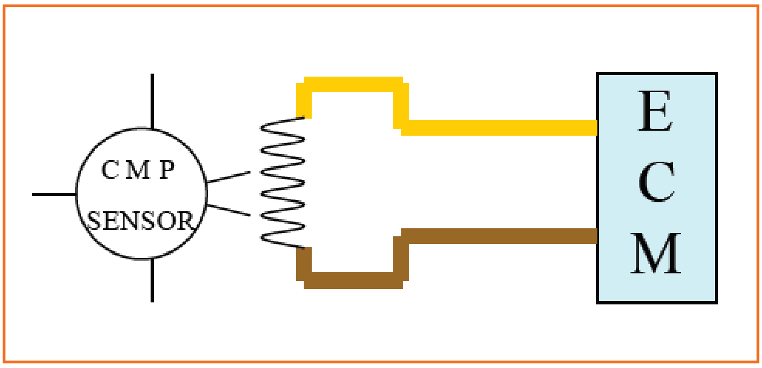


Fig 4.3.22: Cam Shaft Position Sensor

Oxygen Sensor:

- **Location:** On exhaust manifold
- **Function:** Sense unburnt oxygen in the exhaust and signal ECM.
- **Working principle:** Zirconium dioxide element coated with platinum in the oxygen sensor produce the signal in milli voltage.

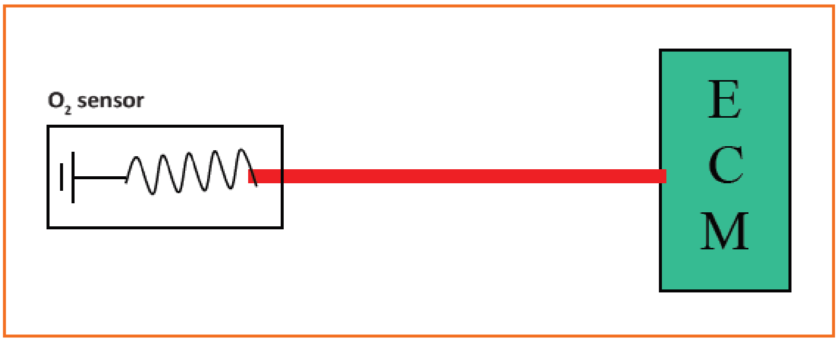


Fig 4.3.23: Oxygen sensor

Crank shaft Position Sensor:

- **Location:** Mounted on oil pan.
- **Function:** To detect piston position and sends signal to ECM.
- **Working principle:** Generates A/C voltage pulse on the rotation of crank shaft.

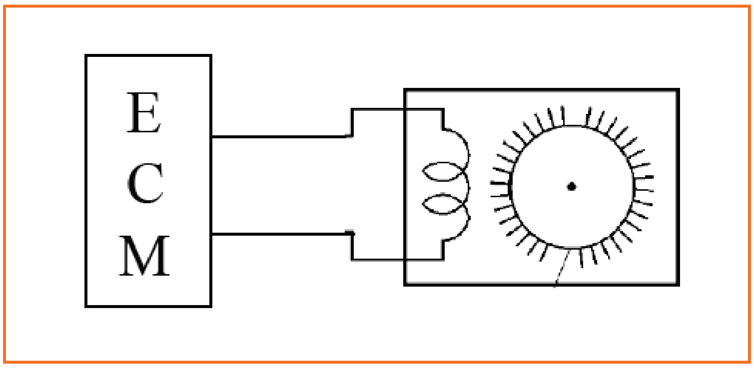


Fig 4.3.24: Crank shaft position sensor

Fail safe operations monitored & controlled by ECM

Sensors	Detecting item	Fail safe operation
O_2	Heater control circuit high or low	Not available
MAP	Manifold absolute pressure circuit high/ low	Not available
IAT	Intake air circuit low or high	ECM controls actuators assuming that intake air temperature is 20°c
ECT	Engine coolant circuit lowor high	ECM controls actuators assuming that engine coolant temp. 80^{0}C and operates radiatorfan.
TP	TPcircuit low or high	ECM controls actuators assuming that 20° throttle open.
CKP	Crankshah position	No fail safe mode operation
CMP	Camshah position	CM changes injection control system from sequential injection to simultaneous one
VSS	VSS malfunctioning	ECM controls actuators assuming that vehicle speed is 10 km/h and stops IAC feedback

Table 4.3.3: Fail Safe Operations

CRDI Engines

Today's diesel engines use CRDI:

- Common rail direct injection (CRDI) is a latest technology through which a diesel engine can be controlled by using computer systems.
- It helps to improve power and performance and reduces harmful emissions. Conventional Diesel Engines are sluggish, noisy and perform poorly.
- It uses a single rail or fuel channel containing diesel compressed at high pressure. Single pump compresses diesel and one single rail contains that compressed fuel. Conventional diesel engines contain same number high pressure pipes from pump as the number of cylinders.

Working of a CRDI engine

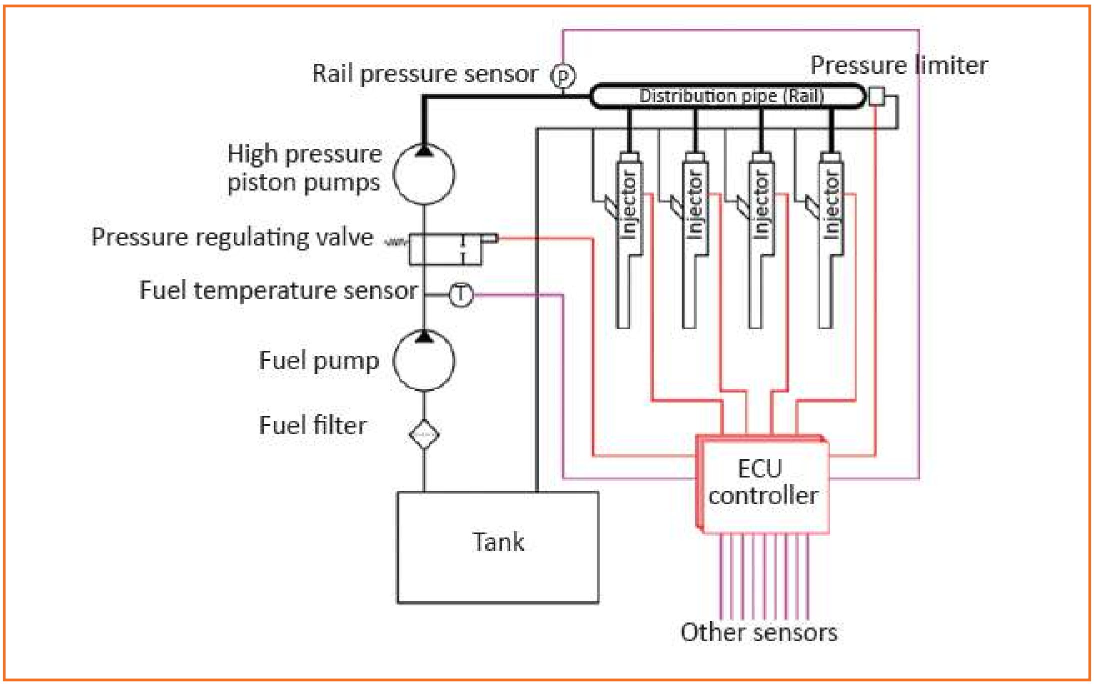


Fig 4.3.25: CRDI engine working

Basic layout of CRDI:

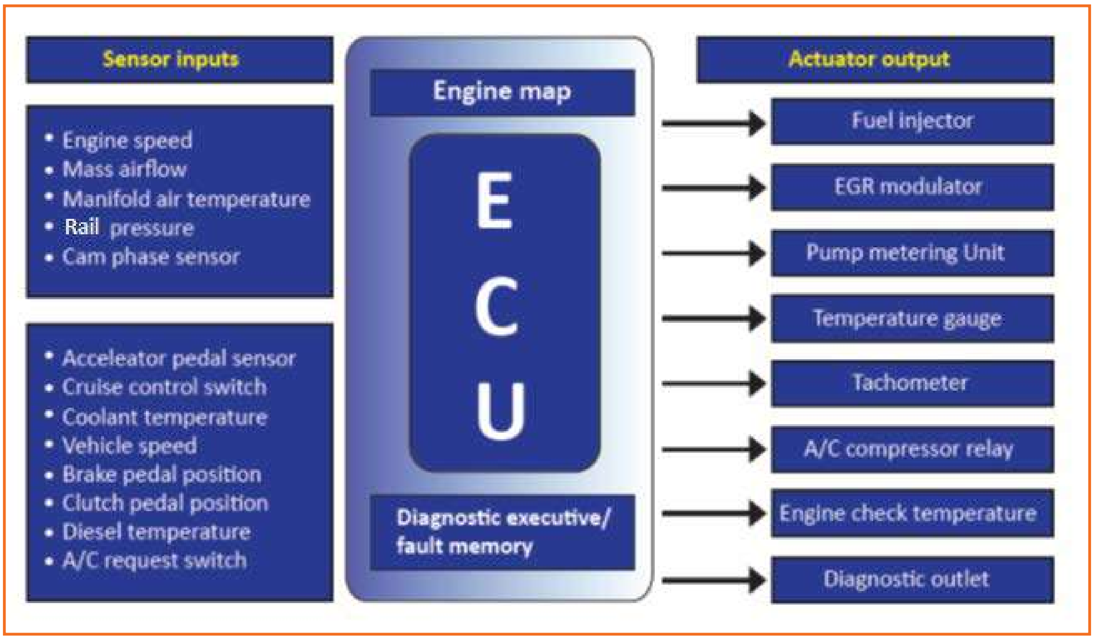


Fig 4.3.26: CRDI layout

Sr No	Sensor	Function
1	Engine speed sensor	Monitors pump delivery speed
2	Crankshaft position sensor	Monitors pump fuel rack position

Sr No	Sensor	Function
3	Charge air pressure sensor	Measures pressure side of the turbo charger
4	Fuel pressure sensor	Monitors fuel pressure
5	Air cleaner vacuum pressure sensor	Monitors vacuum pressure
6	Camshaft position sensor	Monitors crankshaft / camshaft positions
7	Temperature sensors	Measure various operating temperatures like • Intake temperature • Charge air temperature • Coolant temperature • Fuel temperature • Exhaust temperature (Pyrometer) • Ambient temperature
8	Vehicle speed sensor	Monitors vehicle speed
9	Brake pedal sensor	Operates with cruise control, exhaust brake, Idle control
10	Clutch pedal sensor	Operates with cruise control, exhaust brake, idle control
11	Accelerator pedal sensor	Monitors accelerator pedal position
12	Driver input switches	Speed control, idle boost /dechne, engine/ exhaust brake
13	Injector needle movement sensor	Monitors the actual injection time and feeds the informanon to the ECV

Table 4.3.4: Function of sensors

Principles of CRDI Engine:

In CRDI System, cylinders of diesel engine get direct fuel injection through a single line i.e. common rail which connects to all the fuel injectors.

Conventional diesel engine uses direct fuel supply to each injector through separate high pressure pipes. The advantage of CRDI engine is steady pressure is maintained despite of injection sequence. Once built up the pressure remains available throughout the fuel line. Injection timing and pressure can be controlled electronically as per speed of engine and load factor. Electronic control unit (ECU) is maintaining Injection pressure as per requirement based on the information received from sensor on cam and crankshaft. In short, we can say that in this compression and injection take place separately of each other. In this technique injection of fuel (quantity and timing) is very precise based on requirement thus help in fuel efficiency and emission level is also reduced.

Accuracy of spray in combustion chamber considerably reduces the unburned fuel and due to that CRDI is having possibility to meet latest emission guidelines like Euro IV & VI. Now a days CRDI engines are commonly used by major car manufacturers like Hyundai, Ford, Toyota, Mercedes and many more (Mahindra is using it since many years).

New-age features:

1. **Cruise control**
   - Also called speed control, is a combination of electrical and mechanical components
   - Consistency in vehicle speed is set without pressure on the accelerator pedal.
2. **Engine control module**
   - Many drivability problems are NOT caused by engine mechanical problems.
   - Perform a thorough inspection and testing of ignition and fuel systems before testing for mechanical engine problems.
   - **Typical engine mechanical related complaints are:**
     - High engine oil consumption
     - High fuel consumption/Low milage/KMPL
     - Engine mis-firing
     - Loss of power
     - Excessive smoke from the engine exhaust
     - Noise from engine

Visual inspection:

Visual inspection is the preliminary test.

- Oil level and condition
- Coolant level and condition
- Oil leaks
- Colour of engine exhaust smoke

Bluish white	Engine is burning oil, which indicates that the engine has worn valve guides and piston rings
Black	Excessive fuel delivery
White (steam)	White steam usually an indicates defective cylinder head gasket which allow coolant flow in the combustion chamber, where turns to steam.

Table 4.3.5: Engine exhaust smoke colour

Noise problems:

An engine knocking noise is often difficult to diagnose. Different items which can cause deep engine knocking are -

- Clicking valves
- Flex plate cracked
- Drive belts or tensioners loose or defective
- Knocking piston pin
- Piston slapping
- Timing chain noise
- Con rod-bearing noise
- Main-bearing knock

Common engine problems:

- Increased oil consumption
- Engine hesitates, sags, or stumbles during acceleration
- Stalling or rough idling
- Knocking spark (ping or detonation)
- Engine cranking, but is difficult to start
- Engine not cranking or slow cranking
- Poor mileage or fuel economy
- Dieseling or run-on (continued operation of engine after the ignition is turned off)
- Engine backfire
- Lack of power
- Engine surges engine speeds up noticeably under constant load and constant throttle
- Rich exhaust

A proper functioning of petrol engine is producing 17 to 21 in Hg of vacuum at sea level

4.3.10 Fuel System

Fuel supply system of vehicle play important role in functioning of engine. Fuel supply system core function of is to ensure smooth and constant fuel supply to engine's other peripherals. It consists of various devices and components for example Fuel pump, carburetor, fuel cells, filter, fuel cooler, fuel tank for storage and distribution of fuel to engine as per the requirements. In present days pressurized system is used in most of the automobile along with a pump to push fuel from tank to engine of the vehicle.

Components of automobile fuel supply system:

- **Fuel Tank:** Safe container for fuel

- **Fuel Tank Cap:** Covers the fuel tank to keeps air, moisture, dust, dirt out
- **Fuel Pump:** Feeds fuel to engine
- **Fuel Injection System:** Injects fuel into the engine
- **Automotive LPG System:** Feeds liquefied petroleum gas to engine
- **Fuel Filters:** Removes dirt, dust and rust particles from fuel
- **Carburetor:** Mixes air and fuel proper ratio for combustion
- **Fuel Water Separator:** Removes water from fuel
- **Fuel Coolers:** Cool the fuel to control temperature
- **Nitrous Oxide System:** Nitrous oxide heated to about 300 deg C splits into oxygen and nitrogen, releasing more oxygen for combustion resulting in more engine power
- **Fuel Cells:** Hydrogen fused chemically with oxygen from the air to make water, releasing electricity to drive a vehicle

Improving fuel economy:

Several factors contribute for fuel saving. Fuel economy is automobile is consistently improving by using technology for better fuel and its delivery method. The following do-it-yourself list can improve fuel economy by

- Checking and maintaining tire pressure
- Tuning-up the engine
- Checking the wheel alignment
- Use of air conditioning only when needed
- Oil change as per manufacturer suggestion
- Checking cooling system operation
- Avoiding dragging brakes
- Avoiding excessive idling
- Combining trips
- Moderating speed

Fuel Cap

Cap of the fuel helps in protecting fuel from spilling out. Due to fuel supply into the engine vacuum is create which is released by it, also discharge pressure build because gasoline expand and contracts with changing temperature, and also safeguard fuel tank from the entry of external particle.

Fig 4.3.27: Fuel cap

Fuel tank

Generally fuel tank is made by steel or plastic. Job of fuel tank is to store the fuel so that fuel will be supplied to engine based on requirement.

Fig 4.3.28: Fuel tank

Fuel Pump

Fuel pumps are mainly of two types i.e. mechanical or electrical. It supplies fuel to the engine. Mechanical type of fuel pumps are mainly placed on the engine and used in the vehicle having carburetor. Electrical fuel pumps are mounted on fuel tank and are used with fuel injected vehicles.

Fig 4.3.29: Fuel pump

Fuel Lines

Fuel lines, made of mainly by two material i.e. steel or rubber, carry the fuel to the carburetor or fuel injectors.

Carburetor or injection system

Cars have either a carburetor or fuel injection system to mix the fuel with air. Most vehicles today have fuel injectors. Fuel injectors can be two types - throttle body or port. In a throttle body injection system, usually one fuel injector is used to supply fuel to all of the engine's cylinders. In a port injection system, there is one fuel injector for each cylinder.

Fig 4.3.30: PCV valve

PCV Valve

Positive crankcase ventilation valve allows venting out of the crankcase, the blow-by gases, combustion products and oil vapors.

It reduces air pollution, increases fuel economy and re-circulate excess gas. It also helps in reducing air pressure within the engine.

Fig 4.3.31: Fuel filter

Fuel filter:

Fuel filter is located in-between the fuel tank and the carburetor of injection system. Job of fuel filter is to clean the fuel before it enter in engine. It may be also located under the vehicle near frame member or near carburetor or fuel injectors. Inside the fuel filter there is a paper type element to collect dirt. Clogged fuel filter reduce fuel delivery thus decreases the engine performance and cause extreme wear on fuel pump.

4.3.11 Diagnosis

- Fuel-pump testing includes various tests and procedures.
- Passing one test, does not ensure the problem with fuel pump.

Fuel injection system Dos and Don'ts:

Carefully inspect as follows before proceeding to more detailed tests.

- Air filter (replace if needed) and indicator, if fitted on filter for clogging.
- Obstruction in air induction system
- Check condition of all hoses. Replace any vacuum hose if it is found tear, soft or brittle.
- **PCV :** Positive crankcase ventilation valve for proper operation, replace if needed
- All electrical connections of fuel injection for corrosion/damage

Fuel line pipe:

The fuel line is mainly made up of stiff metallic pipe. This pipe along with hoses made-up of rubber or plastic connect tank with fuel pump and further to carburetor. As the hoses are flexible it helps in little movement between components. Some cars are also using reinforced plastic pipes instead of metal pipes.

Types of pipe connections:

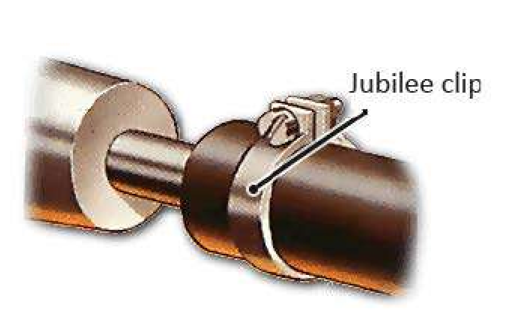


Fig 4.3.32: Jublee clamp

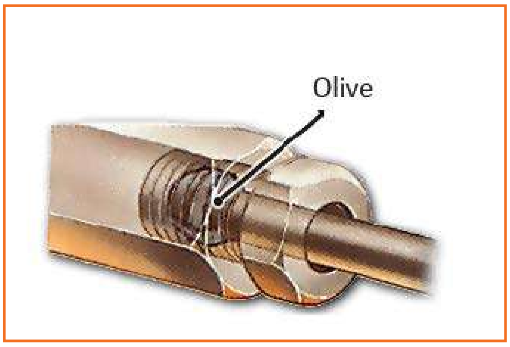


Fig 4.3.33: Metal pipe connection

Fuel pipe connections are of two types i.e.

1. Flexible connection using a jubilee clip and
2. Metal to metal connection. Metal pipes are getting tightened around the olive for sealing.

Inspection:

Pipes, hoses and their connection should be checked for fault periodically to rule out possibility of fire.

- To check the pipe first of all as a safety precaution battery should be disconnected then after place the car on jack and then check the whole length carefully. During inspection special focus should be given on joints and dark stains to rule out the leak. Ensure and tighten all union pipe connection using spanner.
- Rust can damage the pipe thus check it carefully and if found remove it using brush. If pipe shows any sign of damage due to rust should be replaced.
- Flexible hoses connection also needs to be checked carefully by bending and twisting. If it is too soft or hard due to contamination or old age, should be replaced. Check the tightness of securing clips and ensure that they are not rusty.
- Check the positioning of pipe inside compartment and ensure it is not close to hot parts and also certify that it is secure in designated clips and not laying anywhere.
- If pipe is damage, it should be replaces immediately. To replace the pipe first drain the fuel tank.

4.3.12 Lubrication System

In automobile job of lubrication system is to collect, clean, cool and re-circulate oil in engine of a vehicle.

There are two purposes of lubrication:

- For bearings, cooling by absorbing the friction-generated heat.
- Lubrication is applied In between two moving surfaces to create a thin film which separates the surfaces.

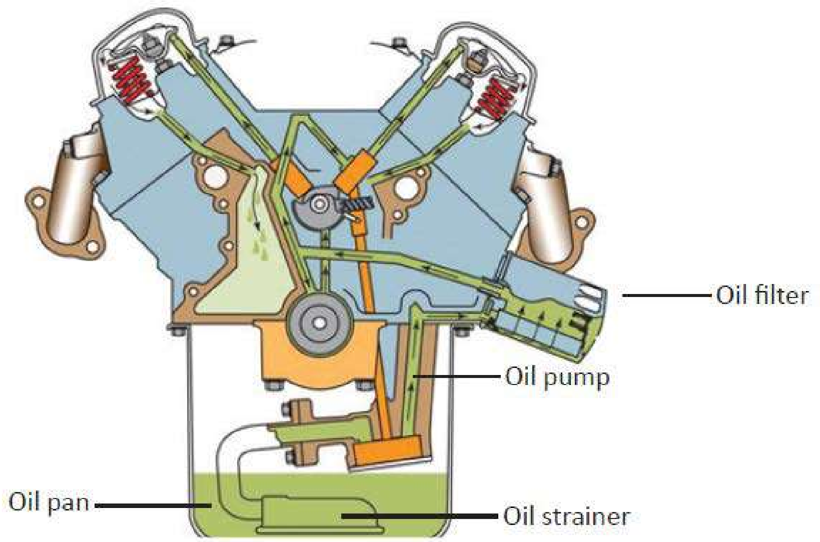


Fig 4.3.34: Lubrication system

Need for lubrication:

The lubrication system is an important system of high-speed engines. Engine's improper and inadequate lubrication may cause -

- Scoring of cylinders
- Excessive wear and burning of bearings
- Misfiring of cylinders
- Sticking / Seizure of piston rings
- Engine deposits and sludge
- High consumption of fuel

Functions of lubrication system:

- To distribute the lubricant to all the surfaces needing lubrication.
- To act as cooling agent and remove heat from engine parts.
- To reduce noise by absorbing shocks between bearings and other parts of the engine.
- To provide an effective seal between piston rings and cylinder walls.
- To function as a cleaning agent.

Types of lubricants

The lubricants are of three types -

1. **Solid:** Graphite, mica, soap stone or steatite
2. **Semi-solid:** Grease
3. **Liquid:** Mineral oil, vegetable oil, animal oil etc.

Main parts of a lubrication system:

Oil Pump: Oil pump forces the oil from the sump to the main oil gallery.

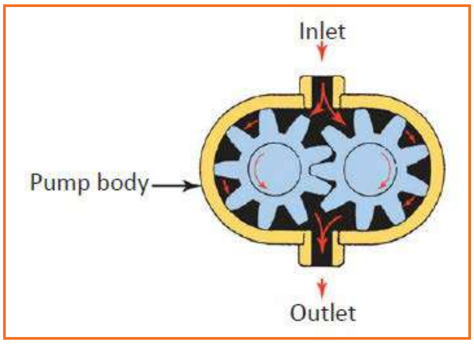


Fig 4.3.35: Oil pump

Four types of oil pumps are used:

1. Gear type oil pump
2. Rotor Type oil pump
3. Vane type oil pump
4. Plunger type oil pump

Engine parts which require lubrication:

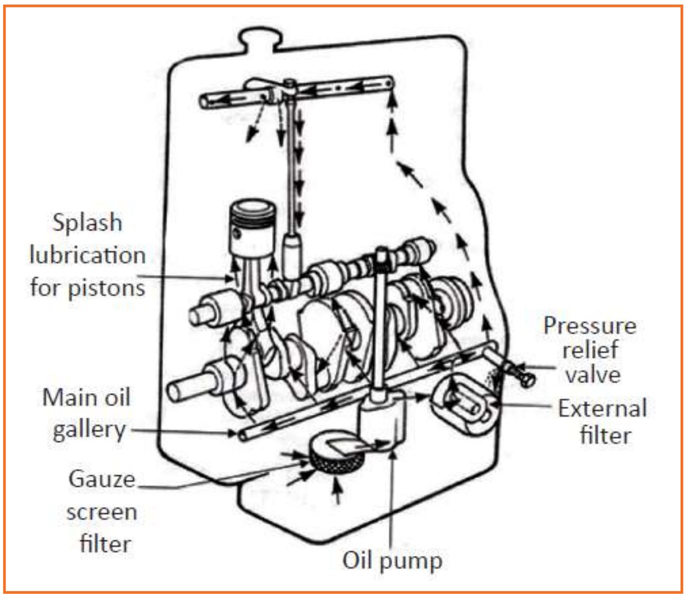


Fig 4.3.36: Engine parts require lubrication

- Crankshaft bearings
- Crankpins
- Big and small ends of connecting rod
- Bushes of gudgeon pin
- Inner walls of cylinders
- Piston rings
- Valve operating mechanism
- Timing gears

- Camshaft bearings

Oil filter:

A rubber diaphragm acts as an anti-drain back valve to keep the oil in the filter when the engine is stopped and the oil pressure drops to zero. It may not be available if filter is fitted in bottom (sealing ring side) up .

Fig 4.3.37: Oil filter

Operation of Oil filter:

1. Engine oil enters the oil filter through small holes around the filter's center, flows through the pleated paper filtering media.
2. Through the large hole in the center of the filter It comes out.
3. The central metal cylinder having holes, does not allow the paper filter to collapse under pressure.
4. When pressure differential from the inlet to the outlet side of the filter is very high due to clogging, by pass valve opens, allowing the oil to bypass the filter.
5. The bypass valve is normally provided in the center on the oil filter.

Fig 4.3.38: Oil filter inner

4.3.13 Diagnosis

To troubleshoot an engine lubricating system, analyze the symptoms of system operation. The four problems that most often occur in the lubrication system are as follows -

- High oil consumption (oil must be added frequently)
- Low oil pressure (gauge reads low, indicator light glows, or there are abnormal engine noises)
- High oil pressure (gauge reads high, oil filter swells)
- Indicator or gauge problems (inaccurate operation or readings)

When diagnosing these troubles, make a visual inspection of the engine for obvious problems. Check for oil leakage, a disconnected sending unit wire, low oil level, damaged oil pan, or other troubles that relate to the symptoms.

High Oil Consumption

When there is excessive oil consumption in the engine, the reasons are -

a. more oil goes to combustion chamber and gets burnt
b. some leakage occurs in some part of - the line and
c. loss of oil in form of vapour through ventilating system. Oil can enter the combustion chamber through rings and cylinder walls, worn piston rings and worn bearings.

Low oil pressure

Low oil pressure can result due to -

a. weak relief valve spring
b. worn oil pump
c. cracked oil line
d. obstruction in the oil lines
e. very thin oil and
f. worn out bearings.

Care should be taken to remove these defects as far as possible to increase the oil pressure in the lubricating system. Sometimes defective oil pressure indicator shows low oil pressure. This should be checked.

Excessive oil pressure

Excessive oil pressure may result due to -

a. stuck relief valve
b. strong valve spring
c. clogged oil line and
d. very heavy oil.

These defects should be removed to reduce the excessive oil pressure in the lubricating system. Sometimes defective oil pressure indicator records high oil pressure. Care should be taken to check this defect.

Indicator or gauge problems

A bad oil pressure indicator or gauge may scare the operator into believing there are major problems. The indicator light may stay on or flicker, pointing to a low oil pressure problem. The gauge may read low or high, also indicating a lubrication system problem.

Inspect the indicator or gauge circuit for problems. The wire going to the sending unit may have fallen off. The sending unit wire may also be shorted to ground (light stays on or gauge always reads high).

To check the action of the indicator or gauge, remove the wire from the sending unit. Touch it on a metal part of the engine. This should make the indicator light glow or the oil pressure gauge read maximum. If it does, the sending unit may be defective. If it does not, then the circuit, indicator, or gauge may be faulty.

4.3.14 Cooling System

When the fuel in an engine is burnt it produce lot of heat. A part of it is removed along with exhaust gases and by the lubrication system. Cooling system job is to take out the leftover of excess heat. Cooling system should maintain temperature within fairly close limits so that optimum compression ratio and maximum power is obtained.

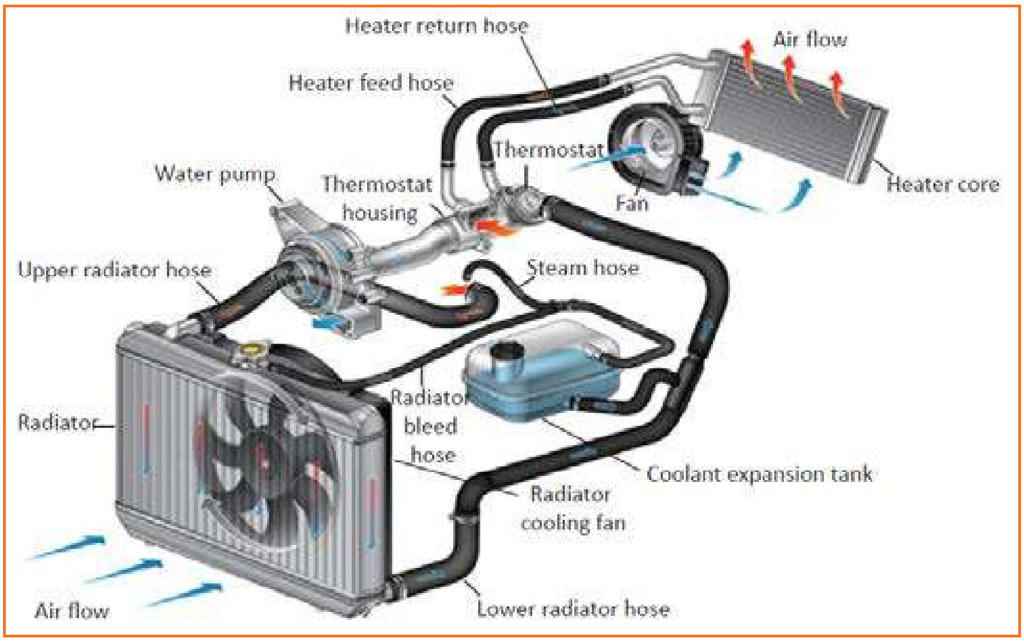


Fig 4.3.39: Engine cooling system

If the temperature of engine is very high:

- The engine will be overheated
- The film of lubricating oil will lie burnt off which may damage cylinder walls, pistons and piston rings
- Detonation may be caused
- The engine may be seized / ruined

If the engine is too cool:

- Incomplete burning of fuel takes place
- Engine will lose power

4.3.15 Cooling System Operation

Coolant is basically flowing through the engine to absorb the heat.

- After engine it further flows back to radiator so that heat can be emitted to air.
- Coolant re-circulation continues to maintain the cooling effect.
- Coolant is circulated through water jackets in engine block & cylinder head

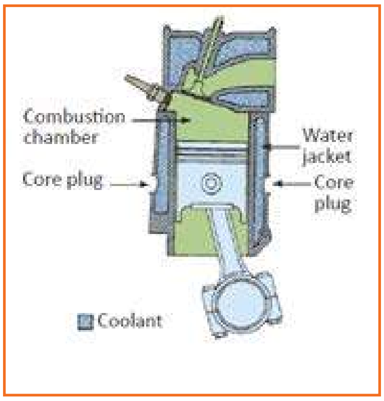


Fig 4.3.40: cooling unit

Cooling system types:

Two types of cooling systems are commonly used -

1. **Air cooling:** It is rarely used on cars although motorcycles utilize

this system. In this, air is conceded over cylinder and the cylinder head. To obtain better cooling, fins are cast on hot areas, which provide large heat radiating surface.

The advantages of air-cooling are:

- Simpler design
- No radiator is required
- No danger of freezing water

The disadvantages of air-cooling are:

- Air-cooled engines are more likely to overheat
- Fan takes away 5% of the engine power
- It is difficult to maintain even cooling

2. **Liquid cooling:** The majority of engines are water cooled because of the advantages

   - Mechanical noise is reduced
   - Temperature of the various engine parts is more uniform

Pump circulation system:

It is used in all modern engines for positive circulation of coolant. Coolant is pumped from top of engine to top of radiator. While flowing in the radiator, heat is lost to the air. Coolant is then pumped back through the engine.

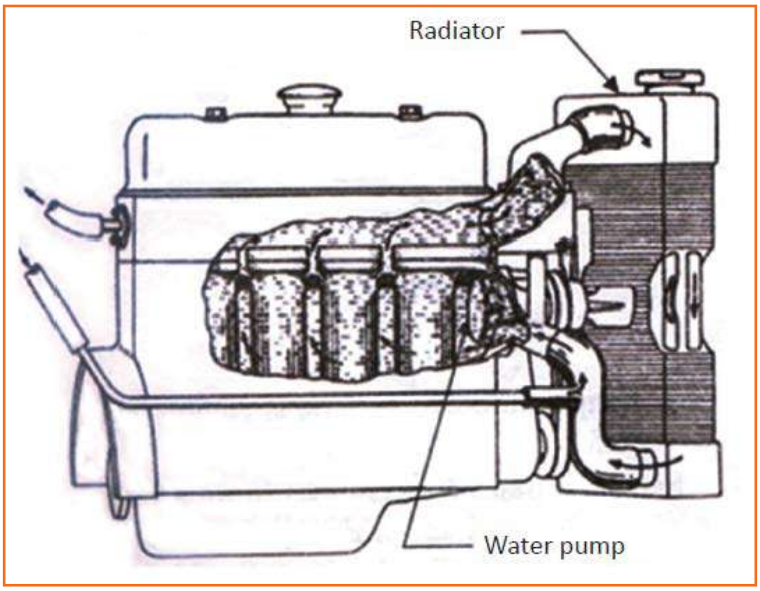


Fig 4.3.41: Pump circulation system

Parts of the Pump Circulation System:

- **Water pump:** At the front end of the engine an impeller type water pump is mounted. On the front end of the crankshaft there is a pulley which drives the pump through a belt
- **Radiator:** It has two separate circuits — one for the coolant and other for the air. The first one allows the coolant to pass from the top to the bottom tank of radiator and latter lets the air to

pass from the radiator front to back

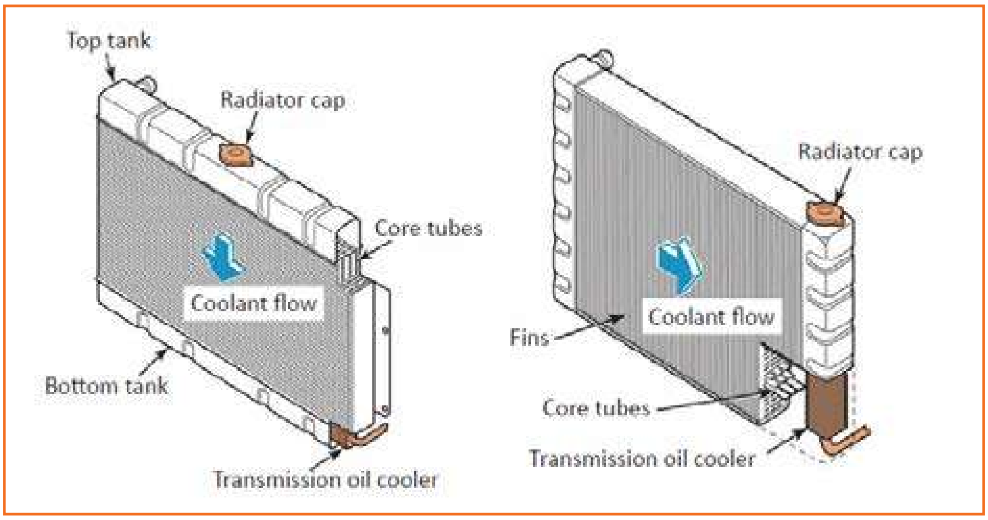


Fig 4.3.42: Radiator

Vehicles having automatic transmission having transmission fluid cooler mounted in radiator tank.

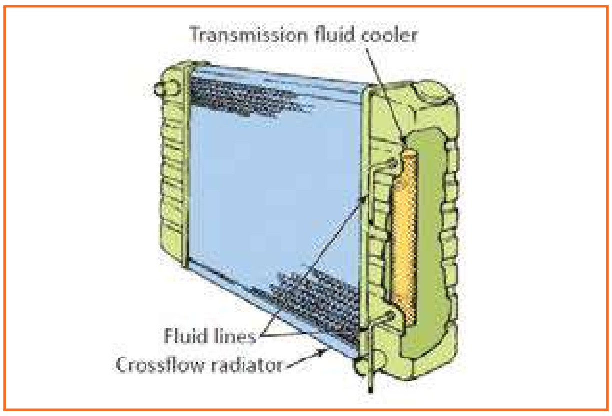


Fig 4.3.43: Transmission fluid cooler

- **Colling fan:** A fan having four or more blades is mounted on back side of radiator. Fan is driven by belt connected on the pulley of crankshaft. When it rotates, air is pulled from the radiator and through back toward the engine. Electric fan is in most of modern cars.

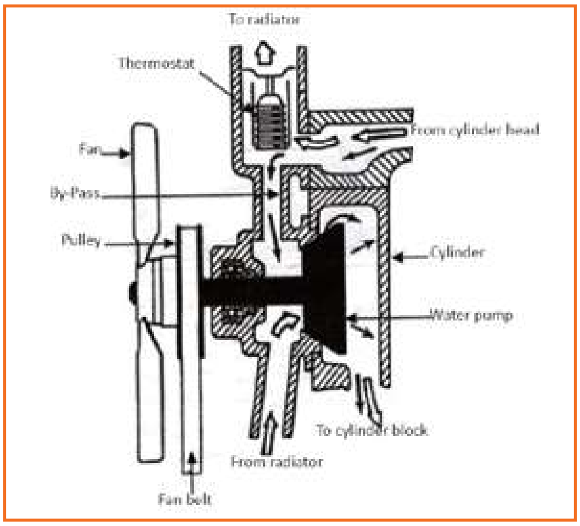


Fig 4.3.44: Fan, water pump and thermostat

4.3.16 Thermostat

Thermostat: An engine works poorly when it is below it's normal working temperature. It uses a lot of fuel, produces less power, emits more pollution and is subject to much more wear than when it is running at its normal temperature. So, a thermostat is used for blocking the coolant flow through radiator, until the engine is warmed up. Once the engine reaches its operating temperature (generally about 200 degrees F, 95 degrees C), the thermostat opens. The thermostat is a valve, which opens automatically at a predefined temperature.

Thermostats are two types:

- Bellows Type
- Wax Pellet Type

Cross section of typical wax actuated thermostat showing wax pellet & spring

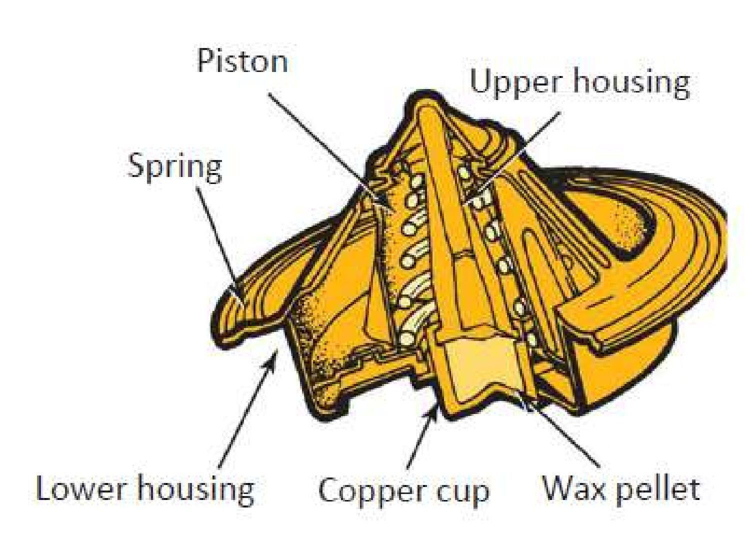


Fig 4.3.45: Thermostat

How thermostat works:

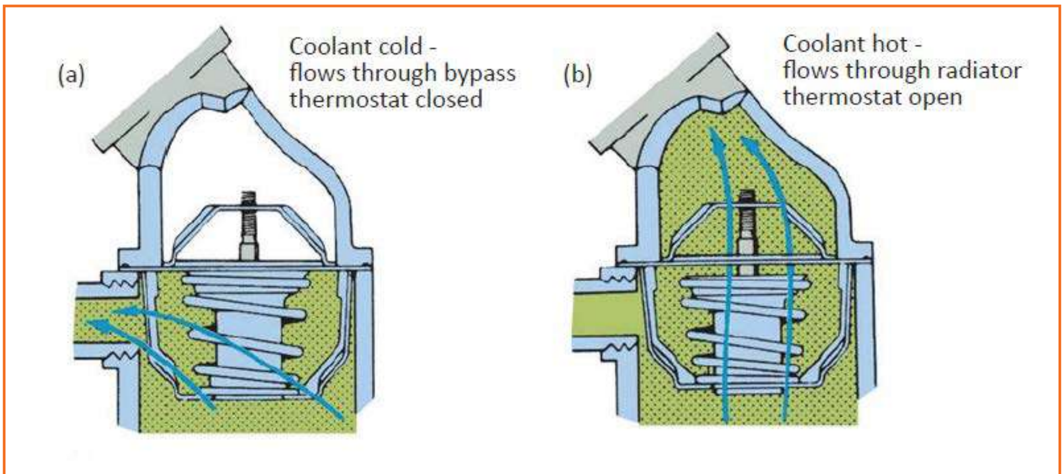


Fig 4.3.46: How thermostat works

a. During cold stage of engine, flow of coolant is through the bypass.

b. During open state of thermostat, coolant flow towards radiator.

Radiator pressure cap: The operating pressure of the system is managed by the radiator pressure cap. When the pressure inside the cooling system increases above its psi rating, the pressure cap releases some of the coolant into the overflow tank to reduce the pressure. It also allows coolant to be sucked from the reservoir back into the cooling system when the pressure drops below the rating. During pressurize stage of cooling system, the increase in boiling point enables the engine to operate at a higher temperature with the result that power, economy and engine life are all improved.

Pressure cap also prevents boiling of coolant even if the temperature exceeds 100 degree C or when the vehicle is driven at high altitude, where atmospheric pressure is lower and coolant may start boiling below normal working temperature.

Hoses: The hoses carry the coolant from the radiator to water pump and from engine to radiator. Hoses are slowly getting damaged with the time and it is mainly manufactured using rubber. It should be flexible and not dry otherwise it will develop cracks.

Water jacket: Water jackets are provided in cylinder block and the cylinder head. Cold water from the radiator flows through water jackets. This water carries the heat from these hot parts to the radiator.

Antifreeze mixtures: When the car is parked and the atmospheric temperature below freezing chance is that pump-circulated water in the cooling system may freeze. When this occurs, the expansion may cause the water jackets pipes or radiator to break. To prevent freezing, an anti-freeze solution is added to water which reduces temperature at which freezing of the coolant occurs

4.3.17 Testing of Thermostat

If the thermostat works properly, the hose will stay fairly cool for certain minutes, then will quickly warm up.

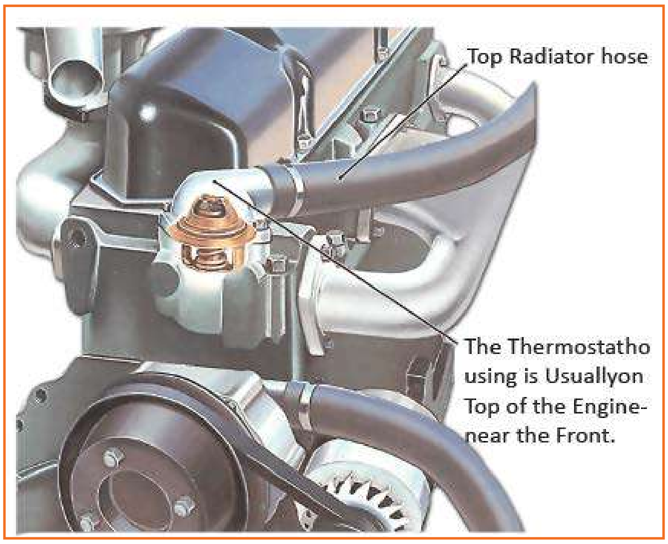


Fig 4.3.47: Thermostat testing

After starting the vehicle if hose warms gradually it means that the thermostat is open but in case hose is not warming much and engine is hot it means that the thermostat is closed.

Always use the thermostat compatible with your car.

Most of the thermostat have stamp of temperature on which it usually open.

Testing a thermostat in a pan:

1. Position thermostat in water pan in hanging position and make sure neither thermostat not thermometer is not in contact with bottom or sides of pan as direct metal touch will spoil the test.
2. Place a thermometer in the water and write the temperature on which thermostat open. It should start opening closure to the temperature marked on the thermostat.
3. Water heating process should be continued for further checking that thermostat valve opens fully.

Fig 4.3.48: Thermostat testing

4.3.18 Coolant

Reason for using coolant:

- Absorb heat from engine and transfer to radiator
- Protects engine and cooling system from rust and corrosion
- Prevents freezing in cold climates

All manufacturers recommend the use of ethylene glycol based coolant, which contains:

- **Ethylene glycol (EG):** 47%
- **Water:** 50%
- **Additives:** 3%

Why normal tap water is not good as coolant:

- Water is vital part of coolant. However, it may affect the corrosion protection property of coolant.
- Municipal water supply in the city is chlorine treated and may cause corrosion, if the chemical contamination levels are high.
- If we consider well water it may also have iron and minerals and its use in coolant increases risk of corrosion and electrolysis.
- To maintain the quality of coolant specially due to water quality vehicle manufacturers recommend premixed coolant because water used in premixed coolant is demineralised to avoid chances of corrosion.

4.3.19 Testing of Coolant

Normal coolant tests include:

- **Visual inspection:** Coolant has to be clean & bright.
- **Freeze/boiling point:** If freezing point is high or low boiling point, it indicates dilution contain high water level. There are two devices used to check antifreeze strength - the antifreeze hydrometer and the refractometer. The antifreeze hydrometer is used to measure the freezing point of the cooling system. A squeeze and release bulb draws coolant into the tester, and a needle floats to show the freeze protection point.

Fig 4.3.49: Antifreeze hydrometer

- **pH:** Wrong pH indicates buffer loss, used to help maintain the pH level.
- **Coolant voltage:** High voltage is indicative of wrong pH or stray current flow.

4.3.20 Car Radiator

In latest cars radiator has four side mountings. It also has top and bottom hoses. A fan is mounted on fan hood and bolted to secure it. In some cars radiator is mounted at the face of engine bay.

Old cars was using radiator manufactured using copper and brass materials and have the possibility of repair using soldering process. But the latest cars are using radiator manufactured using aluminium cores tanks are made-up of plastic material. These latest radiators are bit sensitive and can be easily damaged by clip over tightening or by applying forces on hose or pressure cap.

Radiator is used in all latest car cannot be repaired by technician and in case of damage needs to replace with new one. Due to aluminium use it is having more fins on the core. Due to more fins it is having high chances of clogging due road dirt.

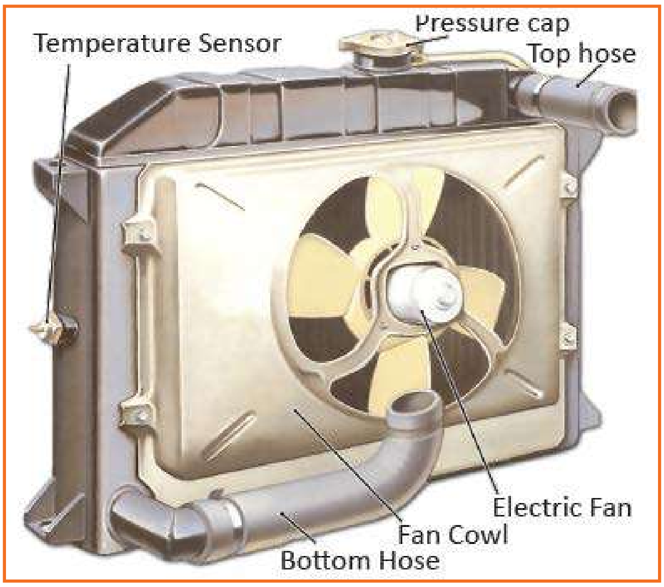


Fig 4.3.50: Car Radiator

4.3.21 Inspection of Hoses and Radiator Cap

Most of the problem associated with cooling system is due to water hoses. It develop cracks very easily due to engine movement or even when it is getting old or deterioration of inner fibre due to the hot water.

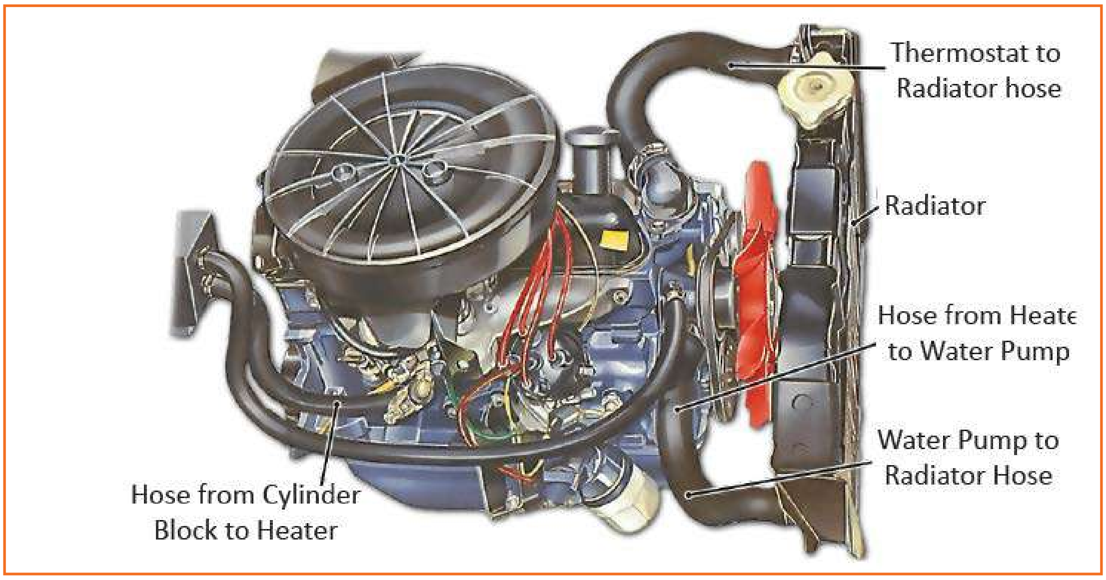


Fig 4.3.51: Parts of cooling system

1. Always check the hoses during cold state of engine. If you find it is deteriorated consider it very seriously as it may cause coolant loose which result in overheating of engine and sometime seizure of engine also. If hose is worn-up or damage, should be replace as early as possible.
2. Before replacing the hose first cooling system needs to be drained. For draining the coolant, remove the cap to radiator and then open the drain plug / cock. If there is no drain plug / cock, open the bottom hose. If coolant is good and can be reused collect it in a clean container. If coolant is poisonous thus never drain it on the road.
3. Always replace the hose with correct one. It should match with internal diameter. During replacing the hose it is advisable to replace clips also for achieving more effective sealing effect. Over tightening of clip should be avoided as it may cut the rubber.
4. After replacing the hose, turn-off the drain plug / cock of radiator and slowly refill the coolant.
5. For reuse coolant with antifreeze, filter it using strainer or cotton cloth. To check the leakage place the radiator cap back to its location and fix it then start engine on up to working temperature and tighten the clips if necessary. Top up the coolant to the required level during cold stage of engine. Do not open the pressurised cap during hot state of engine as it will release the liquid with force and may give burn injury also.

Where to look for coolant leaks:

For ease of locating the crack simply press or pinch the hose so that crack will became widen to identify. While inspecting the hose for damage bends, junctions and clips area has to be inspected very thoroughly. If any swelling is found it indicates damaged inner reinforcing fabric which will rapture any time. For inspecting bottom side or behind area of hose better use proper light source and mirror.

Fig 4.3.52: Coolant leaks

If the stubs show brown rust deposit it means leakage of hose under pressure and clips needs tightening.

Testing the radiator cap:

- Small valve should move freely.

  While checking the coolant level always checks the radiator cap also for following -
- Rubber or fibre sealing ring and large pressure relief valve are intact, small valve is moving freely and is in the centre.
- Efficiency of the cap can also be checked by warming the engine and loosing the cap to its first stop only using glove.
- If air or steaming of liquid is not observed, cap may need replacement.
- Always ensure proper pressure rating during replacing cap as if it is weak pressure will be lower and in-case it is strong during hot state of engine system may become over pressurised.

Fig 4.3.53: Radiator cap

4.3.22 Inspection for Coolant Leak

Leakage in the water cooling system may be difficult to locate, especially when it is internal leakage.

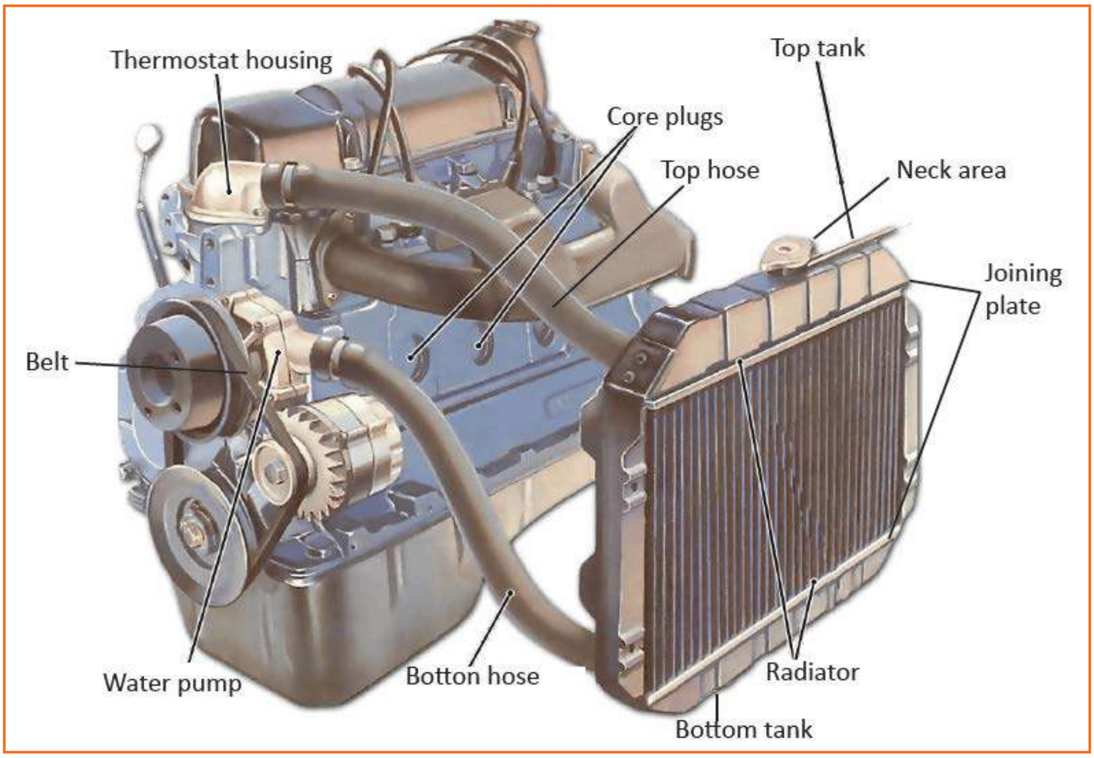


Fig 4.3.54: Water cooling system

Cooling system leakage check:

- Core plugs of cylinder block.
- All hoses connections for tightness and also inspect cutting of rubber
- Cracks in hose
- Radiator layer splits
- Reservoir / Catch tank & its pipe
- Water-pump bearings & water pump gasket
- Thermostat housing & gasket

Fig 4.3.55: Leak check

Signs of leak:

- Temperature gauge showing rising temperature
- Coolant leakage beneath the car
- Drop in the radiator coolant level
- Rust coloured stains in engine cove

Hidden core plugs:

- Locate hidden plugs using mirror and torch specifically behind engine area
- If you cannot locate a leak it means one or more gasket is damage.
- During travel on road if you experience a small leak, release cap of radiator to one turn only and drive the car to home or service station. You need to consistently check temperature gauge and if it is showing high temperature stop the car and wait till the engine is cool down.

Inspecting the water pump:

1. Loosen the fan belt and check bearings.
2. Water-pump bearing is checked by loosening the drive belt then shake the fan blades forwards and backwards.
3. If any wear found in the bearing it may burst water seal which will lead to leak. Flange bolts Tightening or replacement of gasket may stop the leak.

Fig 4.3.56: Water pump check

4.3.23 Air Intake and Exhaust System

The intake and exhaust system deals with the inflow of fresh air and the outflow of used gases in the engine.

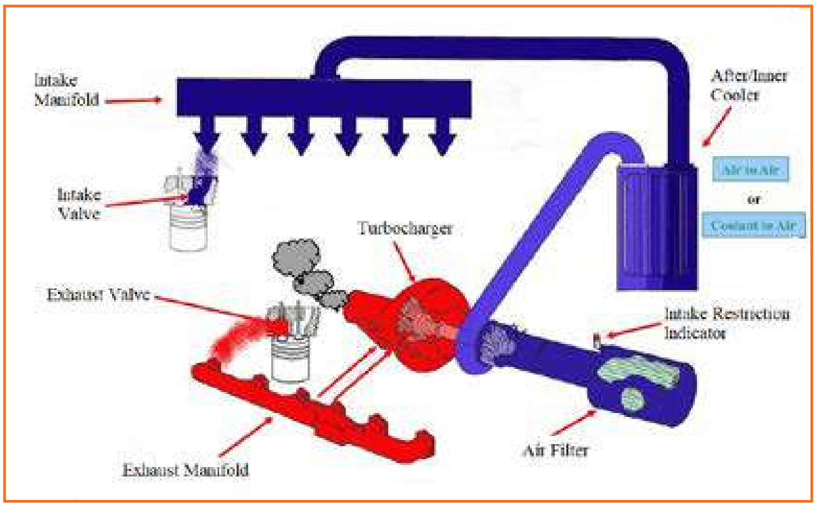


Fig 4.3.57: Air intake and exhaust system

Air Intake System

This system allows fresh air to enter the engine. Its main parts are -

a. air cleaner,

b. intake manifold,

c. intake port and

d. intake valve.

Air cleaner

The operating efficiency, good performance and durability of an engine depend mainly upon its cleaner. It is a device, which cleans and filters the air before entering the combustion chamber of an engine.

An IC engine uses large quantities of air for combustion, the ratio being 14-15 lb of air for every lb of fuel bursts. The volume of the air used is about 10,000 gal/gal of fuel. Unfiltered air may contain millions of particles of abrasive dust and other matter, which could cause rapid wear.

Intake manifold

The intake manifold is required to deliver into the cylinders either a mixture of fuel and air from the carburetor or only air from air-cleaners. The inlet manifolds are made in one or two pieces either from cast iron or aluminium alloy. They are also bolted from separate castings into a single unit. The manifold flanges are connected to the cylinder block or cylinder head by means of asbestos-copper gaskets, studs and nuts.

Exhaust System

The exhaust system collects exhaust gases from the engine and expels them out. The system consists of -

a. exhaust valve,

b. exhaust port

c. exhaust manifold,

d. turbo charger (auxiliary unit) and

e. muffler.

f. Catalytic Converter

g. Oxygen sensor/sensors (Petrol Engine)

Exhaust manifold

The exhaust manifold collects exhaust gases from the exhaust ports of various cylinders and conducts them from each end to a central exhaust passage. It is usually made of cast iron. The exhaust manifolds are designed to avoid the overlapping of exhaust strokes as much as possible, thus keeping the back pressure to a minimum. This is often done by dividing the exhaust manifold into two or more branches so that no two cylinder will exhaust into the same branch at the same time.

Turbocharger

This is an exhaust driven turbine, which drives a centrifugal compressor wheel. The compressor passage is usually located between the air cleaner and engine intake manifold, while the turbine is located between the exhaust manifold and muffler.

Muffler

The muffler reduces the noise of the exhaust gases by reducing the pressure of the used gases by slow expansion and cooling. On the other hand, the muffler must not cause any appreciable restriction to the flow of oil that could raise the backpressure excessively. The muffler contains a number of chambers through which the gas flows. The gas is allowed to expand from the first passage into a much larger second one and then to a still larger third one and so on, to the final and largest passage which is connected to the tail (outlet) pipe of muffler

Catalytic Converter: Converts toxic pollutants to lesser harmful gases (CO to CO2, HC to H2O)

Oxygen sensor/sensors: These are generally available in MPFI petrol engines to assess the rich and lean mixture and to give feedback to ECU for correction in the fuel quantity for lowering the pollution level.

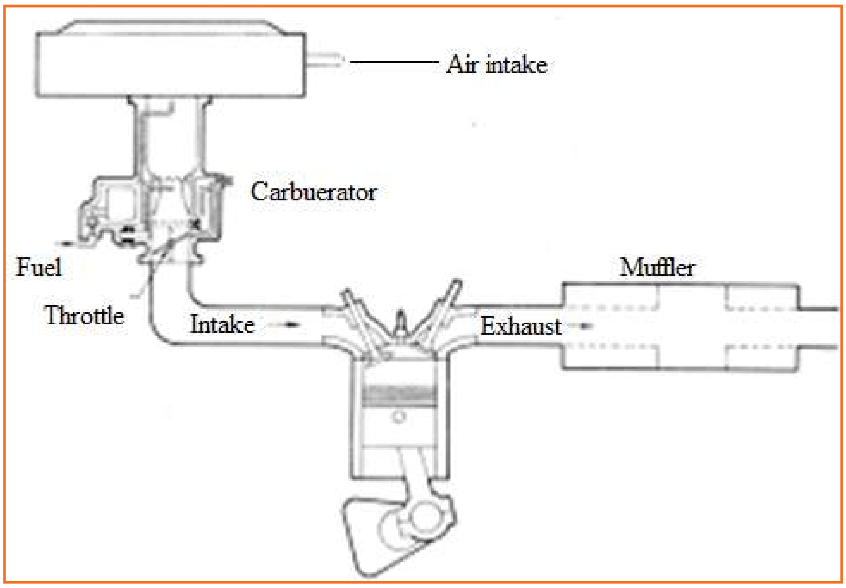


Fig 4.3.58: Exhaust system

4.3.24 Inspection of Air Intake and Exhaust System

Common problems in air intake and exhaust system

1. **Strange engine noises:** When the vehicle car is idle or stationary, feel and hear the smooth vibrations of an efficient engine. If you notice unusual noises, in particular a coughing, popping or spitting noise, this shows that the engine isn't getting enough airflow, which means air filter needs to be replaced/cleaned.
2. This is happened due to air filter of engine becomes dirty or clogged. This reduces the airflow, changing the air-fuel mixture. The rich fuel mixture creates a black soot residue which covers the spark plugs. The noise comes from the spark plugs not firing properly due to this residue. Dirty spark plugs can also cause problems with starting your car and misfiring.
3. **Decreased performance:** When you press the accelerator, if it is slow and sluggish second, this means a dirty air filter is preventing engine from receiving the clean air it needs to perform optimally. Simply replacing the air filter can eliminate this issue.
4. **Decreased fuel economy:** Decreasing fuel economy is a clear sign of a bad or dirty air filter. A bad or dirty air filter restricts air flow, lowering the oxygen in the mixture. Engine compensates for this by consuming more fuel to produce enough power to move the same distance or speed with a clean filter.
5. **Exhaust smoke:** There are generally three types of smoke generated from vehicle in different situations i.e.

   a. **Blue smoke –** this is usually an indication of oil burning in the combustion chamber. This could be caused by valve seals, valve guides, piston rings, worn cylinder walls, or the PCV system.

   b. **Black smoke –** An insufficient air supply means your engine will be running on a fuel-rich mixture, which won't burn completely before it enters the exhaust to leave the car as a black soot-like residue. This residue can be seen as black smoke. Alternatively, the heat in the exhaust might ignite the unburnt fuel, causing flames at the end of the exhaust and a popping sound. It could be caused by a clogged fuel injector or clogged air filter.

   c. **White/gray smoke –** This can generate due to coolant burning in the combustion chamber. Meaning that either the cylinder head, engine block, or head gasket are cracked or damaged.

4. **Smell of petrol in the exhaust:** If you smell petrol when starting the car, it's because insufficient air is entering the fuel injection system and the excess unburnt fuel exits the car through the exhaust pipe (hence the smell). When you replace the air filter, the smell should go.
5. **Air filter looks dirty:** A brand new air filter is a white / off-white colour, which will slowly darken as it accumulates dust and dirt over time. A visual inspection of your air filter under bright light will show a lot of dirt, but not all the tiny particles can be easily seen.
6. **Check engine light comes on:** An inadequate supply of air can result in carbon deposits accumulating in the engine, which will eventually trigger your check engine light. If the light comes on, check your air filter to see if it needs replacing before you run other diagnostics. For this reason, most car manufacturers recommend changing your air filter every 12,000 miles (approximately 19,000 km) or every 12 months, whichever comes first, regardless of how dirty your air filter appears to be.

7. **Rust:** If you're known to take shorter trips as opposed to longer ones, your system may be more susceptible to rust. Taking short trips frequently lets water vapor collect in the exhaust system, but it never gets hot enough to burn off. Gradually this condensation will turn to rust and corrode your exhaust from the inside out.
8. **Broken hangers:** Hangers are the handy little parts that are meant to protect exhaust system from banging around when you hit a bump. They help keep your exhaust secure on car. Once the hanger breaks and falls off, all the exhaust pipes become free to move around. Their movement may lead to dents, cracks and, in some cases, it may cause entire pieces of the exhaust system to break off. Exhaust system hangers should be routinely inspected to ensure none are broken or missing altogether.
9. **Faulty oxygen sensor:** Even though many of today's vehicles having numerous oxygen sensors, a malfunction in just one can be enough to confuse vehicle's system. If one of car's oxygen sensor gives out, the engine's computer can't create the correctly balanced air-fuel mixture to run efficiently. This could lead to a mixture that's low on air and high on gas, a blend that's hotter than intended, or it may cause a clog in your catalytic converter leading to further damage of your system and car.

4.3.25 Transmission System

It is a device which is basically connected backside of engine. Drive wheels of the vehicle get the engine power through transmission system. The main job of transmission system is to make sure that power is delivered to the wheels while keeping the engine within the define RPM (Revolutions Per Minute) range. This job is performed using combinations of available gears. When first gear is applied speed of engine is much higher than drive wheels while in the upper gears engine is gradually going towards ideal state but vehicle moves in higher speed. Apart from having different forward gears vehicle is also having a neutral gear used for disconnecting the engine from drive wheels and a reverse gear to allow wheels to move in opposite direction.

Why do we need transmission ?

- To modify torque as per the requirement (Torque requirement at wheels is more at the time of take-off, acceleration and climbing a slop as compared to drive at constant speed on levelled road)
- To keep engine speed in optimum range irrespective of vehicle speed.
- To drive the vehicle in different road and traffic conditions with ease
- To disconnect the engine from wheels to stop the vehicle for some time
- To drive the vehicle in reverse direction.

When the output RPM from transmission are reduced as compared input engine RPM, the torque is multiplied by the reduction ratio.

Types of drive line

Front wheel drive

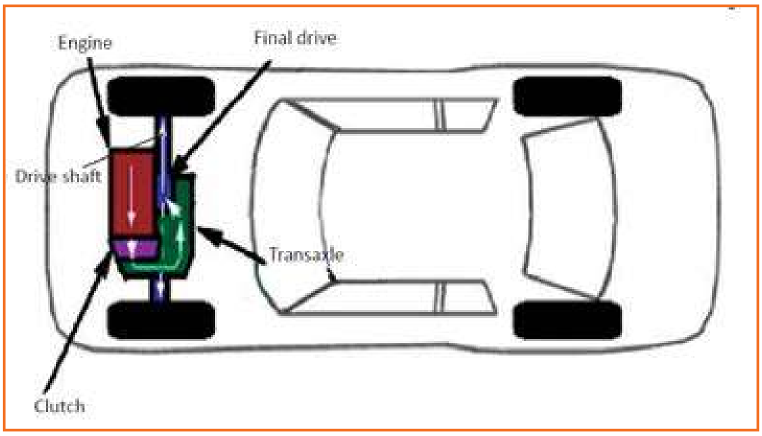


Fig 4.3.59: Front wheel drive

In front wheel drive car, transmission is basically united with the final drive to form transaxle. Transaxle is a device setup in the transmission gear box which combines multiple components like clutch, final drive in a single unit.

Fig 4.3.60: Gear box

In front wheels drive layout vehicle front wheels are driven. In today's cars are mostly using this layout having engine in front with front wheel drive. In this layout engine is placed in the front for front wheels driving. Most of the new cars are front wheel drive cars due to compact packaging. In the layout transaxle is directly connected to front axels for providing power to front wheels.

Rear wheel drive:

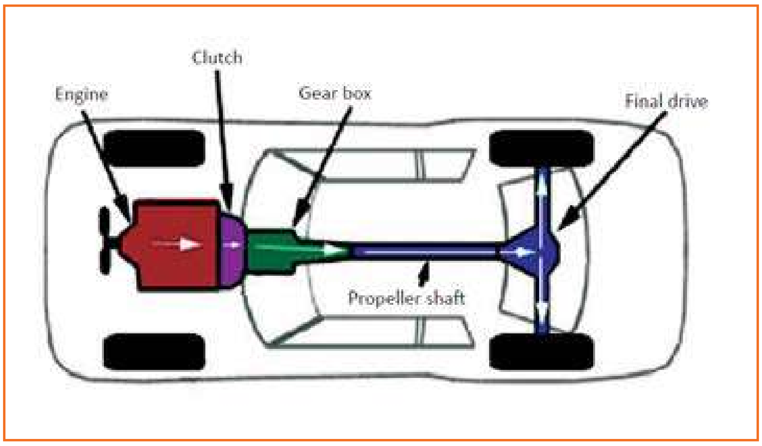


Fig 4.3.61: Rear wheel drive

In rear wheel drive, the rear wheels are driven through the engine, clutch & transmission in manual transmission.

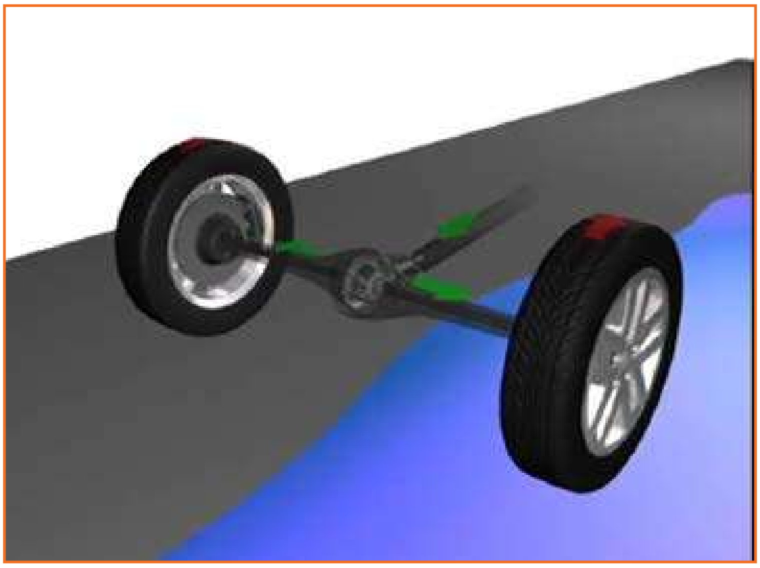


Fig 4.3.62: Rear wheel drive

In this layout flow of power is going from the engine in a simple and straight way. After reaching to final drive it is divided and forwarded to the two rear wheels.

Before reaching to final drive, it passes torque converter and then after transmission and drive shaft in auto transmission.

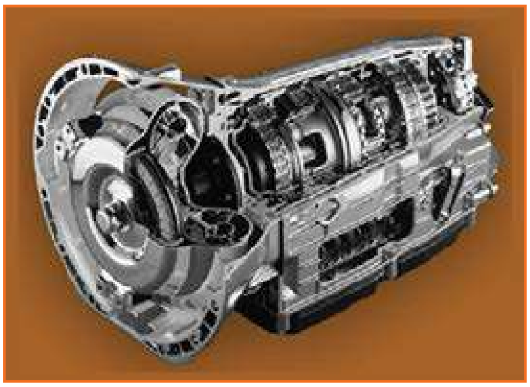


Fig 4.3.63: Manual transmission

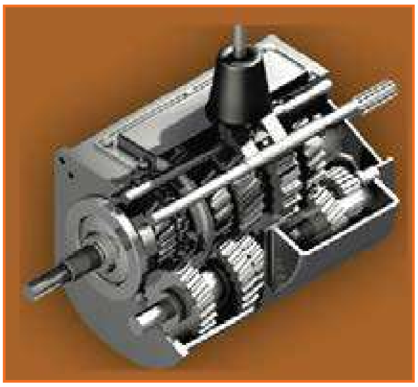


Fig 4.3.64: Automatic transmission

Four wheel drive: When engine torque is supplied to all four wheels or all four wheels are pushing the car. Four wheel drive vehicles are fitted with one more aggregate called transfer case.

Four wheel drive layout are basically of two types:

1. **Part Time Four Wheel Drive -** It is basically having two-wheel drive with an option of four-wheel drive capability. This mechanism is usually found in pickup trucks and other off-road vehicle. It may be of two types-Mechanical shifting and electric shifting.
2. **Permanent For Wheel Drive -** In some high performance cars and SUVs it acts full time and normally referred as "All Wheel Drive".

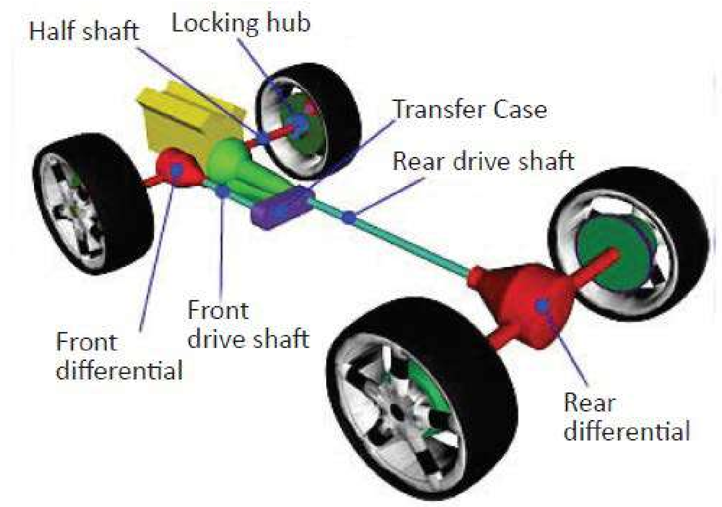


Fig 4.3.65: Four wheel drive

4.3.26 Clutch

Clutch is the crucial link between the power plant (engine) and the driveline. The purpose of the clutch is to link or de-link (engage or disengage) the engine from the driveline, as desired by the driver at the time of gear shifting or applying the brakes. It also facilitates gradual and smooth engagement of transmission with engine.

What does the clutch do?

- Controls engine power transmitted to the wheels
- Separates engine and gearbox so that driver can change gear
- Permit engine to be started and move run without car movement

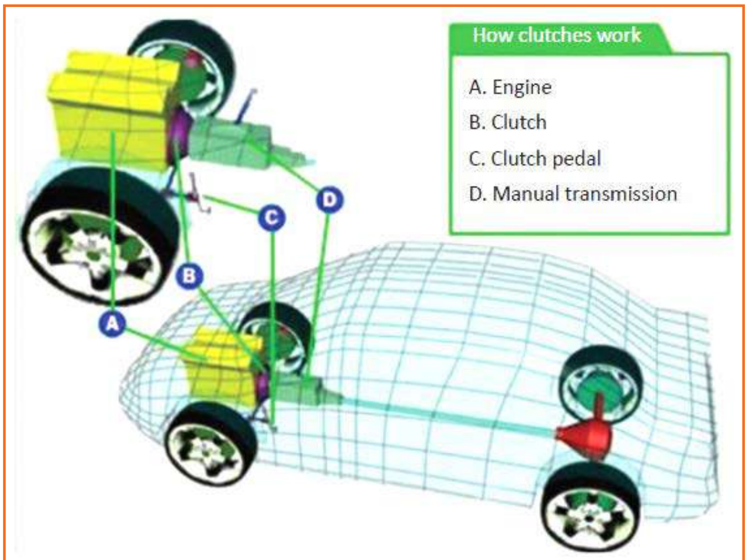


Fig 4.3.66: Location of clutch

Where is the clutch located?

The clutch assembly is situated between engine and the transmission /transaxle.

Components of the clutch:

- Clutch pedal
- Clutch fork
- Clutch release bearing
- **Clutch unit:**
  - Pressure plate
  - Clutch plate
  - Flywheel

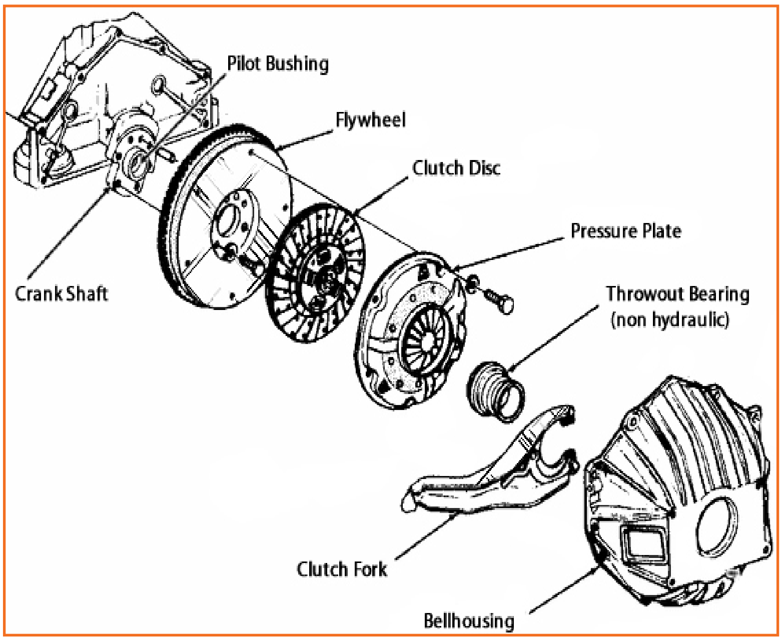


Fig 4.3.67: Components of the Clutch

How different parts work:

- Clutch pedal
  - Situated on the left side of brake pedal.
  - When pedal is pressed the clutch mechanism pulls the pressure plate away from the flywheel and clutch plate becomes free. The torque transmission to gearbox/transmission is stopped.
  - When pedal is released, the springs of pressure plates pushes the pressure plate towards flywheel and the clutch plate is pressed in between flywheel and pressure plate. The clutch plate starts rotating with flywheel because of friction transmitting torque to gearbox/ transaxle.
- Clutch fork
  - Applies pressure on pressure plate fingers through the clutch release bearing.
- Clutch release bearing
  - Moves the disc on and off pressure plate during pressed and depressed position of clutch pedal.
  - Due to pressure on release bearing pressure plate decrease it's pressure against clutch disc.
- Pressure plate
  - Round, metallic device containing springs, fingers and levers.
  - Pushes the clutch disc against the constantly rotating engine flywheel. Friction material causes the clutch disc to rotate at the same speed as the engine flywheel.
- Clutch plate
  - Torque is transmitted from engine flywheel to gearbox through clutch plate. When it is pressed in between flywheel and pressure plate it rotates with the speed of flywheel and torque is transmitted.
  - By clutch mechanism when the pressure of pressure plate is removed by pulling it away from flywheel, the clutch plate becomes free and no more torque is transmitted.

- Flywheel
  - Is secured at rear of the engine (crankshaft).
  - The crankshaft converts up and down reciprocating movement of pistons into rotational movement.
  - Thus, flywheel turns, during running stage of engine. It absorbs energy during power stroke and releases in other strokes.

How are these components arranged?

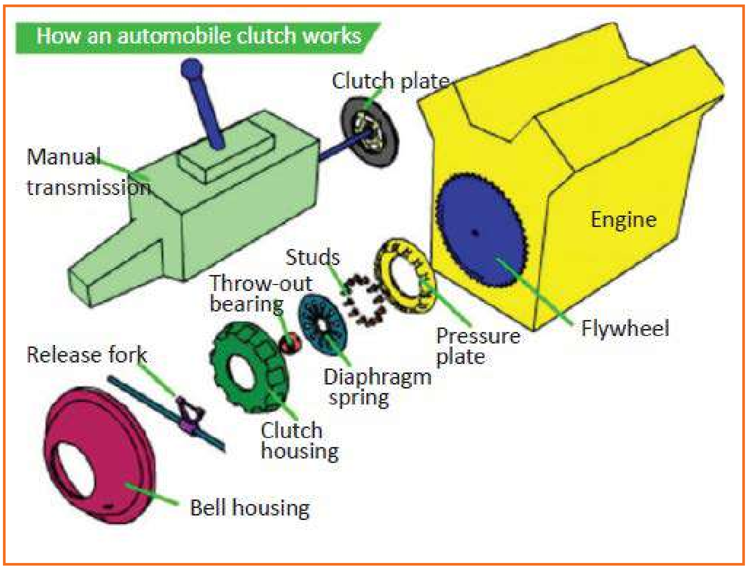


Fig 4.3.68: Components of the Clutch

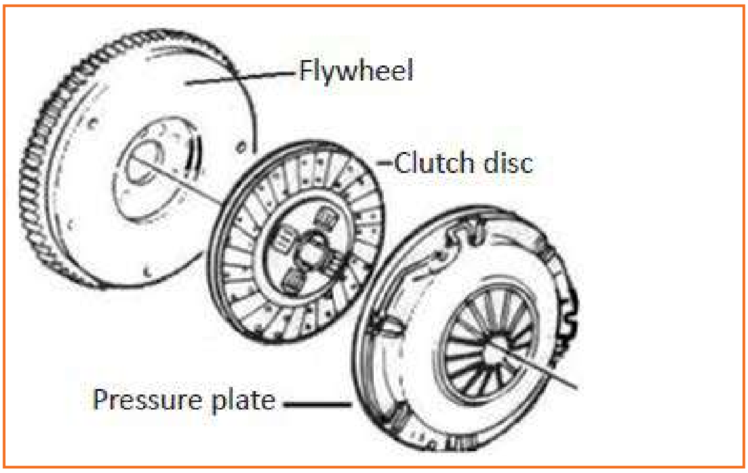


Fig 4.3.69: Clutch unit

How does the clutch work

When the clutch pedal is depressed -

- Discs move apart
- Engine and gearbox are disconnected

Then gears can be changed manually.

Fig 4.3.70: Clutch unit

The springs in clutch plate help to isolate transmission from shock of clutch engaging as well as engine vibrations.

Clutch plate

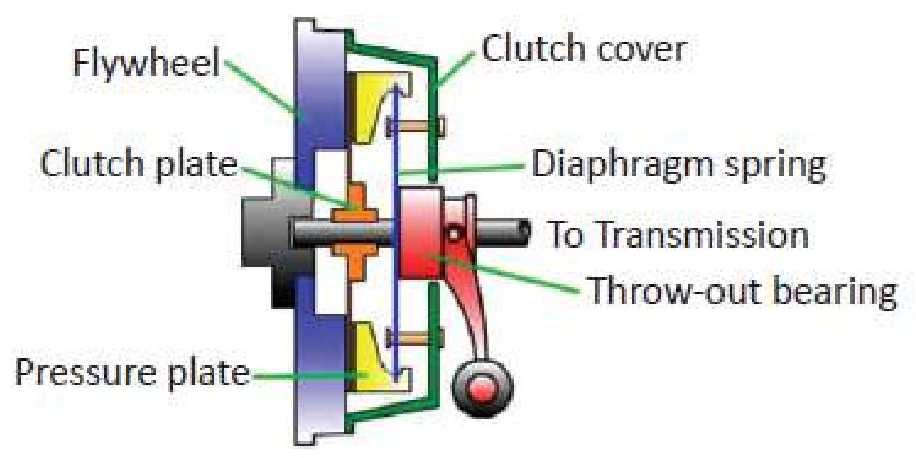


Fig 4.3.71: Clutch working

- During up position of clutch pedal clutch is engaged.
- During down position of clutch pedal clutch is disengaged.

Clutch working

Types of clutches:

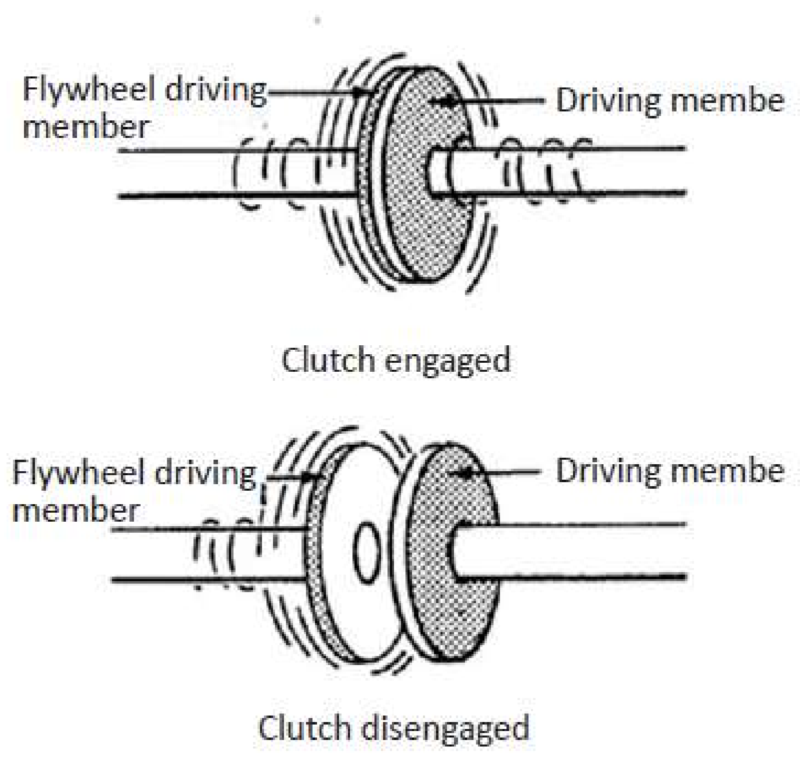


Fig 4.3.72: Engaging and disengaging

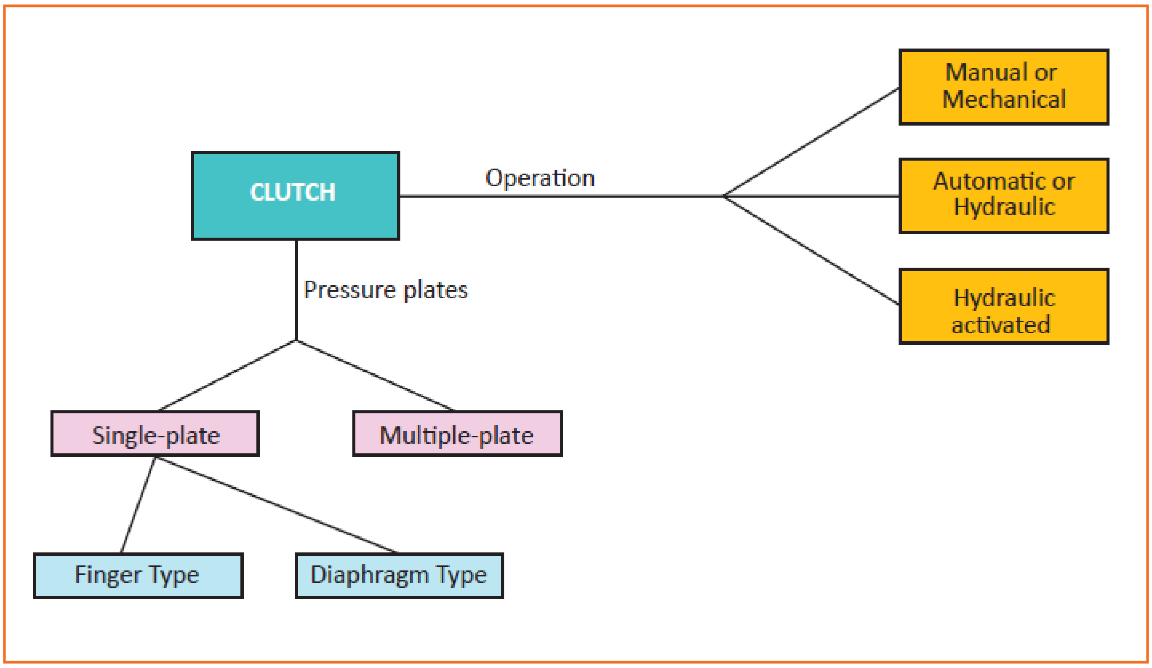


Fig 4.3.73: Types of clutches

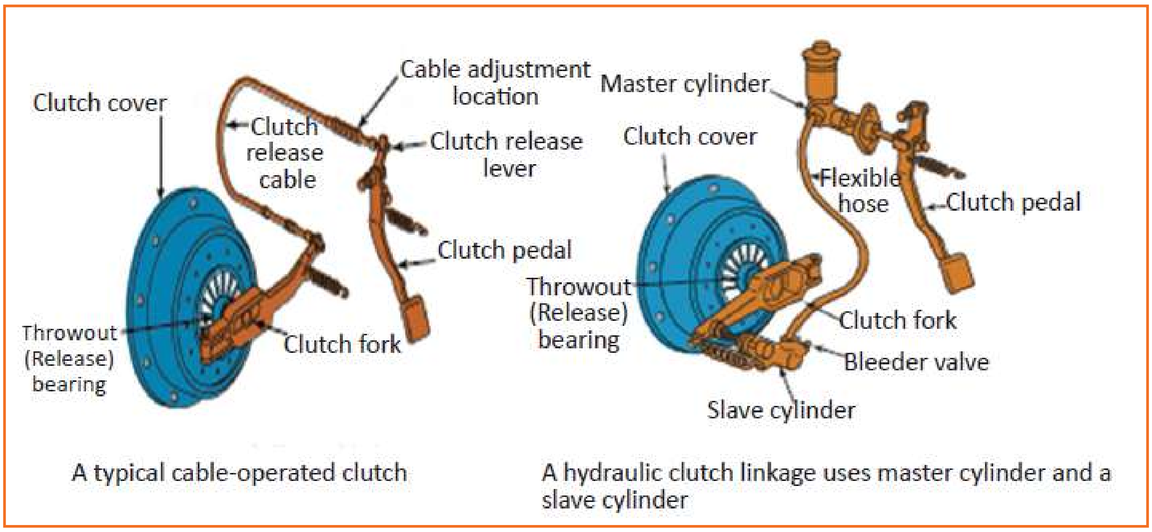


Fig 4.3.74: Types of clutches

Fig 4.3.75: Types of clutch pressure plate assemblies

4.3.27 Inspection of Clutch

Visually check the outer surfaces of the clutch cable at the pedal and clutch lever ends for damaged. Pedal flopping unnecessarily on to the floor is another possible problem with a cable operated clutch. This is due to 2 possible reasons:

1. The cable may be broken.
2. The metal of the bulkhead may have collapsed or rusted, where the cable passes through

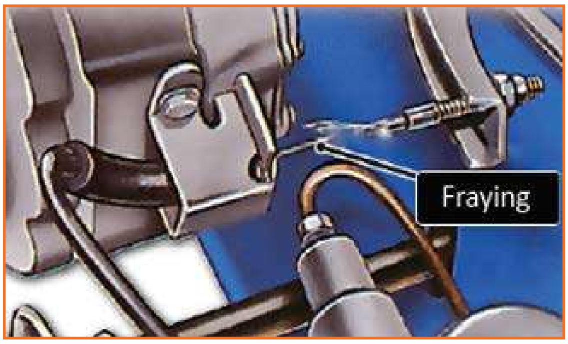


Fig 4.3.76: Clutch inspection

Find the problem:

1. If you feel the clutch stiff, first check the entire clutch cable, starting from clutch pedal below dash to bulkhead. Check for inner / outer cable damages. Inspect carefully as the damaged strands may be near inner cable and may be difficult to distinguish. Even minor damage should not be ignored.
2. If damages is not found around pedal, check it from the engine bulkhead to clutch housing. Try to find broken areas or any kinks that may be restricting the free movement inner cable.
3. In case it is near the exhaust pipe, check for slipping from its place and came close to pipe. Plastic cover of outer cable and nylon cover on inner cable can be easily melted due to heat.
4. Finally check attachment to clutch housing for any signs of damages.

Check the pedal:

1. If cable is intact, then check the clutch pedal, if it is causing the problem. The pedal is pivoted on a shaft. Pivot shaft can be examined using a torch. When clutch pedal is moved with hand, pedal is moving not pivot shaft.
2. If the pedal has got stuck, lubrication and cleaning with oil may move the pedal freely. Otherwise, check the clutch cable connections.

4.3.28 Troubleshooting of Clutch

Problem 1: Abnormal facing wear

Classification/Probable Causes	Technical Details/Remedial Actions
Ussally caused by overloading and the resultant excessive slippage while starting.	Avoid overloading and excessive slippage.

Problem 2: Bearing Noise from Clutch

Classification/Probable Causes	Technical Details/Remedial Actions
Pilot bearing damaged.	If noise is coming without clutch pedal depresses, probably flywheel bearing is faulty.

Problem 3: Clutch is noisy when pedal is all the way out and engine is running

Classification/Probable Causes	Technical Details/Remedial Actions
Clutch linkage improperly adjusted	AdJUst the linkage.

Problem 4: Clutch noise when pedal is depressed

Classification/Probable Causes	Technical Details/Remedial Actions
Clutch release bearing worn or damaged	Replace release bearing

Problem 5: Clutch Pedal Hard

Classification/Probable Causes	Technical Details/Remedial Actions
Clutch cable bent/broken	Check/replace cluth cable
Clutch Master/Slave Cylinder laeking	Check for leakages/replace
Check clutch tubing routing	Check greasing in Cluth half shaft
Clutch master push road bend	Make sure Cm (push rod is always straight in actuation)
Greasing inside clutch release bearing guide tube dried.	Check Clutch Released Bearing service guide.
Misaligned parts/linkages	Check & align properly

Problem 6: Clutch Pedal Spongy

Classification/Probable Causes	Technical Details/Remedial Actions
Check clutch tubing and routing	Bleed properly wih correct oil laval in the reservoir. Tight all the joints as per spec. Check in case of any damage or pinching.
Improper Bleeding	Bleed properly with correct oil level in the reservoir.
Leakage from joint	Tight all the joint as per spec.

Problem 7: Clutch pedal will not come all the way back

Classification/Probable Causes	Technical Details/Remedial Actions
Fault in leakage	Check and adjust

Problem 8: Hard/difficult gear shifting

Classification/Probable Causes	Technical Details/Remedial Actions
Broken or damaged clutch plate.	Change the clutch plate.
Clutch does not disengage fully.	**Check free play:** Ensure that when the pedal is depressed, the linkage (cable of hydraulic) moves the activating lever on side of clutch housing. If linkage or cable is broken replace it, if the hydraulic system is empty then fill the reservoir with fluid and bleed clutch system.
Pressure plate out of adjustment causing clutch plate drag.	Balance the cover assembly. But if the clearance between the sides of the pressure plate lugs and sides of the windows in the cover is excessive, the pressure plate is likely to be forced off center; replace the cover assembly.
Pressure plate is parallel with the flywheel face, in excess of the permissible tolerance.	Readjust levers and, if necessary, to new eye-bolts.

Problem 9: Difficulty in engaging gear after vehicle has been stored for a length of period

Classification/Probable Causes	Technical Details/Remedial Actions

Problem 10: Drag or Spin

Classification/Probable Causes	Technical Details/Remedial Actions
Broken facings of driven plate.	Fit new clutch plate.
Dirt or foreign matter in the clutch.	Dismantle clutch from flywheel and clean the unit, see that all working parts are free.
Distorted driven plate due to the weight of the gearbox being allowed to hang on clutch plate while assembling.	Using a jack do the fitment of new driven plate assembly using a jack to take the overhang gearbox weight.
Broken facings of driven plate.	Jack up driving wheels, start engine in gear, press clutch pedal and apply brake. If not successful, dismantle clutch, check for broken facing & replace driven plate

Classification/Probable Causes	Technical Details/Remedial Actions
Driven plate hub binding on splined shaft.	Clean splines & lubricate them with grease
Improper pedal adjustment not allowing full movement to release bearing.	Correct pedal adjustment.
Misalignment between the engine and splined clutch shaft.	Check and correct the alignment.
Driven Plate show trace of oil or grease	Fit new clutch plate
ilot bearing or bushing or clutch shaft binding.	Renew or lubricate pilot bearing.
Damage pressure plate/ clutch cover.	Renew defective parts.

Problem 11: Engine runs, but car does not move when in gear (propeller shaft not turning)

Classification/Probable Causes	Technical Details/Remedial Actions
Clutch slipping or failed.	Check for correct free play.

Problem 12: Fierceness or Snatch

Classification/Probable Causes	Technical Details/Remedial Actions
Binding of clutch pedal mechanism.	Free and lubricate journals.
Misalignment.	Check and align.
Oil / grease on facing of driven plate.	Fit new driven plat, eliminate ingress of oil / grease.
Worn out driven plate facings.	Change clutch plate.

Problem 13: Fracture of driven plate

Classification/Probable Causes	Technical Details/Remedial Actions
If the gear box is hanging during assembly with shaft in hub resulting in distorted driven plate. This may cause metal fatigue and breakage.	Fit new driven plate taking care proper reassembly.
Misalignment distorts the plate.	Check, align and fit new driven plate.

Problem 14: Gear grinding while changing gear

Classification/Probable Causes	Technical Details/Remedial Actions
Clutch not operating correctly.	Check and correct.

Problem 15 : Shudder

Classification/Probable Causes	Technical Details/Remedial Actions
Contact friction facing area unevenly distributed.	Distortion may be the cause, assemble new driven plate.
Improper alignment.	Check and align.
Oil/ grease/ foreign matter on the driven plate facings.	Fit new plate or remove reasion of foreign matter.
Pressure plate not parallel with flywheel face above the permissible tolerance.	Reset the cover assembly correctly, if necessary, fit new eye bolts.
Unstable or ineffective rubber engine mountings.	Replace mountings and ensure elimination of endwise movement of power unit.

Problem 16 : Slip

Classification/Probable Causes	Technical Details/Remedial Actions
Binding of clutch pedal mechanism.	Free & lubricate journals.
Pedal adjustment not proper, as indicated by lack of the requisite free or unloaded foot pedal movement.	Ensure proper pedal adjustment and the clearances.
Incorrect setting of release levers.	Reset the levers.
Oil/ grease on the driven plate facings.	Fit new plate and eliminate oil leak.
Weak pressure springs.	Fit new springs.

Problem 17 : Tick or Knock

Classification/Probable Causes	Technical Details/Remedial Actions
Hub splines badly worn due to misalignment.	Check, align and fit new driven plate.
Worn pilot bearing.	Renew pilot bearing.

Table 4.3.6: Troubleshooting of clutch

4.3.29 Transmission Gear Box

Gears:

- Automobile transmission has multiple gears, which can be changed to vary speed as required. Gear shifting may be Manual or automatic. Gears also provide directional controls (forward and reverse).
- Gear looks like wheel having teeth around its circumference to interlock with similar teeth on the other gear wheel so that force can be transmitted between the two devices in a direction tangential to their surfaces.

Functions of a gear box:

Gears are mainly used for following reasons:

- For reversing rotation direction
- For increasing or decreasing rotation speed
- For moving rotating motion to a different axis
- For keeping synchronized rotary motion of two axis

To transmit & modify the torque to wheels required by the driver and is actuated by gear lever which selects the required gear ratio and also enable neutral position & able to reverse vehicle.

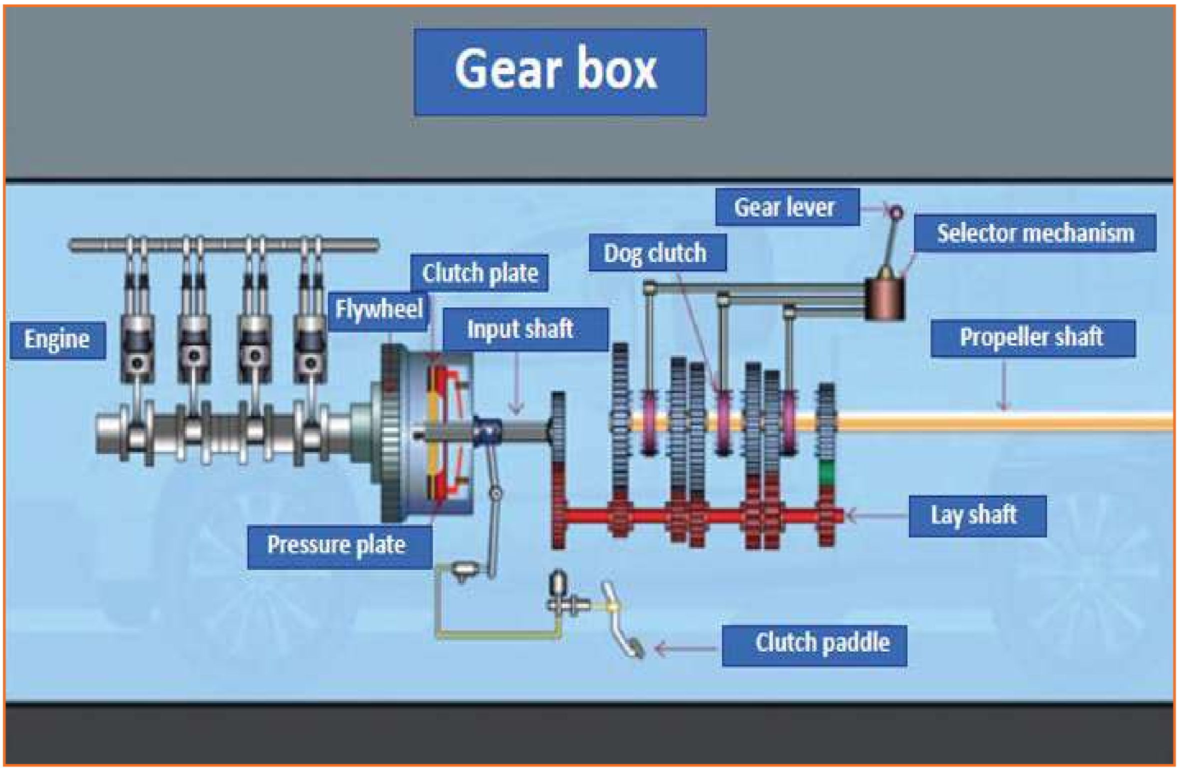


Fig 4.3.77: Gear box

While transmitting power it also modifies the torque as per the road condition. Namely while starting the vehicle from rest position, while climbing the hill or when the vehicle is accelerated or pulling the load etc.

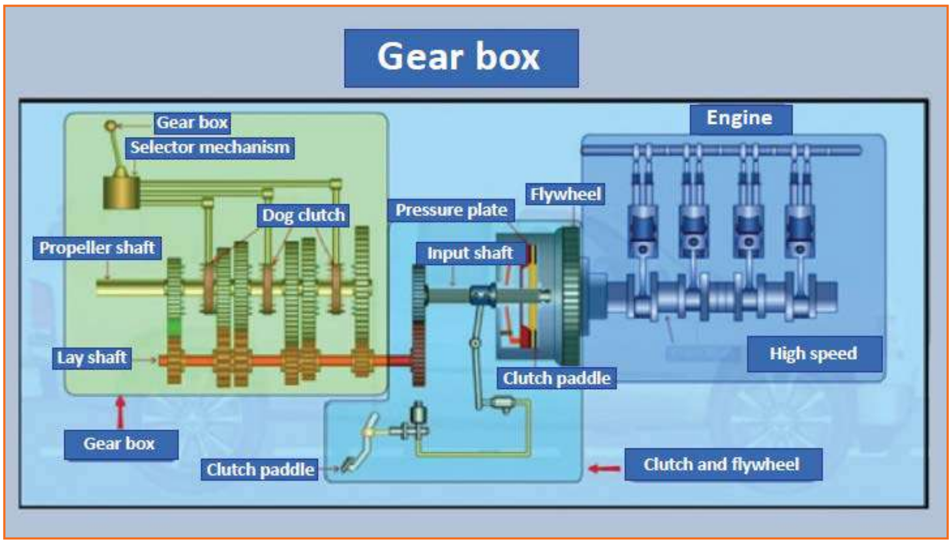


Fig 4.3.78: Gear box

Working principle:

- The most important feature of gears is its different diameters.
- Therefore, the rotation speed (Gear Ratio) and torque (Torque Ratio) of each gear is different.

Fig 4.3.79: Transaxle

How does transmission system work?

- Engine is connected to transmission through clutch plate.
- Driveshaft output is transmitted to differentials, to drive the wheels.
- Main function of differentials is to differentiate the speed of inner and outer driving wheels on turns.
- Change of direction and gear reduction is done by pinion and crown wheel.

Types of Gear Box/Transmission

There are three different types of gear box -

- Manual
  - - Sliding mesh or Crash mesh gear box
  - - Constant mesh gear box
- Automatic
- Semi-Automatic or AMT (Automated Manual Transmission)

Types of gears:

Gears are flat circular objects that have teeth on edge. The variation in gears is because of change in these teeth. There are different types of gear boxes

Fig 4.3.80: Dog teeth gear

- **Dog teeth gears:** In this type of gear mechanism for locking made up of collar on shaft and it is sliding sideways thus the inner surface teeth bridges with two circular rings along with teeth on surface.
- **Spur gears:** This is a basic gear having straight cut teeth. In this type of gear angle of teeth is parallel to the axis of gear.
- **Worm gears:** When reduction of gear required in large way, worm gears are suitable, here gear can be turned by the worm but worm cannot be turned by gear because very shallow worm angle.
- **Helical gears:** It provides wider gears teeth contact. The cut of angle gives gradual engagement. Helical gears operate more smoothly & quietly than spur gears.

Fig 4.3.81: Spur gear

Fig 4.3.82: Worm gear

Fig 4.3.83: Heical gear

Operation of the system:

1. Every engine has a defined limit of maximum RPM, beyond which it will explode. This is indicated by red line / zone in the RPM meter on the instrument panel.
2. Horsepower of engine and torque are maximum at narrow RPM ranges.
3. For the engine to stay below redline and near the RPM band we shift gears.
4. Five speed transmission provides five different gear ratios to input shaft for achieving different RPM at output shaft.

4.3.30 Gearbox Lubrication

- Gearbox consists of various moving parts. Some of the parts are in staying inside oil some of them receiving oil from other moving parts.
- Gearbox contain a filler plug to indicate oil level. Gearbox also contains other plugs so before unscrewing it ensure selection of right plug.
- The job of oil is to provide lubrication so that contact between metal-to-metal or teeth on gears etc. can be prevented. In market various types of oils are available which is used as per manufacturer recommendation.
- High level of lubrication on gear teeth is required even when temperature rises.

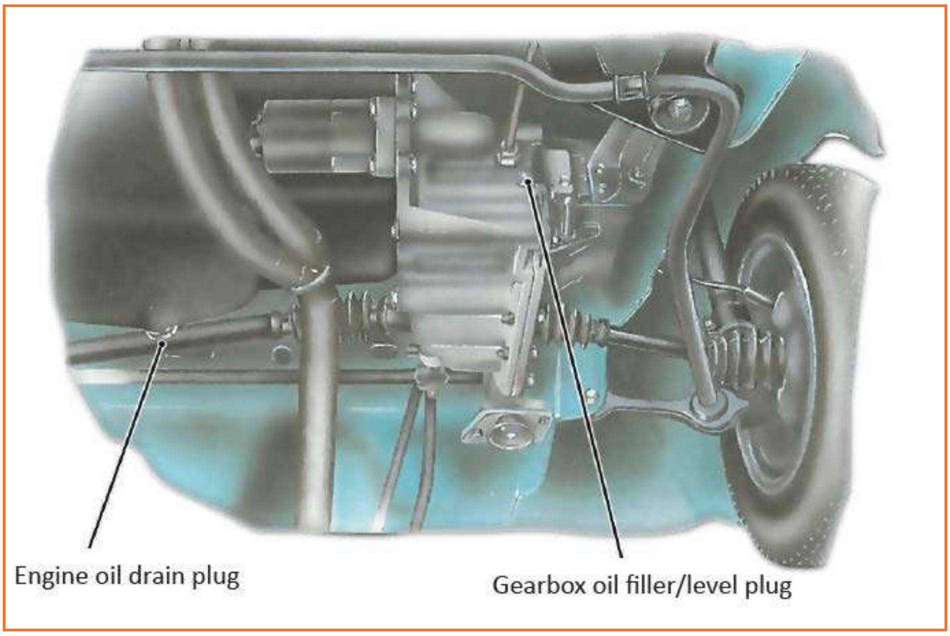


Fig 4.3.84: Layout under a transverse-engine front-wheel-drive car

In typical layout gearbox is mounted at the rear side of engine and under the floor. Instead of oil level plug some the gearbox also equipped with dipstick facility. Plug is reachable from inside. Clean the area around plug before plug removal so that entry of dirt particle inside the hole can be restricted.

The oil in the gearbox is not dropping up to 50,000 km. In case during routine oil change it is observed or top up required to maintain correct level this indicates a leakage and needs to be checked very carefully. Gearbox oil has to be changed periodically as per schedule defined by manufacturer.

Checking the gearbox for oil leaks:

- If the sealing washer of drain plug is damage it will cause leak.
- Jack up the car, chock the wheels, apply handbrake and clean road dirt from surrounding area. There is a possibility that you may not find leakage immediately.
- Drive car a few kilometres then again look thoroughly for the leakage.
- Leakage is mainly caused by oil seal, gasket or sealing washer.
- Casing damage is very rare

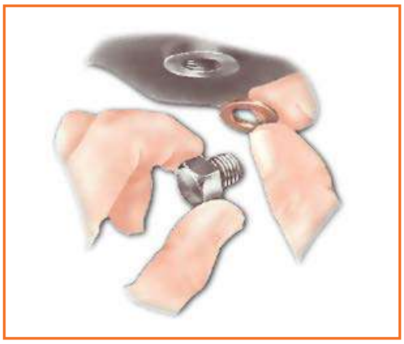


Fig 4.3.85: Draining gearbox

- Gaskets used in the plates can cause leakages, hence the inspection plates should be checked carefully.
- Use of wrong type of washer or damaged washer in filler plug also cause leakage.
- When replacing the gasket, properly clean the leftover of gasket and also necessary to avoid any scratches on metal while cleaning.

Fig 4.3.86: Draining gearbox

4.3.31 Troubleshooting of Gearbox

Problem 1: Hard gear shifting

Classification/Probable Causes	Technical Details/Remedial Actions
Bent or seized selector rods.	Replace broken/worn parts.
Clutch not disengaging.	Check clutch operation and adjust or replace as needed.
Oil, grease, foreign material over driven plate.	Clean/replace driven plate
Synchronizers or sleeves damage.	Dismantle gearbox & replace parts as required.

Problem 2 : Gear box becomes unusually hot

Classification/Probable Causes	Technical Details/Remedial Actions
Air vent port is closed.	Clean and free the air vent.
Too high ambient temperature.	Use cooling fan / move to low temperature area.
Improperly mounted bearing.	Reassemble and tighten it
Contaminated oil.	Flush interior and replace oil.
Gear box overload resulting in overheating	Reduce gearbox load and check if the temperature reduces otherwise larger gearbox may be required.
Ventilation not proper.	Ensure adequate air flow in the area and allow for cooling of the system.
Insufficient or excessive lubricating oil.	Adjust oil level.

Classification/Probable Causes	Technical Details/Remedial Actions
Oil viscosity is improper.	Change oil having the correct viscosity.
Shaft is connected improperly.	Align input shaft properly.

Problem 3 : Gear slippage or slow shifting

Classification/Probable Causes	Technical Details/Remedial Actions
Defective parts gears / synchronizers.	Replace defective gear / synchronizer.
Gear damage.	Replace gear or readjust the gear.
Low levels of transmission fluid.	Fill it with enough fluid.

Problem 4: Total clutch failure

Classification/Probable Causes	Technical Details/Remedial Actions
Vacuum line disconnected, transmission will not shift properly, when the hose connecting the transmission to the engine vacuum cracks or burns, or collapses onto itself.	Check the proper functioning of the clutch

Problem 5: Input and output shafts do not rotate at all

Classification/Probable Causes	Technical Details/Remedial Actions
Bearings worn / damaged.	Replace the bearings. (Consult authorized dealer)
Oil contaminated with foreign particles.	Foreign particles needs to be removed and oil filter has to replace by flushing interior. (Consult dealer)
Gear teeth are worn.	Need to replace gear. (Consult dealer)
Gears in locked position.	1. Replace gear if wear and tear in gearbox. 2. Remove foregion object from the gearbox if any. 3. Other wise consult your dealer.
Improper installation.	All bolts connecting motor to Gearbox should be tightened
Teeth seizure.	Replace gear. (Consult dealer)

Problem 6: Input and output shafts rotate in idle condition and output shaft is not driven when engaged

Classification/Probable Causes	Technical Details/Remedial Actions
Input shaft is broken.	Replace shaft. (Consult dealer)
Input shaft or worm teeth are damaged.	Replace shaft / worm. (Consult dealer)
Wheel boss / shaft key damaged.	Replace the wheel / key. (Consult dealer)
Wheel teeth worn.	Replace the wheel. (Consult dealer)

Problem 7: Main body has cracks or shaft is broken

Classification/Probable Causes	Technical Details/Remedial Actions
Connection is improper.	Align properly.
Gear box overloaded.	Decrease gearbox load, larger gearbox may be needed
Gear housing has lesser thickness or has cavities.	Replace gear housing (Consult dealer)
Impact load > rated load.	Reduce impact load or use a larger model.

Problem 8: Oil leaks from gearbox

Classification/Probable Causes	Technical Details/Remedial Actions
Air does not escape.	Inspect oil cap.
Cover mounting fasteners loose.	Tighten fasteners.
More quantity of oil.	Adjust oil level with mark on oil gauge.
Gear case has cavities.	Replace gear case. (Consult dealer)
Gear case has fissures.	Replace gear case. (Consult dealer)
Input and output shafts are marred.	Replace shafts. (Consult dealer)
Oil seal is defective.	Replace oil seal.
Other than normal installation directions, (horizontal oblique, upside-down etc)	Contact dealer about installation.

Problem 9: Teeth are worn

Classification/Probable Causes	Technical Details/Remedial Actions
Too high ambient temperature.	Use cooling fan / move to low temperature area.
Improper backlash.	Do reassembly with proper adjustment.
Contaminated oil.	Flush interior and replace oil after.
Excessive speed.	Reducer speed or use a different model.
Contaminated oil.	Remove particles, clean the interior and replace oil.

Problem 10 : Unusual or excessive noise

Classification/Probable Causes	Technical Details/Remedial Actions
Bearing are improperly mounted.	Adjust the bearing (Consult dealer).
Bearings are damaged or worn.	Replace worn parts (Consult dealer).
Contaminated oil.	Foreign particles should be removed oil filter has to replaced by flushing interior. (Consult dealer).
Gear box overloaded.	Reduce gearbox load, larger gearbox may be required.
Improper installation or connection.	Loose bolts should be tightened and align correctly.
Improper meshing.	Adjust properly (Consult dealer).
Input speed is too high.	Lowering the input speed may help reduce the noise.
Oil seal is not wet with oil.	Lubricate the seal.
Transfer case chain slipping.	Replace transfer chain.
Transfer case noisy, (bearings or gears)	Replace damage parts.

Problem 11 : Vibration is excessive

Classification/Probable Causes	Technical Details/Remedial Actions
Bearings worn / damaged.	Replace bearings. (Consult authorized dealer)
Oil contaminated with foreign particles.	Foreign particles should be removed and oil filter has to be replaced after flushing interior. (Consult dealer)

Classification/Probable Causes	Technical Details/Remedial Actions
Gear teeth are worn.	Need to replace wheel. (Consult dealer)
Mounting bolts are loose.	Tighten the loose bolts.
Wheel is improperly aligned.	Replace the wheel. (Consult dealer)

Table 4.3.7: Troubleshooting of gearbox

4.3.32 Propeller Shaft

Propeller shaft also called a driving shaft, transmits torque from gearbox to final drive and rotation. It connects other components of the drive train, which are not connected directly, due to distance or as they need to permit some relative movement in between them.

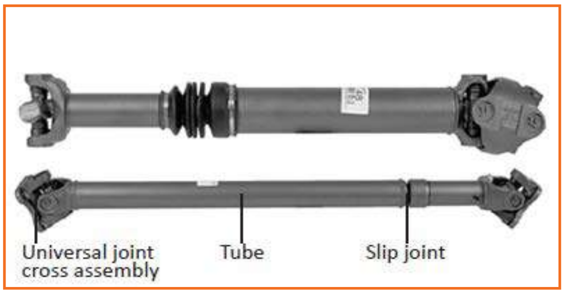


Fig 4.3.87: Propeller shaft

Propeller shaft made up of universal joint, slip joint & hollow tube. In case of commercial vehicle more than one propeller shaft is used to accommodate the distance between. They are also supported with center bearing for additional support.

Fig 4.3.88: Universal joint

Universal joint allows transmission of power between gearbox & rear axle as the rear axles are positioned at different planes in chassis.

When vehicle is in motion the distance between gear box and rear axle varies as per road condition. Slip joint is provided to accommodate variance between gearbox and rear axel.

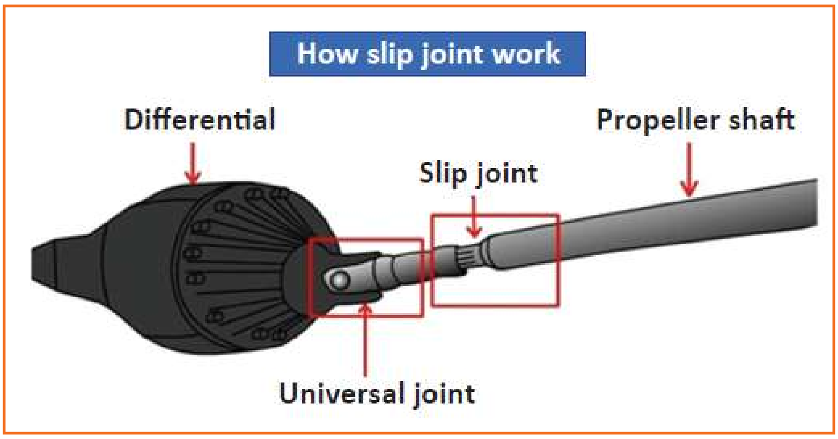


Fig 4.3.89: Slip joint working

Components in propeller shaft:

- Propeller shaft
- Universal joint consists of spider cross & yoke including four needle bearings
- Slip joint

4.3.33 Differential

A device called differential reduces the speed of the inner wheels and increase speed of outer wheels, while taking turns. It also keeps the speeds of all the wheels same, while going straight ahead. A differential consists of one input drive shaft and two outputs to the drive wheels. Drive wheels rotation coupled with roadway.

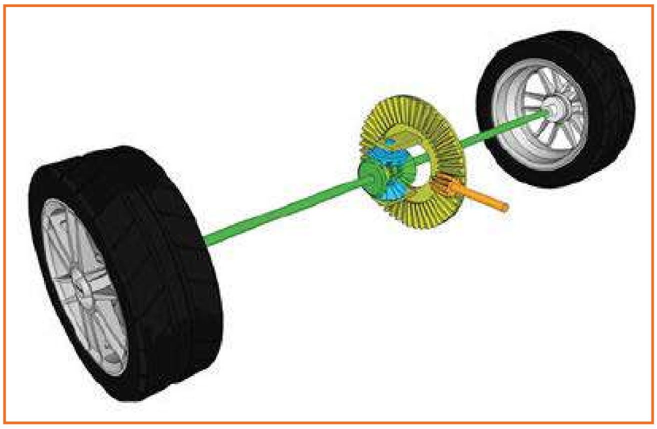


Fig 4.3.90: Differential

What does the Differential do:

A differential has 3 main purposes

1. Transmission of engine power to wheels
2. To work as the final gear reduction in the automobile and slow down the speed of the transmission, before hitting the wheels.
3. Allow wheels rotation at different speeds during turns.

How a differential works:

Crown wheel (1) gets torque (rotation) from pinion (yellow). Two bevel pinions shown in blue color (2) are supported with the help of pin fixed in the housing of crown wheel and free to rotate at pin. The drive axles (3) are fixed with the side gears shown in green color. Both side gears (green) are free to rotate independently in the differential housing.

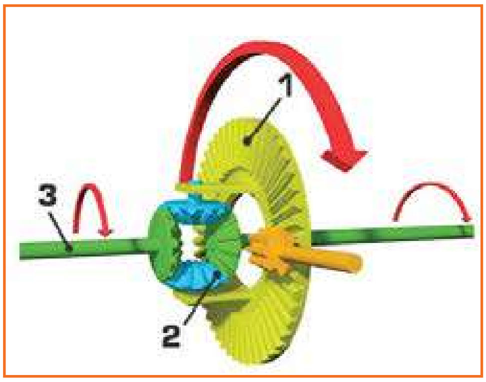


Fig 4.3.91: Differential working

When the resistance on both side gears (in case of straight drive) is equal, the pinions (2) remains stationary over the pin locking the side gears and both side gears rotate with the same speed as crown wheel housing. At the time of turning, as the inner wheel circle becomes smaller, the inner side gear experiences more resistance and the speed becomes slower than the differential housing. This causes rotation of pinions over their pins. This rotation of pinions is transferred to other side gear increasing it's speed (outer side wheel becomes faster). Therefore, when inner wheel speed becomes slower the speed of outer wheel becomes faster. This helps in turning the vehicle.

In case of front engine rear wheel drive type vehicles namely Maruti Van, Mahindra Scorpio, Tata Sumo Trucks, buses etc. the Differential receives torque (in layman's word power) from the gear box and transmit power to wheels in perpendicular direction.

In case of front engine front wheel drive vehicle namely Maruti all new models, Honda all model etc. the differential is mono block with gearbox.

Propeller shaft is not required as the power is not transmitted from the front to back wheel. This is more efficient as power loss is minimal and it is also economical since there is no need of propeller shaft.

Components of differential:

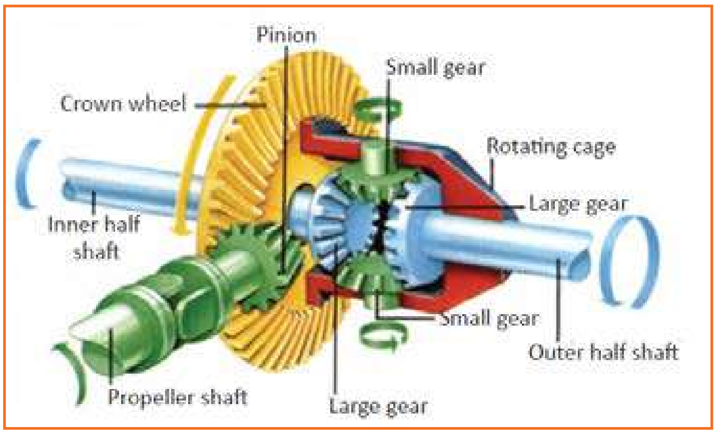


Fig 4.3.92: Differential assembly

4.3.34 Axle

- An axle is the central shaft that rotates the wheels.
- It is fixed to the wheels or its surroundings.
  - When fixed to the wheel, it rotates with the wheels.
  - In other cases, the wheels rotate around the axle.
- Various bearings or bushings are used where it is mounted to provide support where axle is fixed to the wheels.
- It has specific function in different types of vehicles.

Dead Axle:


Fig 4.3.93: Dead axle

- Dead axle is used only to support the vehicle.
- On many front-wheel-drive vehicles, a simple dead beam axle is used on rear, with the help of coil spring suspension and control arms.
- Dead axle is not independent. Wheel one side deflection is transferred to another side wheel.
- In some vehicles, U-shaped axle beam with a torsion bar mounted
- Inside is used to overcome the deflections getting transferred from one wheel to another.

Final drive:

The final drive consists of bevel pinion and crown wheel.


Fig 4.3.94: Bevel drive

Types of final drive:

- **Bevel drive:** In earlier designs the bevel pinion and crown wheel were made with straight cut teeth. Later, spiral gears found more applications to reduce the heavy noise and high wear & tear.

  The pinion, which is meshed into the crown wheel, drives it. The reduction is governed pinion teeth & crown wheel teeth.

Fig 4.3.95: Worm drive

- **Worm drive:**
  - The worm drive comprises a worm shaft worm wheel assembly.
  - The worm shaft has deeply pitched screw cut on it which meshes with the teeth on edge of the worm wheel.
  - This shaft is mounted along the top or bottom of the rear casing.

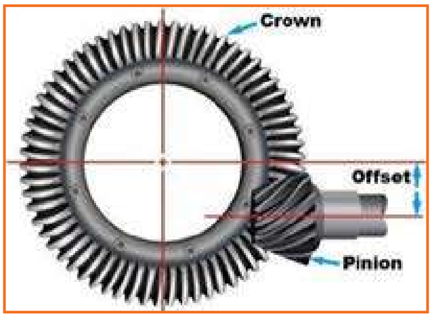


Fig 4.3.96: Hypoid drive

- **Hypoid drive:** This is a modified version of the bevel drive. The difference is that bevel pinion axis is below that of the crown wheel. This arrangement enables chassis cross member and the floor of the body to be lowered several inches without touching the propeller shaft.

Axle ratio:

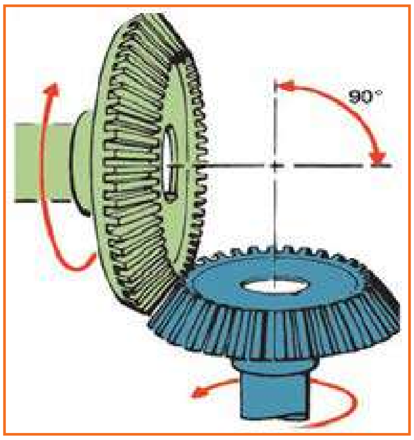


Fig 4.3.97: Axle ratio

It is the ratio between the teeth on crown wheel and the pinion wheel.

Axle Ratio = No of teeth on crown wheel / No. of teeth on pinion wheel

4.3.35 Rear Axle Leaks

Filler plug and drain plug are provided on most of the axles for filling & draining oil. Leak in rear-axle oil may easily go unnoticed, resulting in its sudden seizure, if it is running without oil. This may be very dangerous & expensive.

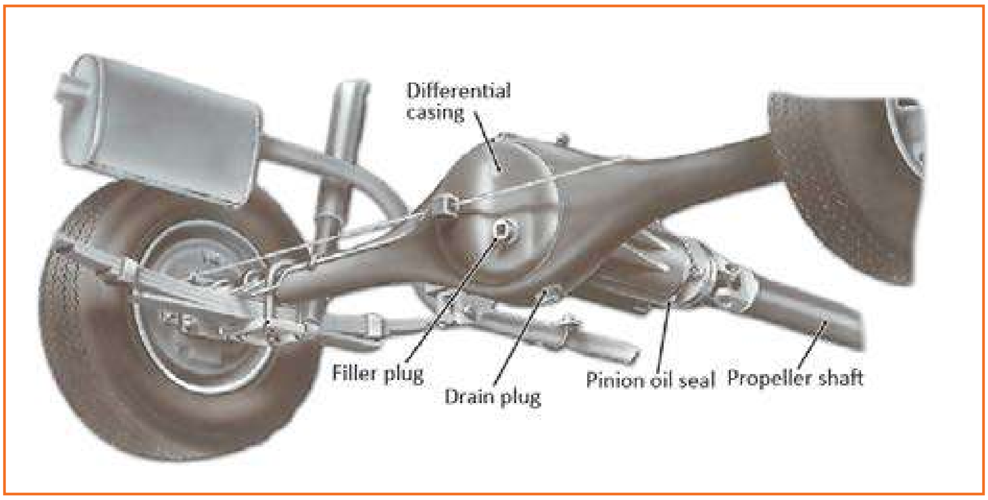


Fig 4.3.98: Parts of real axle

- Oil leakage from the axle may easily be detected by it's presence on the ground below the car. Oil leakage may be visible on inner surfaces of the wheels or on the brakes.
- Defective wheel bearings may also cause oil leakage on wheels or brakes.

- Axle oil being thick in cold conditions is unlikely to drip out of a very small opening, but it may flow easily on getting warmed up during the vehicle run. As such the drip marks may be seen on parking location after returning from a run. Oil became thick as it cools down and then dripping will stop. For any doubt ensure the leakage, paper sheet may be placed under the axle.
- As per vehicle manufacturer recommendation, axle oil should be changed periodically.
- Drain plug is not available in some of the modern cars as they are 'sealed for life' axles, not requiring any oil change. However, these axles may also leak sometimes, needing refilling and the process is done using filling plughole.

4.3.36 Checking the Half Shafts

Half shafts, also called axle shafts, are used in rear-wheel drive cars. They are relatively less troublesome during normal motoring, but considered as stressed parts.

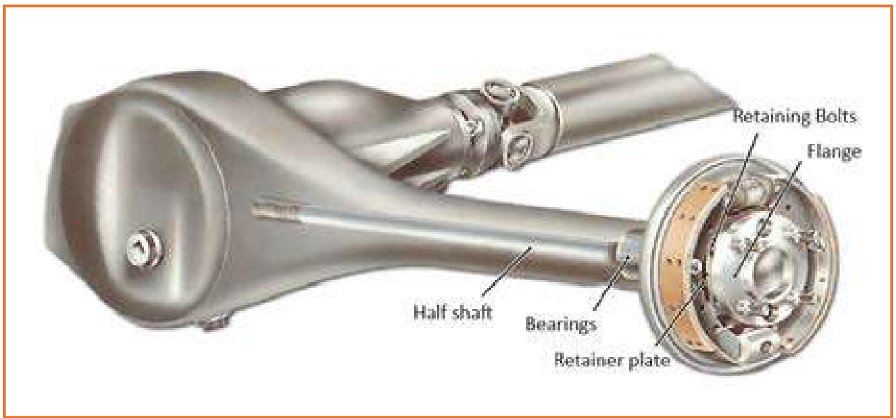


Fig 4.3.99: Half shaft check

- The half shaft has splines to fit in the differential assembly and it runs inside the axle housing.
- Axle shaft inner length is supported and driven by the differential, while the bearings between shaft and axle housing support the outer end.
- The axle bearings may have built in oil seals or separate oil seals. Ball bearings / taper roller bearings / straight roller bearings are used.
- Rear wheels cannot drive, even if one of the half shaft fails.
- A worn half shaft results in knock or clunk during acceleration or deceleration, due to wear or excessive play between differential splines and the shaft.
- Similar symptoms may also be found, in-case crown wheel and pinion, differential gears do not mesh properly, or when the drive-pinion flange splines are worn out, or the drive-flange fasteners are loose.
- Special tools in the garage can check the backlash, in pinion & crown wheel.
- Oil seal failure will result into oil leakage or seepage from axle housing and also on the brakes. The half shaft must then be removed for replacement of oil seal.

Removing the half shaft:

1. Slide hammer, a special tool, is required for removal of half shaft.
2. Remove the retainer bolts / nuts.
3. Loosen wheel nuts and jack up car while supporting the axle housing firmly on axle stands.
4. Remove the road wheel &brake drum.
5. Disconnect the brake pipe if necessary.
6. Service manual helps you decide on visual inspection.
7. Brake system bleeding must be done, if the brake pipe is disconnected.
8. After removing the drum, flange will be seen on half shaft. It may be either forged on shaft, or bolted on it.
9. Hold the shaft by a bolt on retainer behind flange or by retainer. Retainers is accessed through two large holes in most of flanges.
10. For removal of securing nuts or bolts Pass socket spanner through hole. Then connect a slide hammer to shaft flange. Then remove the shaft and bearings.
11. Bolt the slide hammer to the half shaft flange. Then remove the shaft giving steady, even strokes. Ensure retainer is not on hold, before using the slide-hammer. Bolts holding retainer plate also hold back plate. In that case, first free retainer and bolts for holding brake assembly for fitment.
12. Remove the differential pinion shaft (See) and then push in the half shaft so the C-washer retainer can be removed. Then slide and the shaft from the axle housing. If the shaft is tilting, keep it in level, to protect bearing and oil seal.
13. After firmly bolting the slide-hammer to the half-shaft flange, steadily start hammering and remove the shaft slowly.
14. Excessive force may damage the bearings. Bearings maybe reused, if removed properly without any damages.
15. Take care to withdraw tight fitting components slowly and evenly, to avoid any damages or distortions.

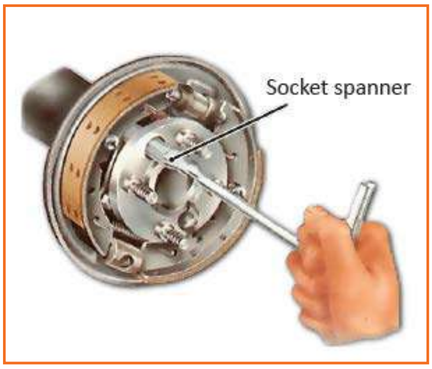


Fig 4.3.100: Removing half shaft

Fig 4.3.101: Removing half shaft

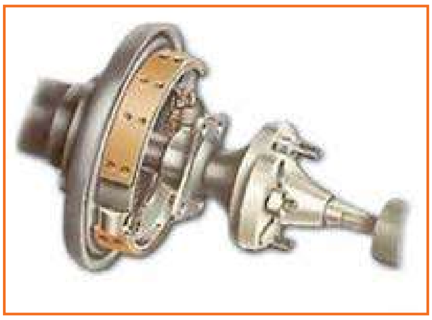


Fig 4.3.102: Removing half shaft

Inspecting shaft, bearings & oil seal:

1. Take half shaft to a workbench.
2. Check if the shaft is broken or developed cracks.
3. Carefully check the shaft for rubbing signs or 'high spots'.
4. Check for distortions, if any, with a straight-edged rule.

5. After cleaning with paraffin, check the bearings and see whether the balls and races show pitting.
6. A badly worn out bearing will not run smoothly and, in extreme cases, will give sloppy feeling.
7. After thorough cleaning, lubricate the bearing with fresh oil. Spin the bearing and listen carefully, grating sound will be clearly audible, indicating a rough running.
8. Better use new bearings, whenever shaft is disturbed.
9. Removal and replacement of being a precise operation requiring a hydraulic press, is normally done in a garage.
10. Shaft may distort, if bearings are hammered off and drifted back on.
11. Integral oil seals bearings are engaged by collar or ring, split it using chisel for removal.
12. Technical skill is required to do the job. It is better to leave it to the professionals.
13. When the seal is not integral with the bearing, as in case of some older cars, remove and replace it before refitting the half shaft.
14. After cleaning slight greasing is required on the whole shaft. Then push it gently into the axle housing till you feel the end come up against the differential side bearing splines.
15. Slightly move the shaft around until the splines get engaged. Drive it fully home with a soft face hammer against the flange centre.
16. Never hit the flange on its edges using steel hammer as it may break.
17. Reassembly flange procedure, brake drum, brake hose & wheel is reverse of removal procedure.
18. After half shafts refitting, place car on to its wheels. Check & top up rear axle oil level if necessary.

4.3.37 Tyre and Wheels

Tyres are made of rubber, and are reinforced with a synthetic fabric and steel wires

There are two kinds in popular use i.e. cross-ply and radial.

Fig 4.3.103: Types of tyre

These terms refer to the way in which the steel wires and the fabric are arranged. Although more expensive, radial tyres are `squashier' and give better road-holding, with rather longer tread life. Because of the different 'grip' of the two types of tyres, it is dangerous to mix them — you should equip your car with radial or cross-ply tyres on all the wheels.

Job of tyre is to offer a frictional interface with the road so that the drive torque can be transmitted to the road for vehicle motion. Tyre also supports the vehicle load.

Classification of tyres

Bias tyres:

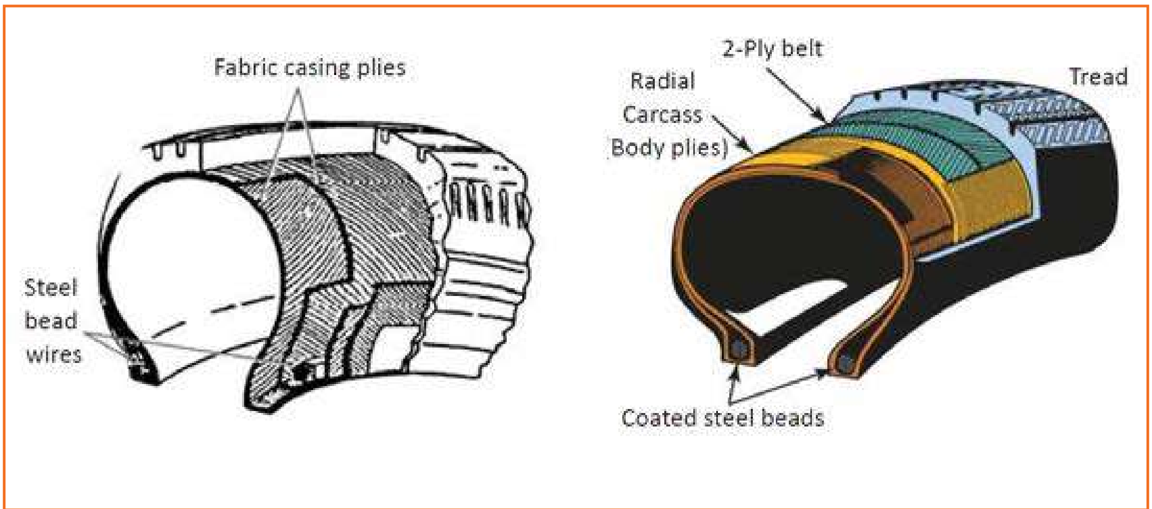


Fig 4.3.104: Tyre 1 & Tyre 2

- Few tyres have one body ply. Some has multiple plies.
- Most of the tyres have an inner tube, which has the same shape as the tyre, but is slightly smaller size.
- It is inserted in tyre & inflated to retain specified air pressure.
- They are made of air tight, impermeable materials like soft, elastic, synthetic rubber, for air leakage prevention.

Tubeless tyres:

Fig 4.3.105: Tubeless tyre

- Tubeless tyre technology is developed to enhance safety.
- In tubeless tyre, valve directly mounted on rim. Tyre and rim of the wheel, form an airtight seal.
- In case of small puncture in tubeless tire, air break out through the hole, leading to moderate deflation.

Highway tyres:

Fig 4.3.106: Highway tyre

- These are steering wheel tyres, but can be used on all wheel positions.
- These are also known as rib tyres.

Semi lug tyres:

- This is manufactured to be used in drive wheel application, but also applicable in steering wheels.

Sand road tyres:

- The more aggressive the tyre tread, the more the tyre will tend to dig down in the sand.
- Three-ply side walls generally let the tyre bag Perform a lot better than the ribbed tyres.

Fig 4.3.107: Sand road tyre

Function of tyres:

- The tyre perform job of primary suspension, Reduce rough surface effects.
- Provides for frictional contact with road surface.
- Allows driving wheels to move vehicle as required.
- Front tyres allow wheels to steer & take turns.
- Tyres allow brakes to slow down / stop vehicle.
- Grip the road thus provide for good traction
- This enables the vehicle to accelerate, brake, and steer without skidding

Construction of tyre:

- Cross ply tyres are not generally used on any mass produced modern cars.
- Details of construction helps in understanding technological development.
- Several textile plies are laid across one other.
- Size of the tyre and the load it has to carry decide the number of plies

Reading tyre specifications:

- There is important information available on tyre sidewall.
- Typically, you'll find Uniform Tyre Quality Grading (UTQG) ratings for tread wear, traction, and temperature.
- You will also find the tyre size, load index, speed rating & inflation pressure.

Types of markings:

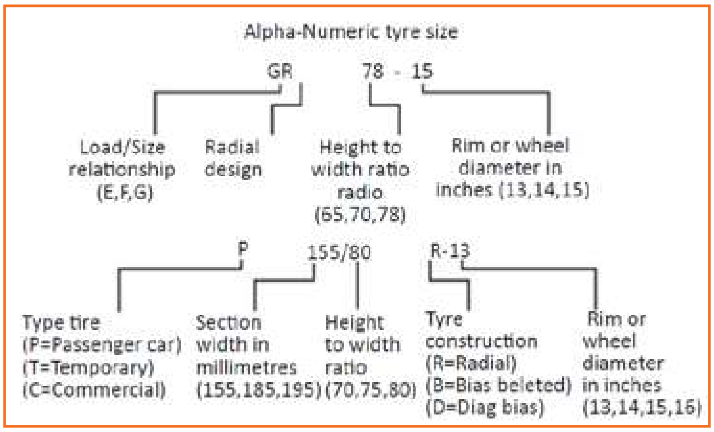


Fig 4.3.108: Tyre marking

The two types are:

- Alphanumeric (conventional measuring system)
- P-metric (metric measuring system)

Tyre inflation pressure:

- Inflated of tyres should always be to the pressure indicated on the driver's door or on pillar by sticker.
- Maximum inflation pressure is available on tyre sidewall.
- In morning before operating the vehicle check tyre pressure, especially in the winter months, as air like a gas, contracts when cooled.
- Driving increases the temperature and therefore tyres pressure also.

Tread pattern:

- The tread of the tyre is consistent touch with road surface.
- It is thick rubber / rubber composite material to provide suitable traction level having long life.
- Grooves geometrical shape, lugs & voids, characterize the tread pattern.

4.3.38 Tyre Inspection

Tyres need extensive inspection for the faults or signage indicating fault with steering or suspension systemsof vehicle.

How to read tyre wear:

- Excessive wear in the center indicates over-inflation or drive wheel heavy acceleration.
- Excessive shoulder wear results from under-inflation and/or high-speed cornering.
- Feathering will happen, if each tread rib edge develops rounded edge on either side. This happen because of depreciated bushings in front suspension.

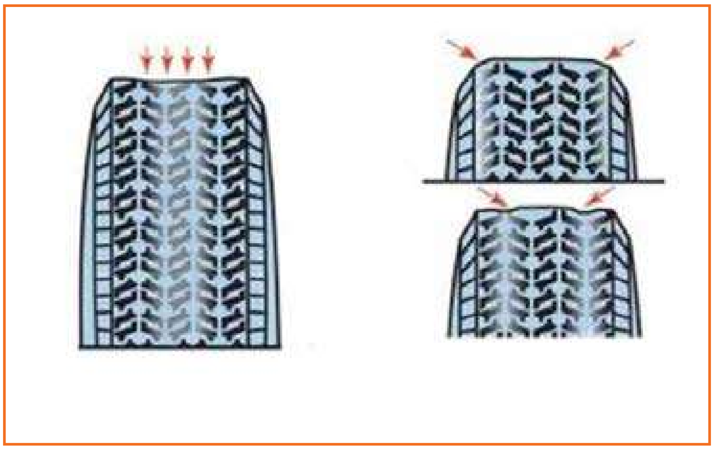


Fig 4.3.109: Tyre wear

- Alignment problem often results in one side wear pattern
- Cupping, appearance of cups in edge proximity of tread on either side, indicate worn out suspension parts.
- Second rib wear is available in radial tyres. It appears where steel belts end in relation to tread. Can be prevented by taking care pressure and frequent rotation of tyres.

The following points related to tyresare important for efficient running of the vehicle -

- tyre pressure
- tyre balancing
- tyre rotation
- tyre specification

4.3.39 Wheel

Wheels are mounted on front and rear axles. As power is supplied to either front or rear axle, axleshafts turn wheels thus vehicle moves

The wheel assembly consists of hub, rim, tyre and tube or tubeless tyre. It should be -

- able to withstand the driving and braking torque
- able to absorb road shocks
- statically and dynamically balanced
- able to grip the road surface

Fig 4.3.110: Wheels & tyres

Wheels carry the load of vehicle & transmit thetorque to the tyres.

Types of rims:

- Pressed steel disc
- Light alloy
- Wire
- divided rims, split rims

Wheel fixing on hub: Wheel studs & nuts areattached to the hub or axles flange. The tapperon wheel nut secures & centers the wheels.


Fig 4.3.111: Type of wheels

Wheel studs are usually right hand threads. If itis left hand threads, it is marked with **"L"**.

While fixing wheel applies correct torque. Nutsshould be tightened in diagonal pattern.

Wheel mounting torque:

- Ensure that wheel studs are clean and dry. They should be torqued to the manufacturer's specifications.

- Lug nuts should be tighten progressively in proper sequence. Star pattern i e first nut should be tighten then skip another and further tighten next nut.

4.3.40 Wheel and Tyre Damage Inspection

During movement of vehicle tyres are under tremendous strains:

Check for any abnormal wear patterns on the tread. Any cuts /embedded nails / stones. Check sidewalls also for cuts / cracks/abrasions / bulges.

They should transmit braking and cornering forces.

Badly worn / damaged tyres are illegal and also potentially lethal.

Inspection of tyres& wheels are recommended when they are mounted on car. For thorough examination ofinside walls, wheels should be removed, once in a year.

Fig 4.3.112: Sign of tyre wear and damage

Inspecting tyre treads and sidewalls:

- Start looking at tread for obvious tyre damage by carefully inspecting abnormal wear of flaws in pattern. Tyres ageing is normally evident from grooves abnormal widening, or tread blocks spaces. If cracks are observed, replace the tyre.
- Look for slots and cuts known as 'sipes' even it is very small. Check for stones or nails causing puncture and can also lead to internal damage.
- Debris should be removed using flat screwdriver. This may reduce chances of tyre puncture.
- Look also for any ' flats ' in tread, worn out by severe emergency braking, when the tyre gets locked & wheel slides on road, wearing off the rubber, generating a lot of heat.
- Because of fundamental problems, perhaps in the tracking or suspension and may lead to failure at high speeds.
- Bulging in the sidewalls indicates carcass damage. These tyres are not safe at high speeds, long before cords are showing through. In case of having doubt, perhaps after hitting a kerb, but cannot see any exterior evidence, let a professional technician remove the suspect tyre and check it.
- Many times, fractures are visible inside, before they are seen from outside. Any break in the carcass construction, the tyre should be replaced, as It cannot be repaired safely.

4.3.41 Troubleshooting of Tyres and Wheels

Problem 1: Abnormal and excessive or uneven tire wear

Classification / Probable Causes	Technical Details / Remedial Actions
Improper tire pressure.	Check/adjust pressure.
Infrequent tire rotation.	Rotate tires more frequently to equalize wear.
Sudden stops /starts, high speed on curves.	Improve driving habits.

Problem 2: Both Shoulders Wear

Classification / Probable Causes	Technical Details / Remedial Actions
Under-inflation.	Refer to tyre manufacturer's rating for road and inflation and inflation pressure recommended at the speeds the tyre will operate. Establish a fleet standard inflation and maintain tyre inflation to fleet standard.

Problem 3 : Centre Wear

Classification / Probable Causes	Technical Details / Remedial Actions
Improper matching of rims and tyres.	Replace either the tyres or the wheels.
Over-inflation.	Replace either the tyres or the wheels.
Tyres haven't been rotated recently.	Replace either the tyres or the wheels.

Problem 4 : Diagonal Wear

Classification / Probable Causes	Technical Details / Remedial Actions
Loose wheel bearings.	Tighten wheel bearings.
Mis - mounted Tyre / wheel assembly.	Check wheel assembly for tyre mounting on wheel / rim, proper mounting of axle.
Mismatch in duals.	Match duals by the tyre brand, size and series (differences no more than 1/4" in overall diameter).
Tread design/ tyre design.	If you have many tyres of same tyre brand try another tyre brands and design.
Under inflation.	Inflate tyres to fleet standard.

Problem 5 : Feather Edge Wear

Classification / Probable Causes	Technical Details / Remedial Actions
Bent axle beam.	Align axle perpendicular to frame rail and parallel to other axles.
Improper wheel alignment.	1. If sharp edges on both steer tyres are pointed to the centre of the vehicle, the cause is toe in. 2. If the sharp edges on both steer tyres are pointed toward the outside if the vehicle, the cause is toe out. Correct alignment
Improper wheel alignment.	If sharp edges point in on one tyre and out on the other tyre, the cause is rear axle misalignment. Correct alignment
Under inflation.	If only one of steering tyres has feather edge wear, the cause may be combination of incorrect toe / rear axle misalignment. Correct both.

Problem 6 : Flip flop wheel shimmy

Classification / Probable Causes	Technical Details / Remedial Actions
Low or uneven tire pressure.	Check tire inflation.
One or more wheels out of balance.	Have wheels balanced.
Uneven or excessive tire wear.	Inspect tires and replace in pairs.
Vehicle out of alignment.	Check and adjust wheel alignment.
Worn steering components.	Inspect tie rods / steering rack for excessive play and repair if required.

Problem 7 : One Sided Wear

Classification / Probable Causes	Technical Details / Remedial Actions
Improper wheel alignment (especially camber).	1. If one sided wear is on the inside of one steering tyre and the outside of the other steering Tyre, the cause may be rear axle misalignment. Correct it. alignment. 2. If one-sided wear is on the outside of both steer tyres, the cause is either toe in or 3. Camber. Check both and correct. If one sided wear is on inside of both steering tires, cause may be either toe out. camber / overloaded axles. Check and correct toe / camber settings. Check load specifications on the axle and avoid over loading above specs.

Problem 8: One Spot (Brake Skid) Wear

Classification / Probable Causes	Technical Details / Remedial Actions
Brake lock due to malfunction / unbalanced brake system aggressive brake application.	**Look for scratches / directional abrasion in and near flat spot:** 1. If you find them, the flat spot is due to brake lock. Check the dual tyres on the opposite 2. End of the axle. If they don't have similar flat spots, only one brake locked, this indicates a single brake problem.Correct the brake problem.

Problem 9: The car front end vibrates at high speeds and the steering wheel shake

Classification / Probable Causes	Technical Details / Remedial Actions
Front end needs aligning.	Have front end alignment checked.
Wheels out of balance.	Have wheels balanced.

Problem 10 : The car pulls to one side while moving

Classification / Probable Causes	Technical Details / Remedial Actions
Front end needs proper aligning.	Check & correct front end alignment.
Mismatch in tires.	Ensure tires are of same type / size.

Classification / Probable Causes	Technical Details / Remedial Actions
Steering components bad.	Inspect tie rods and steering rack.
The car’s tires are not worn evenly.	Replace tires as required.
Unequal tire pressure (car will usually pull to the low side)	Check/adjust tire pressure

Problem 11: Tire squeals

Classification / Probable Causes	Technical Details / Remedial Actions
Front end needs aligning.	Have front end alignment checked.
Improper tire pressure.	Check/adjust tire pressure.

Problem 12: Vibration when you hit a bump

Classification / Probable Causes	Technical Details / Remedial Actions
Broken or slipped leaf spring.	Inspect leaf springs and repair or replace as needed.
Worn shocks or struts.	Replace shocks and/or struts.

Table 4.3.8: Troubleshooting of tyre and wheels

4.3.42 Suspension System

Frame and body of automobile are placed on the front & rear axle through springs and shock absorbers. The assembly of parts which isolate the automobile body parts from the road shocks like bounces, pitches and rolls, is called suspension system.

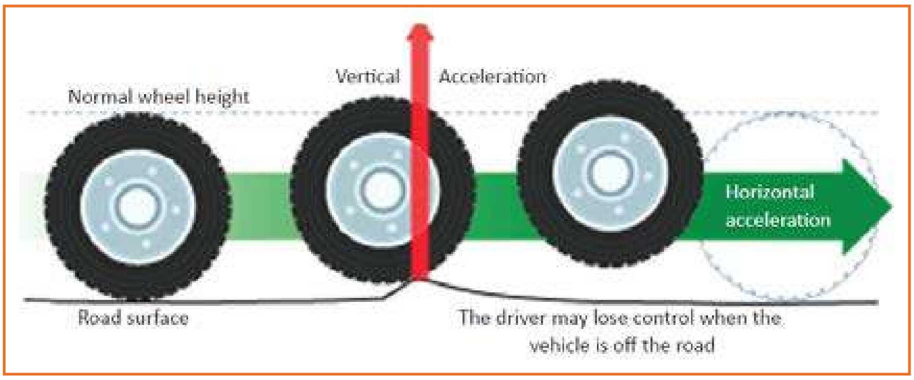


Fig 4.3.113: Need of suspension

Why do we need suspension?

We would not need the suspension if the roads were perfect. But the roads are bumpy and this is how a vehicle would drive without suspension.

What is suspension?

- Vehicle suspension system keeps the tyres on the road and to provide acceptable riding comfort.
- Without proper suspension, vehicle having hard structure would bounce on the ground when the tyres hit a bump.
- The driver may lose control on the vehicle when the tyres are off the ground.

Suspension system – Functions

- Prevent vehicle body & frame from road shocks
- Give stability to vehicle
- Safeguard passengers & goods from road shocks
- Give the good road holding while driving, cornering and braking
- Give cushioning effect
- Provide comfort

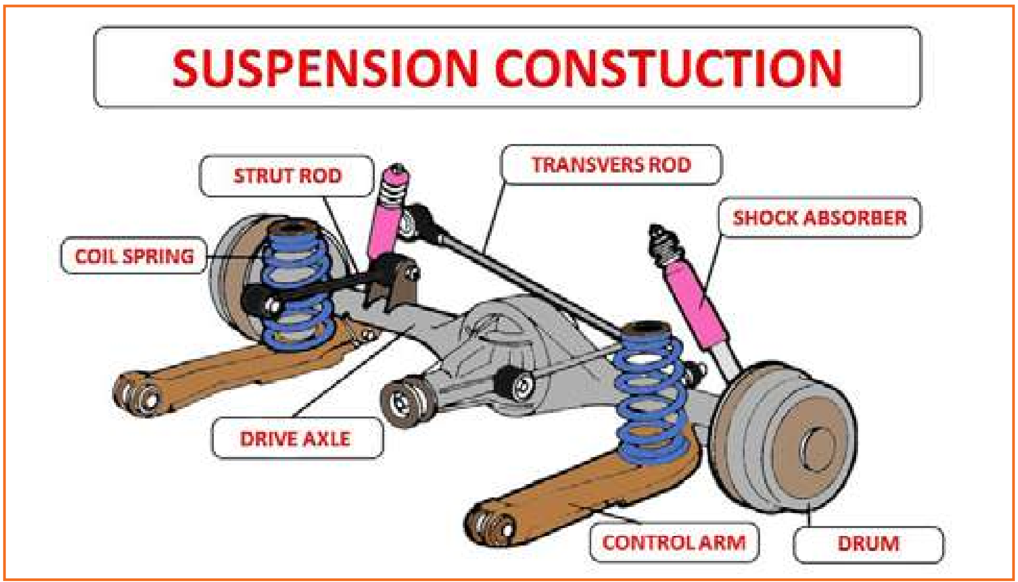


Fig 4.3.114: Parts of suspension system

Working principle:

The wheels are supported by spindle, attached to control arm with ball joints. The control arm attached to frame of vehicle through rubber bushings to help control the NVH i.e. noise, vibrations and harshness of the vehicle.

Requirements of suspension system

- Minimum deflection
- Low initial cost
- Minimum weight
- Low maintenance and operating cost
- Minimum tyre wear

Components of suspension system

- **Struts:** Strut is sturdy shock absorber which is structural component of suspension mechanism. It acts as a suspension link & a shock absorber. Therefore, it's casing must be strong and rigid. The shock absorber is assembled inside strut casing.

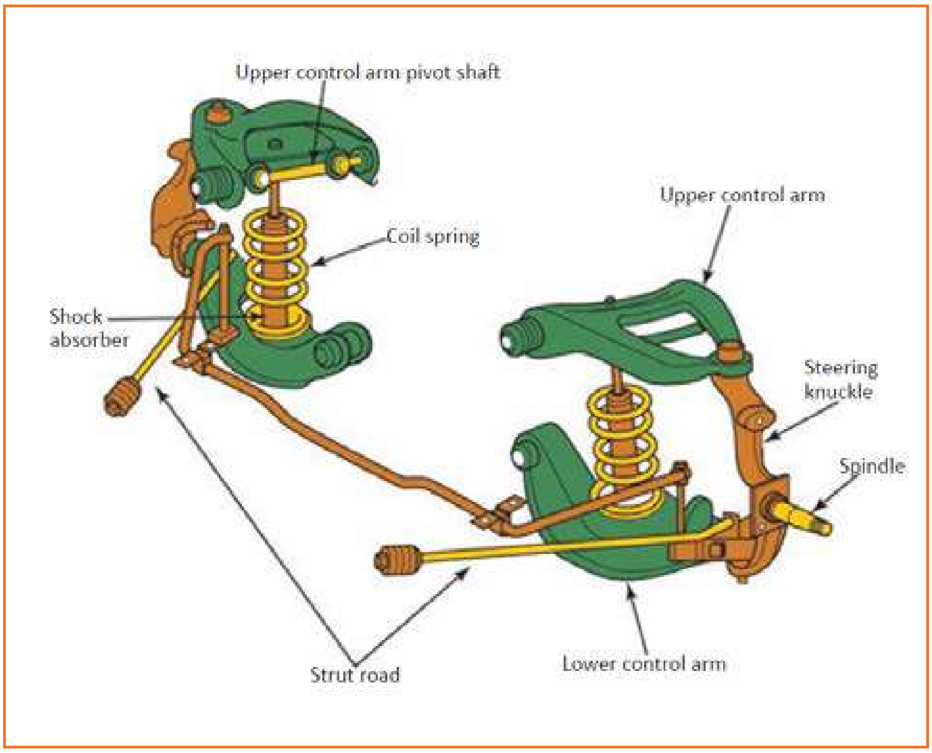


Fig 4.3.115: Strut Rods

Longitudinal support to the suspension to avoid forward or rearward movement of control arms is provided by strut rods.

- **Springs:** Each wheel is mounted with springs, which help to absorb shocks on the road as the vehicle moves on a rough surface.

Types of springs:

– **Coil Spring:** The wheel and arm act as a lever to compress the coil spring. The spring cushion helps isolate noise and vibration from being transferred to the passenger compartment.

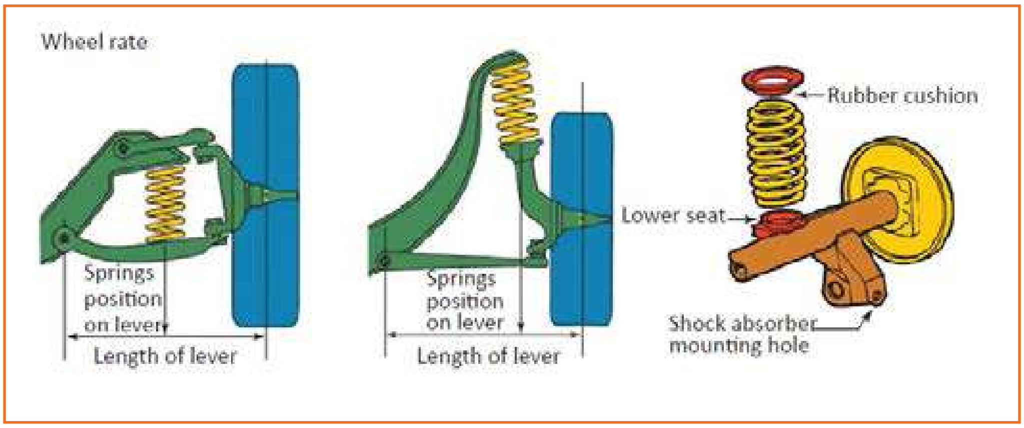


Fig 4.3.116: Coil spring

– **Leaf spring:** Narrow spring steel strip is used in the construction of leaf springs. These metal strips are called leaves. They are assembled using plastic or synthetic rubber insulators. They allow movement freedom through spring operation.

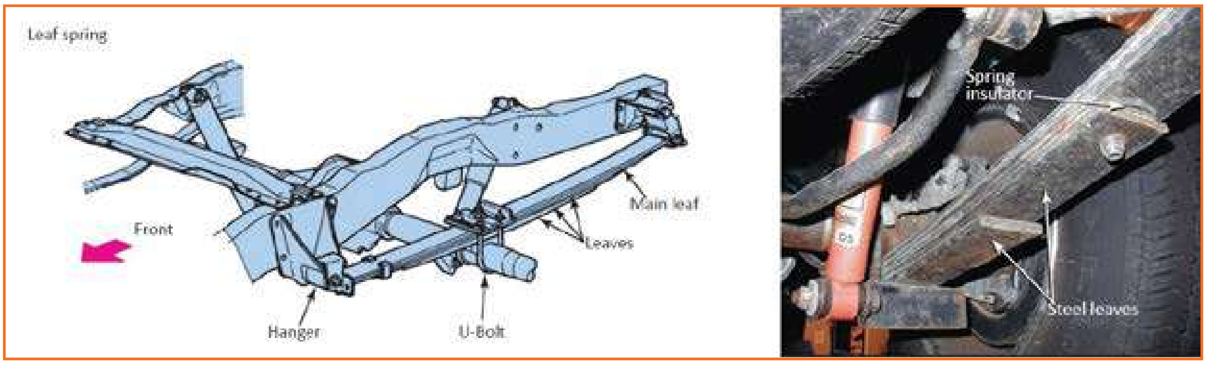


Fig 4.3.117: Leaf spring

A typical leaf spring installation has the longest leaf, called the main leaf, which s attached to the frame through a shackle and a hanger.

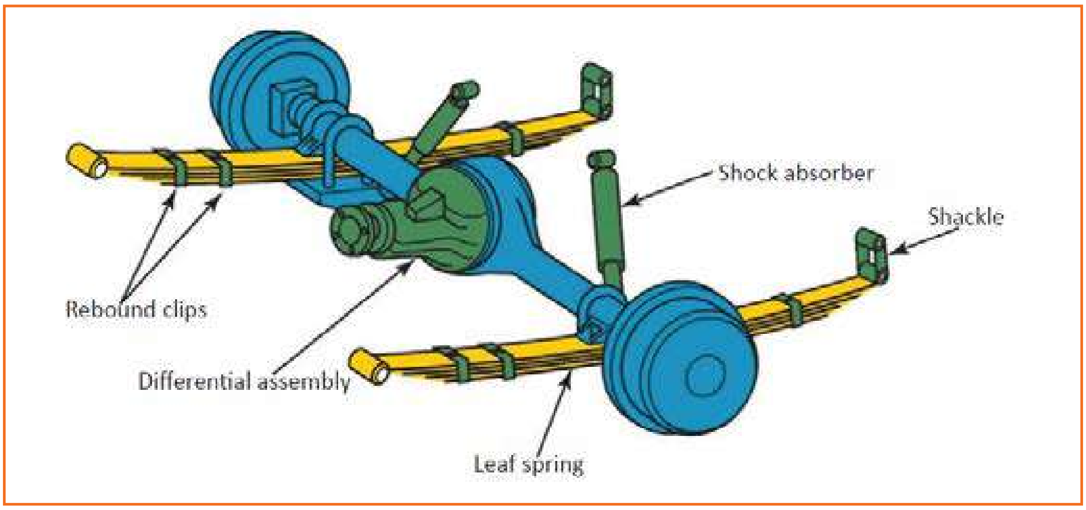


Fig 4.3.118: Typical rear leaf-spring suspension of a rear-wheel-drive vehicle

– **Torsion bar:** A torsion bar made hardened alloy steel acts like a coil spring. Longitudinal torsion bar is attached at the lower control arm at the front and at the frame at the rear of the bar.

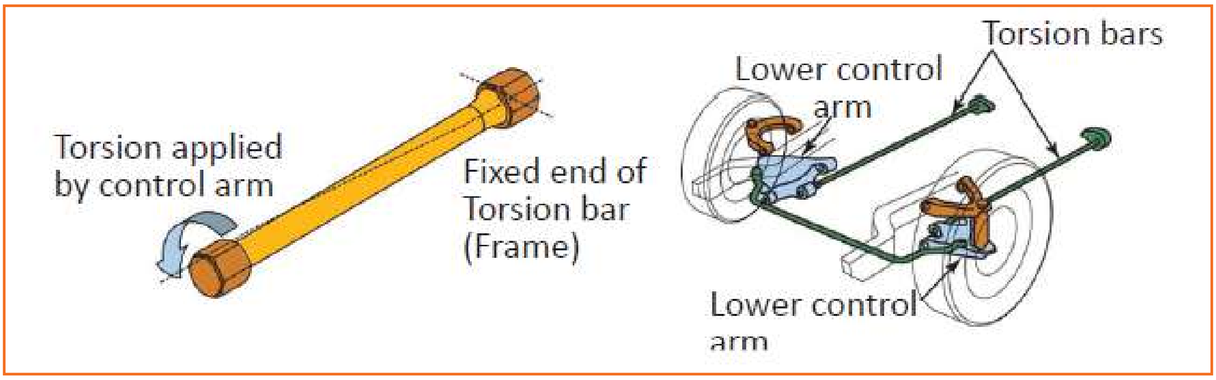


Fig 4.3.119: Torsion bar

- **Steering knuckle: It serves two purposes:**
  1. To join suspension with wheel
  2. To act as pivot point between suspension
- **Control arm:** Control arm serves as connection between knuckle / wheel flange and frame.

  Steering knuckle to Frame or body of the vehicle is connected by it, providing structural support for suspension system.

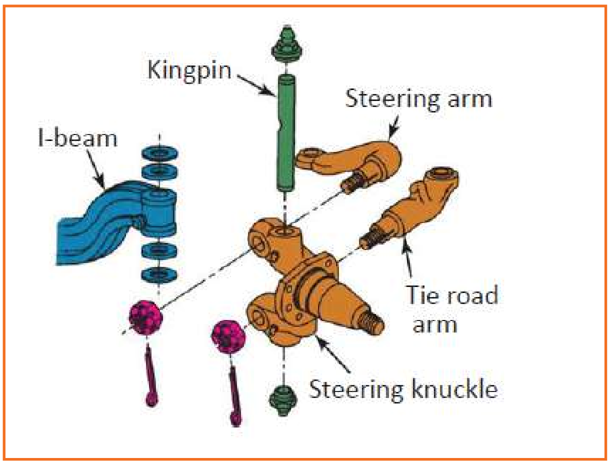


Fig 4.3.120: Steering knuckle

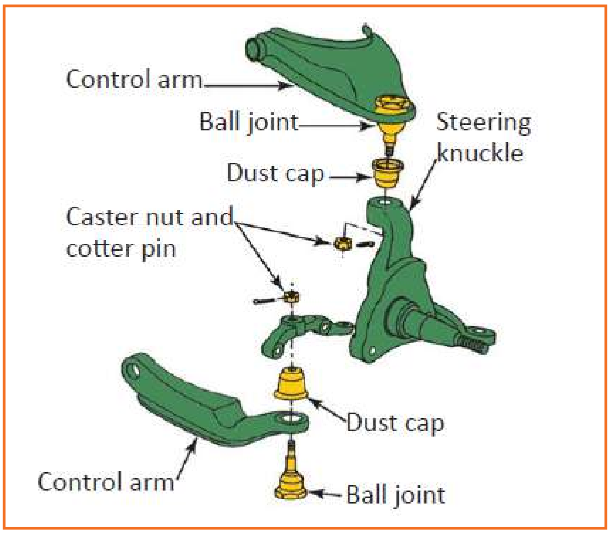


Fig 4.3.121: Control arm

- **Strut rod:** Strut rods are round steel upper control arm rods attached one end at lower control arm and on another end frame of the vehicle with rubber bushings. They provide support to the control arms.

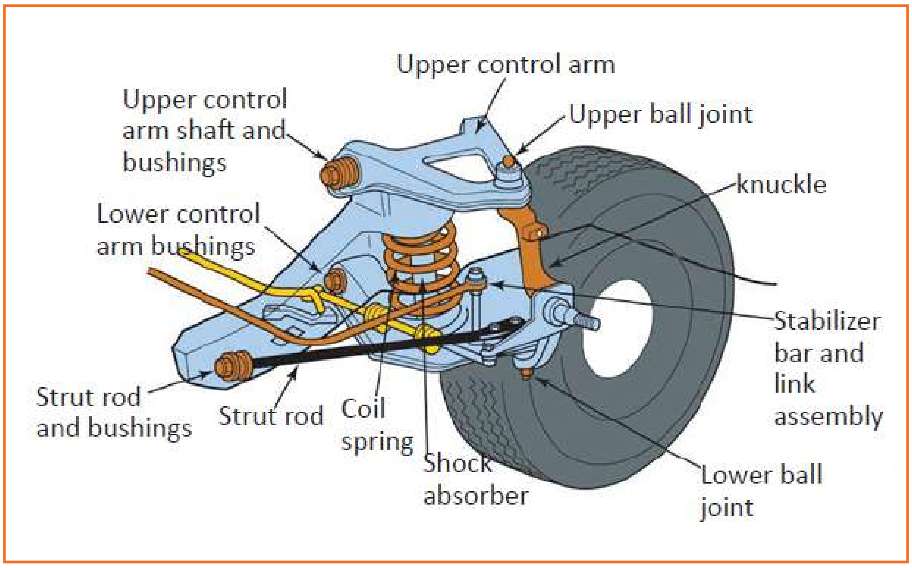


Fig 4.3.122: Strut rod

- **Stabilizer bars:** In the front suspension, this is a round bar of hardened steel.

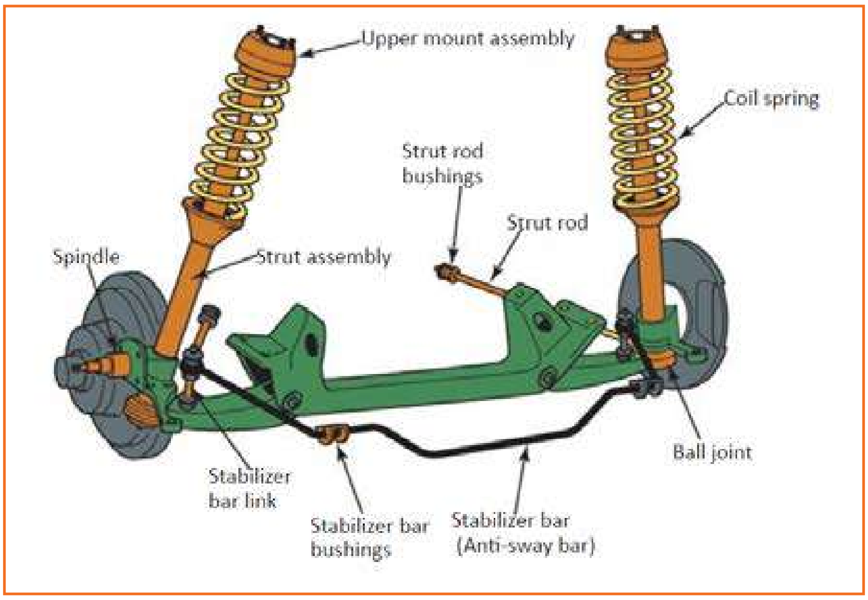


Fig 4.3.123: Stabilizer bars

Stabilizer bar takes twists, during leaning of vehicle body.

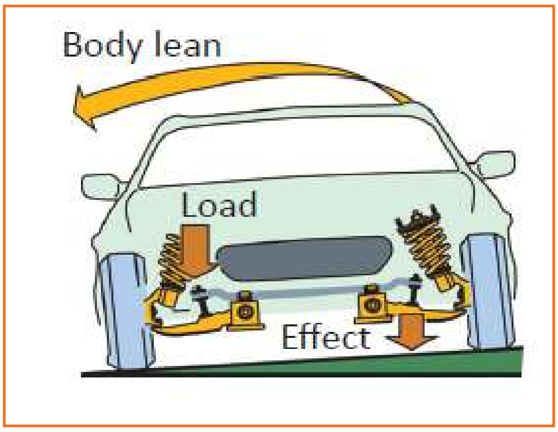


Fig 4.3.124: Working of stabilizer bars

- **Shock absorbers:** If there were no shock absorbers (dampers), after hitting bumps, vehicle will bounce and oscillation may be created. Shock absorbers reduce the speed of bouncing and dampen the oscillations. It works best when mounted close to the spring.
  - Strut is a structural component of the suspension. It work like shock absorber.
  - The casing of the strut is strong & rigid and acts like as a suspension link.

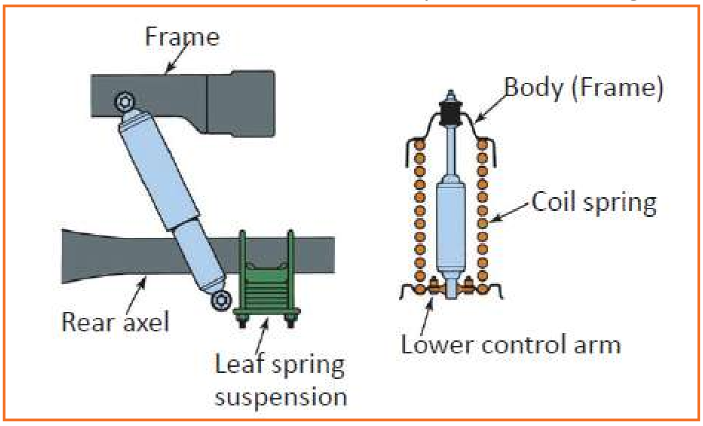


Fig 4.3.125: Shock absorbers

- Shock absorber assembly inside Strut casing may be detachable cartridge or an essential part of strut.
- When a vehicle hits road bump, the suspension moves upward resulting in compression or jounce. During rebound the spring (coil, torsion bar, or leaf) returns back to its position.

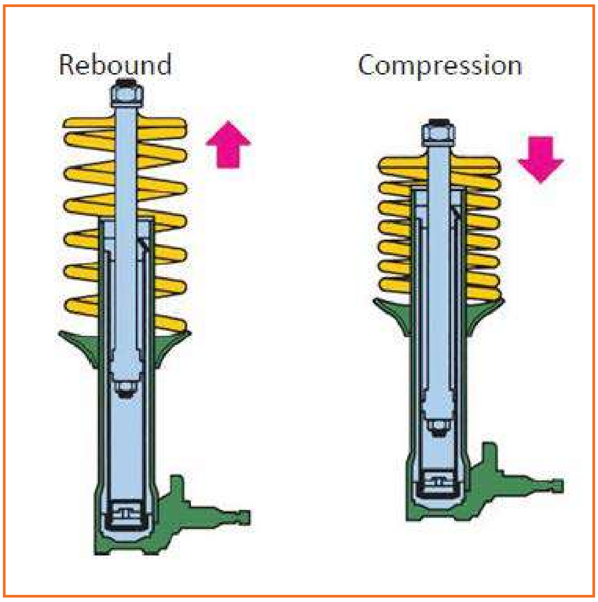


Fig 4.3.126: Working of shock absorbers

Types of suspensions

There are several kind of suspension systems available in the market to make riding in vehicle safer and more comfortable. In most cars, independent front suspension systems have each of the front wheels, attached separately so that it can work independently. Some vehicles may have independent rear suspensions. Thus, we also have four-wheel independent suspension in some cars. Older rear-wheel drive vehicles and many of today's trucks have a dependent type of rear suspension that has the rear drive-axle assembly. Traditionally, double-wishbone suspensions and strut suspensions have been the most common suspension systems found on consumer vehicles, but air suspensions are becoming more popular, and electromagnetic suspensions are coming into play.

Types of suspension:

1. **Independent type suspension**
   a. Independent Front Suspension
   b. Multi-link suspension
   c. Trailing-arm suspension
   d. Independent Rear Suspension
2. **Rigid suspension**
   a. Solid Axle, Leaf Spring
   b. Solid Axle, Coil Spring

Independent suspension:

Most vehicles today use a separate control-arm-type of suspension for each front wheel, which allows movement of one front wheel without affecting the other.

A typical independent front suspension used on a rear-wheel-drive vehicle. Each wheel can hit a bump or hole in the road independently without affecting the opposite wheel.

Independent suspension types: There are two types of independent suspensions:

1. **Independent Front Suspension (IFS)**
2. **Independent Rear Suspension (IRS)**

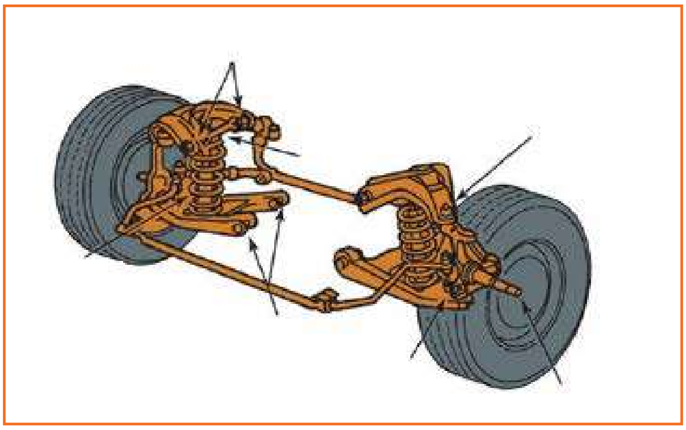


Fig 4.3.127: Independent suspension system

Rigid suspension

There are two types of suspensions:

1. Mcpherson Suspension System
2. Leaf Spring Suspension System

Mcpherson Suspension System

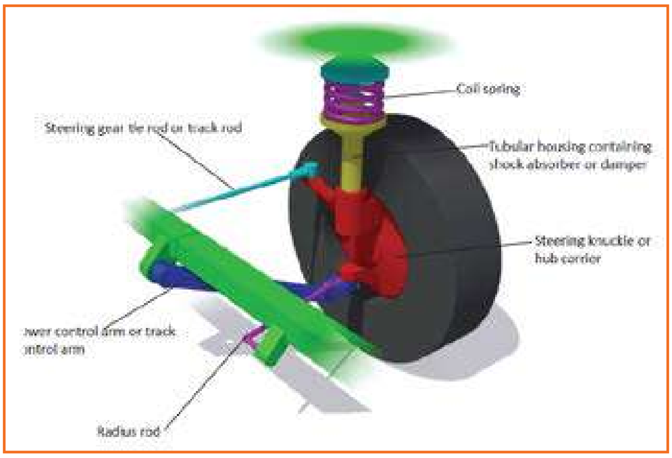


Fig 4.3.128: Mcpherson strut system

Modern vehicles are extensively using McPherson in the front suspension.

McPherson strut consists of a wishbone. It offer bottom mounting point for axle of wheel. Lower arm provides lateral & longitudinal location of wheel. Upper part of hub is firmly fixed to inner part of strut.

Outer part extends upwards directly for body mounting.

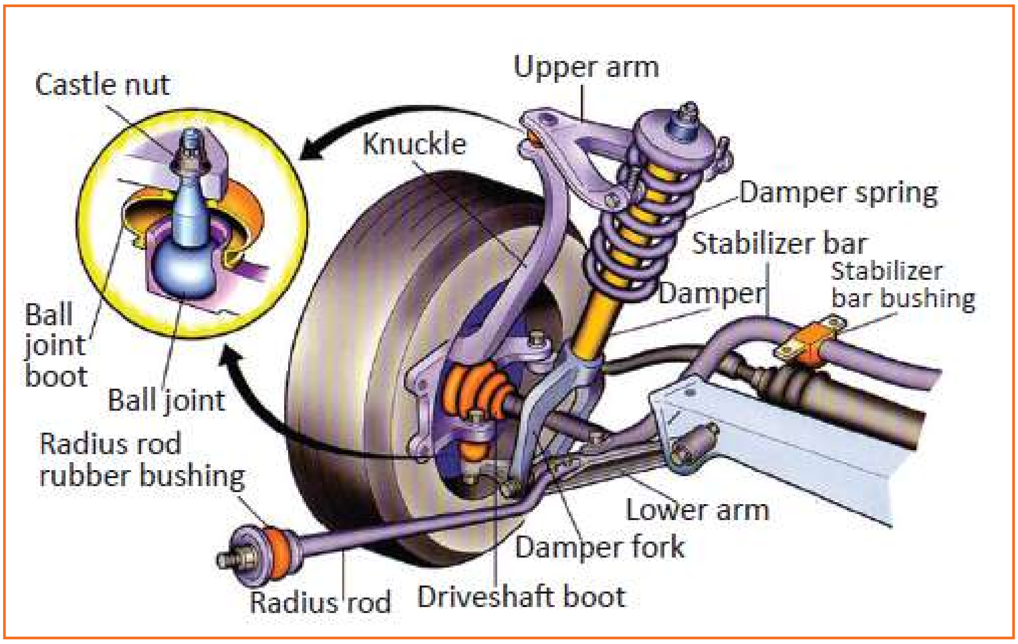


Fig 4.3.129: Mcpherson strut system

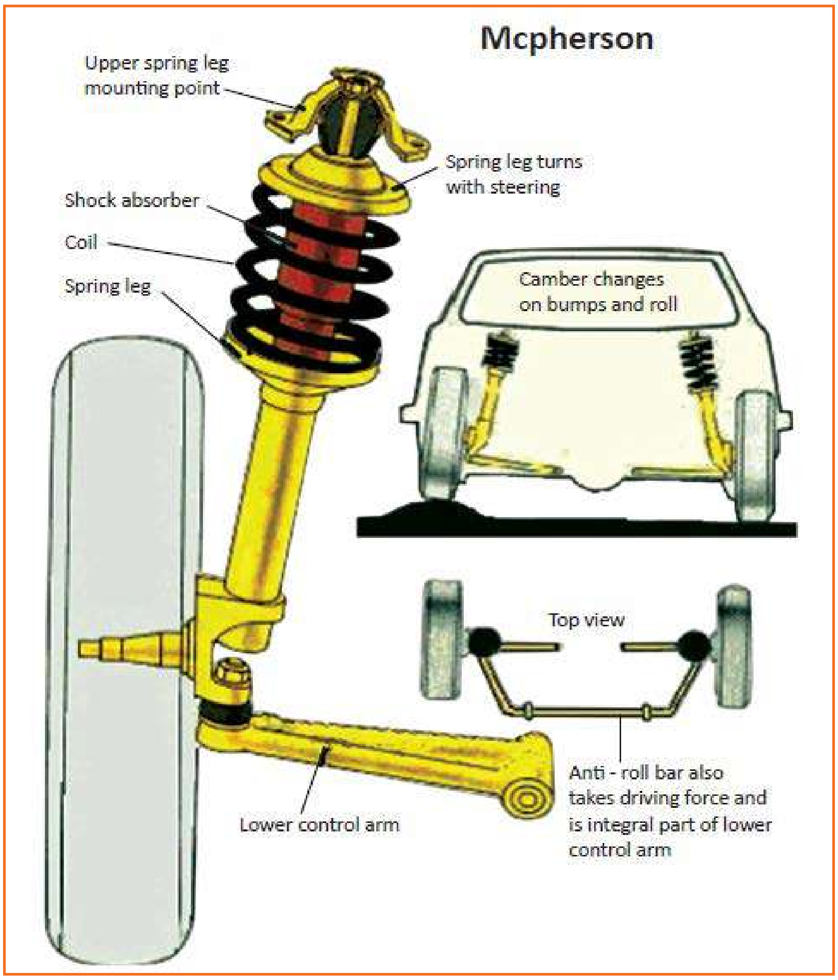


Fig 4.3.130: Mcpherson Strut System

Due to simplicity & low manufacturing cost, MacPherson strut is generally used on high performance cars. However, quality of ride & handling of the car are some of it's disadvantages.

Vertical movement of wheel is associated with some degree of change in camber angle, sideways movement, or both.

It also tends to transmit noise, vibration & harshness from the road directly into the body shell, giving higher NVH levels

Leaf-Spring suspensions:

Leaf spring consists of steel plates leaf

- Heavy / medium duty trucks today use leaf spring manufactured from hardened spring steel.
- The Spring steel used is an alloy steel toughened through heat treatment.
- This provides for a leaf spring plate having capacity to bend without deformation.
- Leaf springs may have single or multiple leaves clamped with each other called spring pack

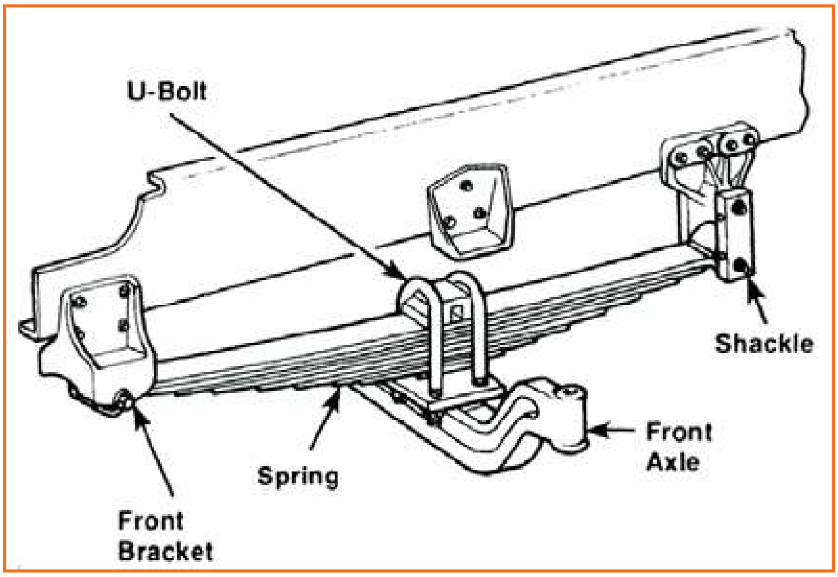


Fig 4.3.131: Spring pack

Spring pack principle:

- Self-Dampening
  - Multiple leaves clamped together, instead of a single metal piece cut to the same shape, are used for better dampening characteristics under shock loads.
- Friction between leaves
  - Friction between leaves also provides for self-dampening of spring pack. Due these two properties dampening properties is retained.
  - The individual leaves must never be lubricated or painted during assembly of spring pack because this will reduce friction between interleaf.
  - The centre bolt clamping leaves is very significant. In the event of breakage of the centre bolt, self-dampening characteristics of spring pack are gone.

Types of leaf spring assemblies:

- Constant rate
  - Leaf spring assemblies having a constant rate of deflection.
- Variable rate
  - Variable deflection rate of leaf-type spring assemblies is obtained by varying the spring assembly length.

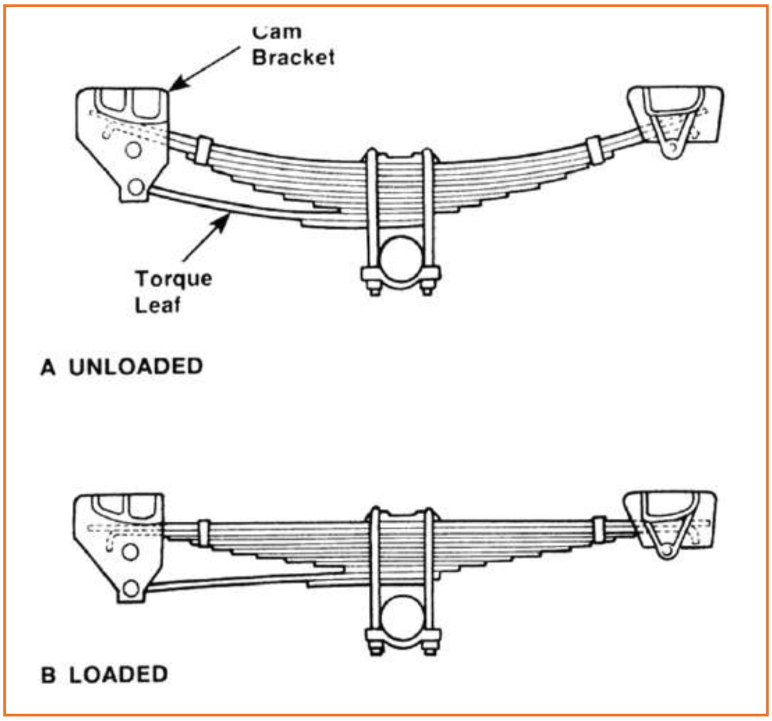


Fig 4.3.132: Progressive spring operation

Leaf Spring - Main functions

- Reduce wheel wobbling
- Provide more space for accommodating engine.
- Simple and strong design ideal for commercial vehicles

Types of shock absorbers: There are various type of shock absorbers that O.E. manufacturers use today. The most common types are-

- Twin-tube
- Gas-charged
- Position Sensitive Damping-Used in very high end cars
- Acceleration Sensitive Damping- Used in very high end cars
- Mono-Tube.

4.3.43 Steering System

A steering system is used to give the driver a mechanical advantage that provides control of the of front wheels position, as road bumps or other forces act against them. This permits the car to be steered and turn to the left or the right, while maneuvering around the curves and corners of roads and streets.

Steering wheel is important component of the steering system, which is operated by driver. Steering system responds based on the input given by drive. Steering system may be direct mechanical contact, as in case re-circulating ball or rack & pinion steering gears. It may be with / without support of hydraulic power steering (HPS). Some modern cars also have Electric Power Steering (EPS).

Collapsible steering column is the major safety concern in modern cars. It collapses if driver is thrown next to the wheel during collision.

Function: Steering system is used for changing vehicle direction desired by the driver. Steering system converts steering Wheel rotary motion into angular motion in order to turn the front wheels which in turn controls the rear wheels.

Working principle:

- The steering wheel motion is conveyed to steering gear and to the cross shaft.
- The drop arm joins the cross shaft to the drag link. So, drop arm moves drag link which then turns the right side steering arm leading the stub axle to move about its king pin.
- This movement is also carried to left side steering arm through tie rod this joins other side steering arm and stub axle.
- This causes front wheels to turn in similar direction.

Types of Steering:

a. Manual Steering System
   - This type uses driver's muscular energy directly at the steering wheel of the vehicle.

b. Steering system assisted by power or power assisted steering.
   - This type aids driver by providing external power assistance. So, the driver uses less effort in operating steering wheel.
   - In the instance of failure of source of power, the steering system works as manual steering.

Power sources for steering:

- **Hydraulic power:** This is the hydraulic pressure generated by a power steering pumps which are driven by the engine.
- **Electronic power steering (EPS):** It functions as the ordinary power steering as well as controls the hydraulic pressure.

Fig 4.3.133: Steering wheel

4.3.44 Components of Steering System

Steering wheel

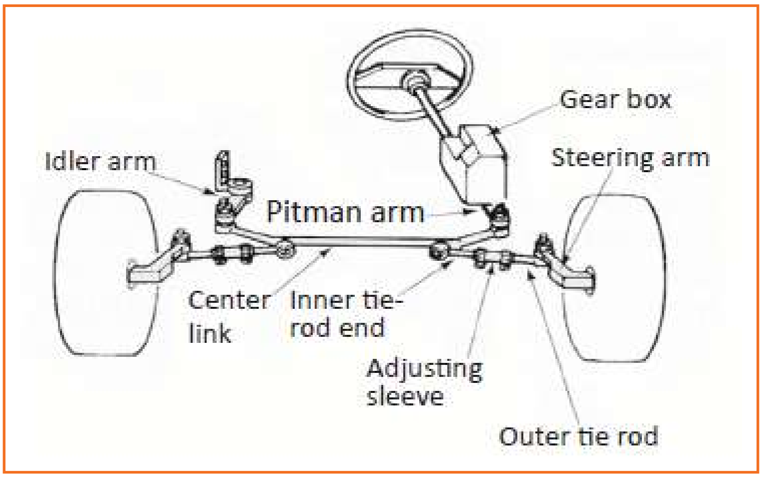


Fig 4.3.134: Components of steering system

- The driver controls vehicle direction using Steering wheel.
- It is made-up of a rigid round rim and a number of spokes connecting the rim to a centre hub.
- It is attached to top portion of steering shaft at its centre.
- This rim helps the driver get a tight grip on steering wheel. The wheel's central hub is bored. It is either splined or fitted with a key-way to get secured to steering shaft top end, called the inner column.

Steering wheel column

- A vehicle's steering column provides connection between steering wheel & steering mechanism.
- Assist driver to manage the height adjustment as per personal convenience.
- Rotary movement of steering wheel is transmitted through steering column to steering gear.
- The column jacket that encases shaft is attached to vehicle body and it offers a stationary mounting point for multiple switches and mechanisms.
- Steering column supports steering shaft. Steering shaft passes through the Steering column.

Fig 4.3.135: Steering column

Parts of the steering column:

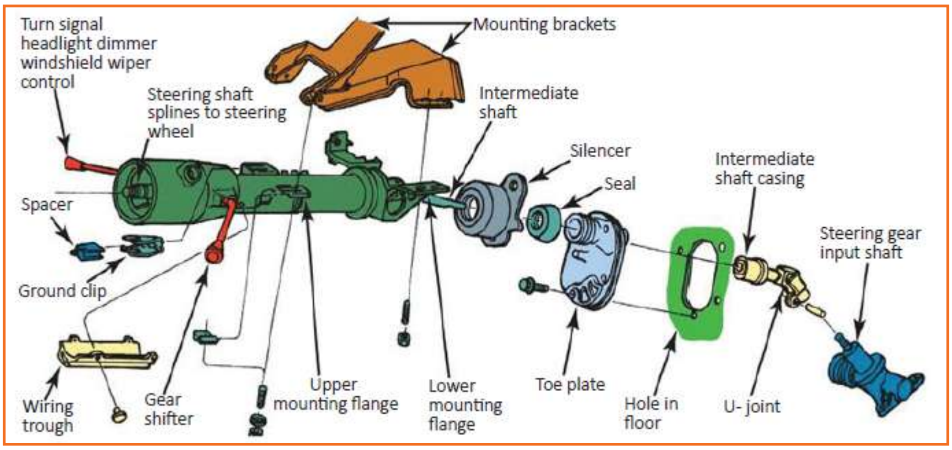


Fig 4.3.136: Components of steering column

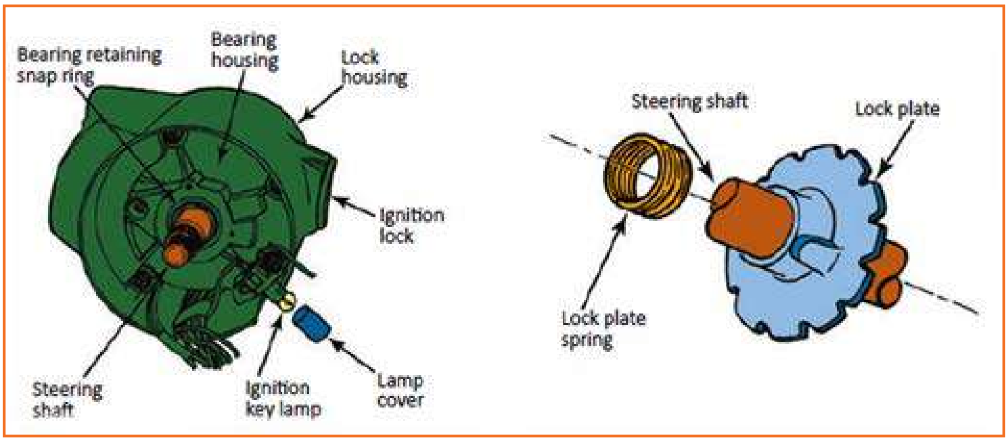


Fig 4.3.137: Upper section of steering column & lock plate

Top portion of steering column have bearing.

The lock plate engages an ignition lock pawl to keep steering wheel in one position during on state of ignition.

Inner and outer column:

a. **Outer steering column**

- A tube within which the inner column can rotate.
- At (or near) its top end is internal bearing or bush.
- The lower end is fitted on to the steering box.

b. **Inner steering column**

- The outer column carries bushes or bearing.
- The top end protrudes from the outer column. It is serrated, splined or fitted with key or key-way to connect to the steering wheel.
- The lower end is fitted with a worm and thread, and the worm is often brazed to the column.

Steering gearbox

- Steering gearbox is mounted on the chassis.
- It contains steering gears, steering cross-shaft, and acts as the container for storing the lubricant.

Steering cross or rocker shaft:

- One of the various forms of gearing converts rotary motion of the inner column to turning motion of the steering rocker or cross shaft.
- The shaft stretches beyond the steering box and contains the steering drop arm.

Drop arm:

- Drop arm is made of tough steel forging which is bored at either or both ends.
- The bore of larger ending is fitted on cross shaft, for which this bore is internally splined or keyed.
- The smaller end is connected with the ball joint which joins the drop arm to the drag link or pull and push rod.

Fig 4.3.138: Drop arm

Universal joint

- Intermediate shaft both ends are attached to universal joint which is fitted between inner column and steering gear box.
- Universal joint works towards transferring the motion at different angles.

Fig 4.3.139: Universal joint

Center Link / Drag Link / Relay Rod / Track rod – Steel Bar Connecting the Right & Left side steering linkages and connects to the Pitman arm, tie rod ends and idler arm

Side of the Steering Linkages

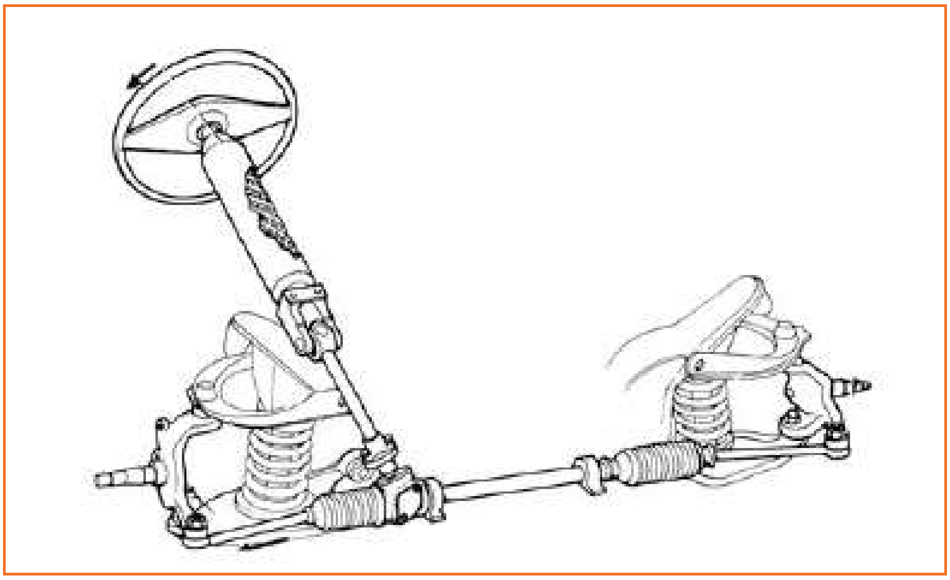


Fig 4.3.140: Steering linkages

Tie Rod Assembly – Two tie rod assemblies are used to fasten the center link to the steering knuckles.

Fig 4.3.141: Tie rod assembly

Ball Joint – Allows suspension movement up & down as well as turning of the wheel.

Fig 4.3.142: Ball joint

Steering gears:

- Input gear in the steering gears pass on rotary movement from steering wheel into steering gear. Output gear makes steering linkage move laterally.
- Steering wheel rotation is transferred to front wheels through steering gear and linkages.
- Turning steering wheel nut moves up / down on threads.

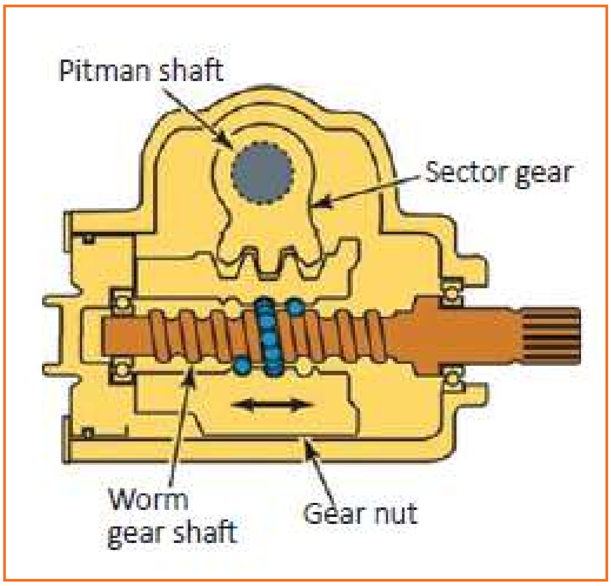


Fig 4.3.143: Steering gears

4.3.45 Types of Steering Gears

Steering system - worm and sector:

- It has a worm firmly attached to steering column, sector and drop arm shaft.
- The sector, virtually a part of large gear wheel, has a number of teeth engaging with the threads of the steering worm.
- As the steering wheel turns, the motion is send out to sector which moves drop arm shaft and subsequently the drop arm

Steering system - Cam and roller:

- This type of gear box wears little because it is made-up of a mechanism with no sliding contact.
- Its parts roll on one another as they move.
- Steering column lower end carries a specially shaped cam or worm. It is engaged by a roller mounted in ball bearings on toe end of an arm attached to the cross shaft.
- The roller and arm swing about axis of cross shaft as the cam or worm rotates. This causes the drop arm to work.
- It is comparatively easy to operate as the road wheels cannot readily turn the steering wheel.

Worm and nut steering system:

- Like to worm and sector, it has a nut that moves up and down the worm with the turning of steering column.
- Steering nut is connected through arrangement of ball and socket to one or two levers which are integral with, but at correct angles to the cross shaft.
- Thus steering nut up & down movement vacillates the cross shaft, at outer end of which the drop arm is mounted on serrations.

Bishop steering system:

- This kind of steering does not use nut.
- It has a conical peg on lever of the rocker shaft which engages a heavier and coarser threaded worm on the steering column.

Worm and wheel steering system:

- It contain worm and gear wheel rocker shaft. It provides radial motion to drop arm.
- The worm is tightly attached to steering shaft end and gear wheel's teeth mesh with worm thread.
- Rocker shaft is fitted through the centre of the gear wheel and carries the drop arm.
- The worm rotation is passed on the wheel and finally to the drop arm through the rocker shaft

Fig 4.3.144: Worm and wheel steering system

Re-circulating ball steering system:

- A sequence of balls move along the threads of the worm and transmit the motion to the connected cross shaft.
- Steering nut has 2 balls set in grove of worm.
- While dismantling this type, specifically notice the number of balls employed and check for cracks or excessive wear of these balls before re-assembling them. This type is used commonly in India.

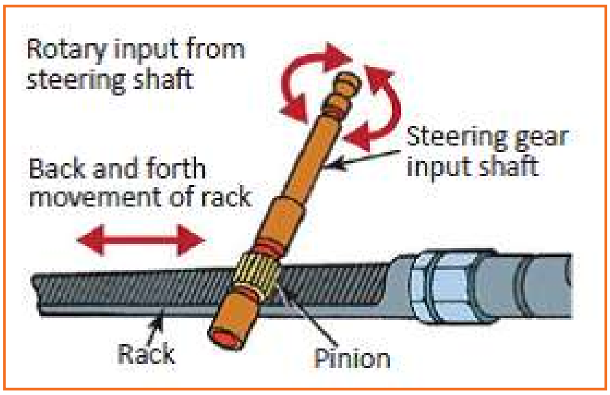


Fig 4.3.145: Re-circulating ball steering system

Rack-and-pinion steering system:

- The rack-and-pinion steering gear is light in weight and occupies less space than a regular steering gear.
- The input gear is pinion gear that receives rotary input from the steering shaft.
- Rack is a rod with gear teeth on one side.
- The pinion gear teeth mesh with the rack teeth, and so wheel the pinion gear turns, it pushes the rack from side.

Working of rack-and-pinion steering system:

- Simple in design and high in efficiency.
- Steering wheel rotary motion is transferred to rack linear motion.

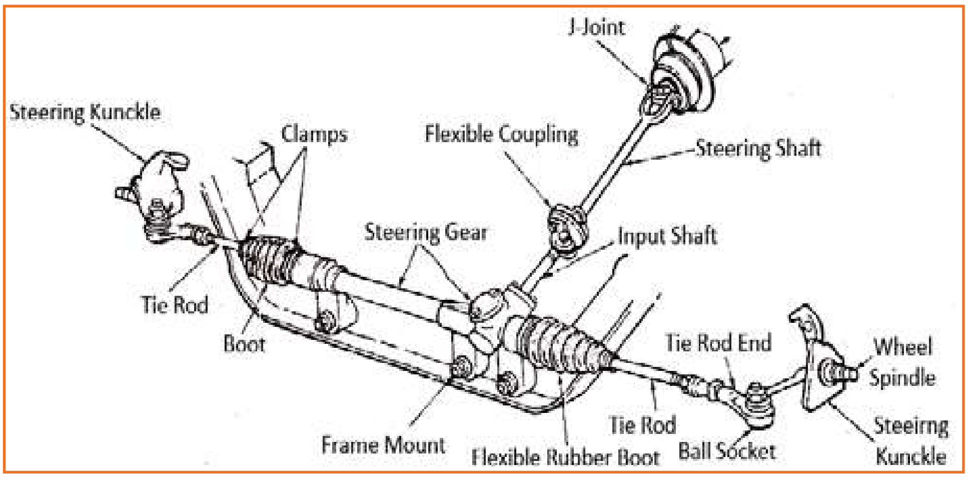


Fig 4.3.146: Rack and pinion steering system

- Both ends of the rack are connected to the steering knuckle on which the wheel is mounted. The angular motion of the rack, wheel direction is changed.
- To help the driver maneuver the steering, sometimes hydraulic assistance is given to rack movement with pressure developed in the hydraulic pump.

Rack is a rod having gear teeth machined on one side. The pinion gear teeth engage with teeth on rack thus when pinion gear turns, it pushes the rack from side.

4.3.45 Components in Hydraulic Power Steering

Components in hydraulic power steering

1. Power steering pump
2. Hydraulic piston
3. Inner and outer tie rod ends
4. Pressure tube
5. Rotary valve
6. Piston for rack

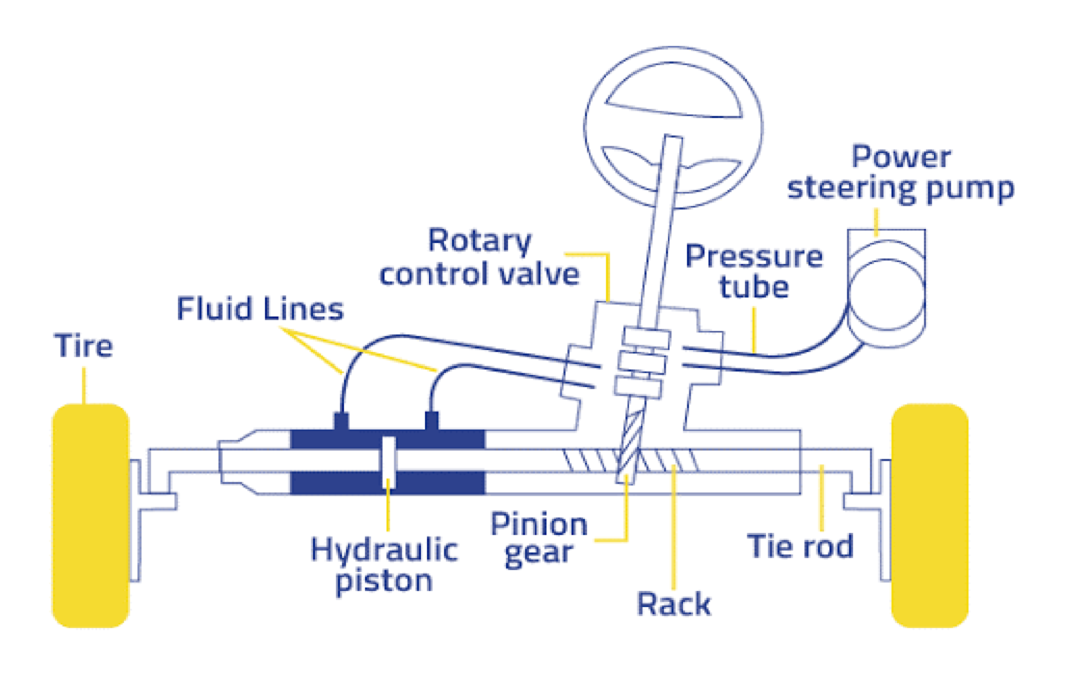


Fig 4.3.147: Components of hydraulic power steering

4.3.46 Components in EPS (Electronic Power Steering)

EPS - Electronic power steering:

Earlier we were using hydraulic power steering (HPS) systems, but now a day most of the cars are equipped with electric power steering (EPS). EPS does not need many so many components like HPS.

- Electric steering system is small in size and even portable compare to hydraulic systems.
- EPS is also energy efficient than the hydraulic systems.

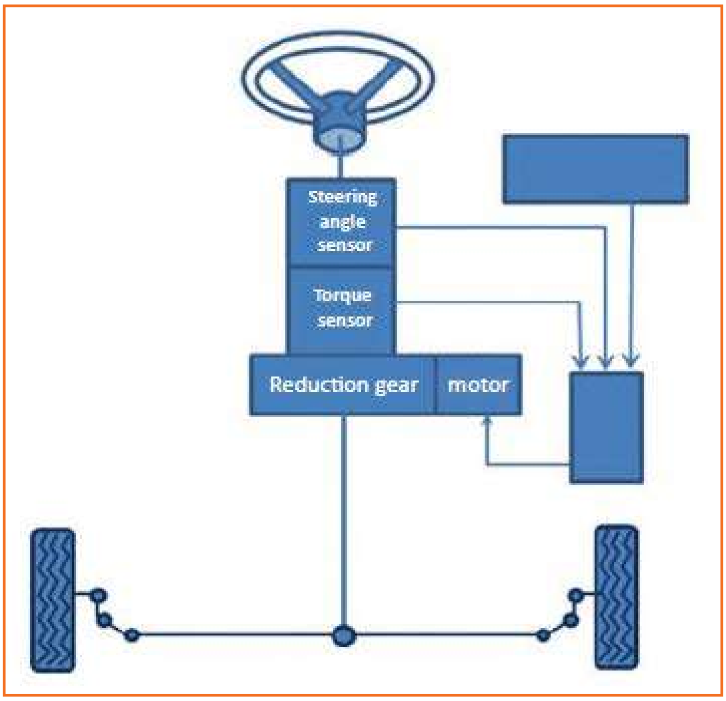
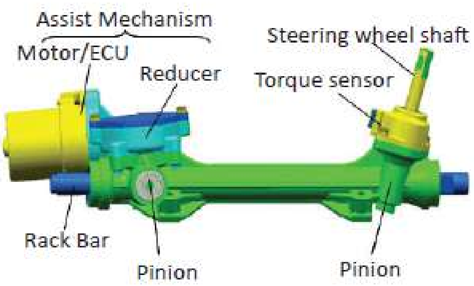


Fig 4.3.148: Electronic power steering

There are 4 types of EPS based on assist motor position:

	
Column assist type (C-EPS)	Pinion assist type (P-EPS)

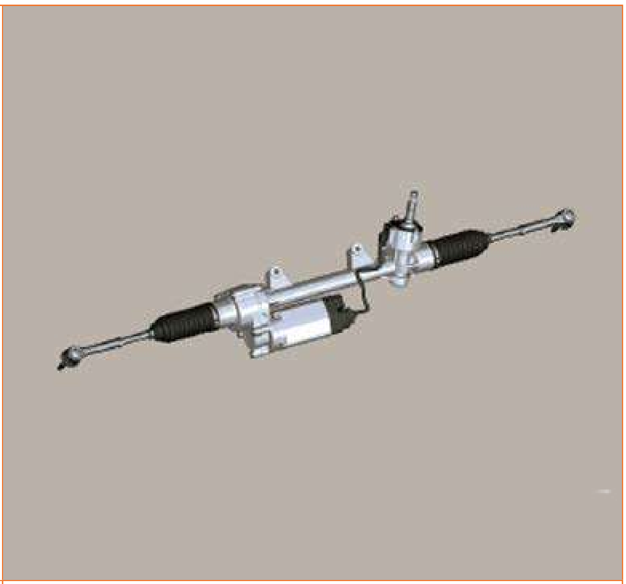
	
Direct drive type (D-EPS)	Rack assist type (R-EPS)

Table 4.3.9: Types of EPS

Unlike a HPS system that continuously drives a hydraulic pump, the efficiency advantage of an EPS system is that it powers the EPS motor only when necessary. This results in reduced vehicle fuel consumption (small amount) compared to the same vehicle with an HPS system.

Power assisted steering system should be checked twice a year or more often as suggested by car manufacturer in the handbook. When steering becomes heavy or jerky, it must be looked into.

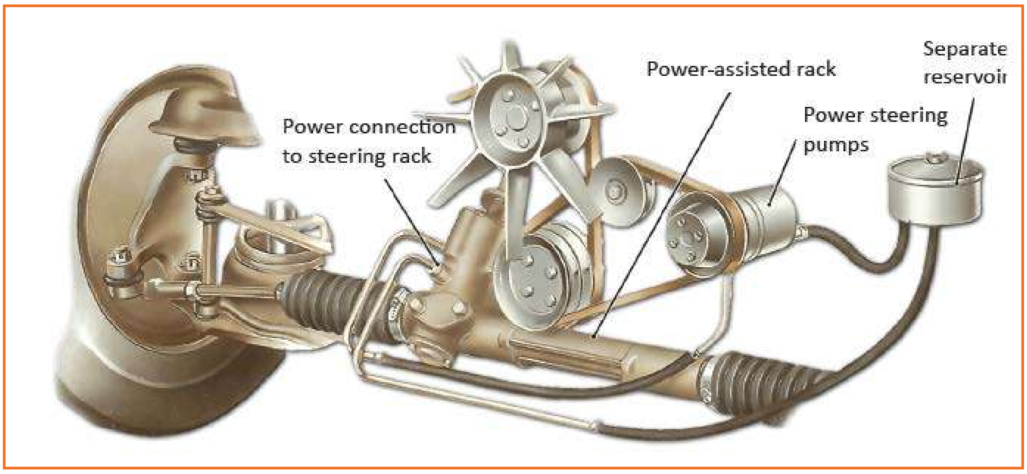


Fig 4.3.149: Steering rack in Power system

In rack & pinion system with power assistance, rack receives hydraulic system assistance. Steering becomes very hard & heavy during steering system failure. During the process of steer the vehicle when stationary with engine switched off it can be observed.

Ensure level of fluid in steering fluid reservoir. If found low, make sure there is no leakages. Leakages may let air in, and the fluid out. System may need bleeding.

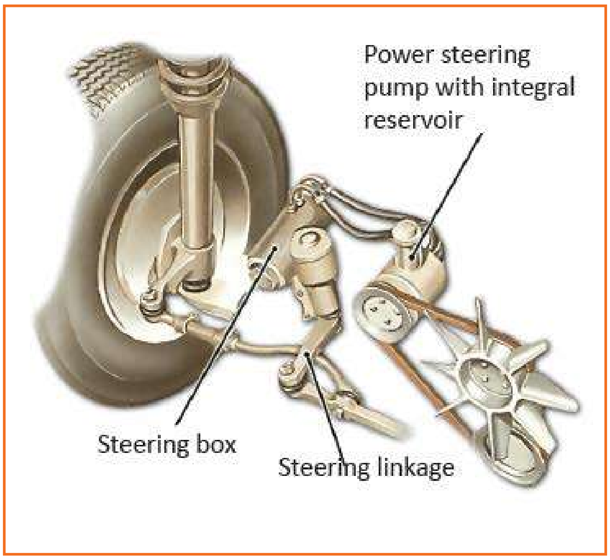


Fig 4.3.150: Steering rack

The reservoir might be above pump, mounted at engine and a belt from the crankshaft is used to drive it or may be separately fitted. It can be traced following the hoses from the pump.

Low level indicate leak. Hose joints tightness should be checked. Check if the hoses are cracked, perished, chafed or damaged. Look for any leaks oozing sticky steering fluid.

Check if any rigid pipework is found on pump, reservoir and rack. From the pipe unions check for leakages and for any sticky liquid trace. If there are none immediately visible, then using engine degreasing solution clean the parts properly.

If you find any joint leaking, then tighten it and also top up reservoir. Normally, use ATF - auto transmission fluid of the grade as per vehicle manufacturer recommendation in the service handbook. Bleed the system to remove air bubbles, if any.

Check if drive belt needs any adjustment or replacement. Any more serious maintenance should be done at the authorised service station or garage.

4.3.47 Checking of Steering-rack

Most of the cars now have rack & pinion steering gear assembly. Normally the rack housing is fixed on front cross member or bulkhead.

Clamps with rubber bushes are used to hold the rack. Any looseness in the assembly allows for the rack movement of the housing from side to side during turning of steering wheel.

Inspect the rack mountings from top and bottom for any abnormalities.

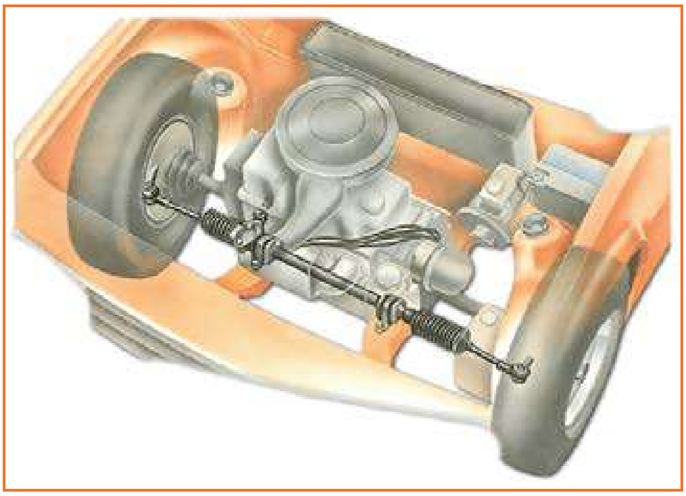


Fig 4.3.151: Power steering rack

Steering rack is connected to bulkhead with help of clamps or brackets. Normally the rack is connected to cross member by 2 U bolts or clamps, with rubber or plastic inserts. In some cars rack & pinion assemblies have central part of rack. Mounting brackets or clamps is at end of rack casing.

Fig 4.3.152: Power steering rack

- Clean dirt and grease by wiping the rack mountings and the surrounding area to inspect them closely.
- Let a support person operate steering wheel and you watch the steering rack mountings carefully for the movements. Car weight on front wheels is good enough for any abnormality in the movement to show up.
- If there is slack movement, then check for the U-bolt or mounting bracket and the securing nuts are in designated location and tightened properly. Check each of them with spanner / socket spanner.
- Using torque wrench ensure that nuts are tightened to the correct loading, as per vehicle manufacturer recommendation in the service manual.
- Check mounting at metalwork.
- Confirm nuts & bolts presence and tightness. Under the U bolts / clamps check rubber inserts.
- Ask to turn the steering wheel and check inserts for movement within the clamp.
- Check them for general conditions and replace them if required.
- Check the mounting brackets, U-bolts or clamps and
- Replace if any damaged observed.
- Check rubber insert for any deterioration.
- Examine the metal parts carefully for heavy rust or other damages that could weaken them enough to cause malfunctioning of the assembly.

Fig 4.3.153: Power steering rack

4.3.48 Steering Rack and Pinion Check

Steering rack checking may involve raising front section of car, putting its weight on wheels. You need to go underneath the car, while helper turns wheels to & fro. Access to proper inspection pit or wheel ramps is required for working on the steering assembly. Other side of the car has ball joints and gaiters.

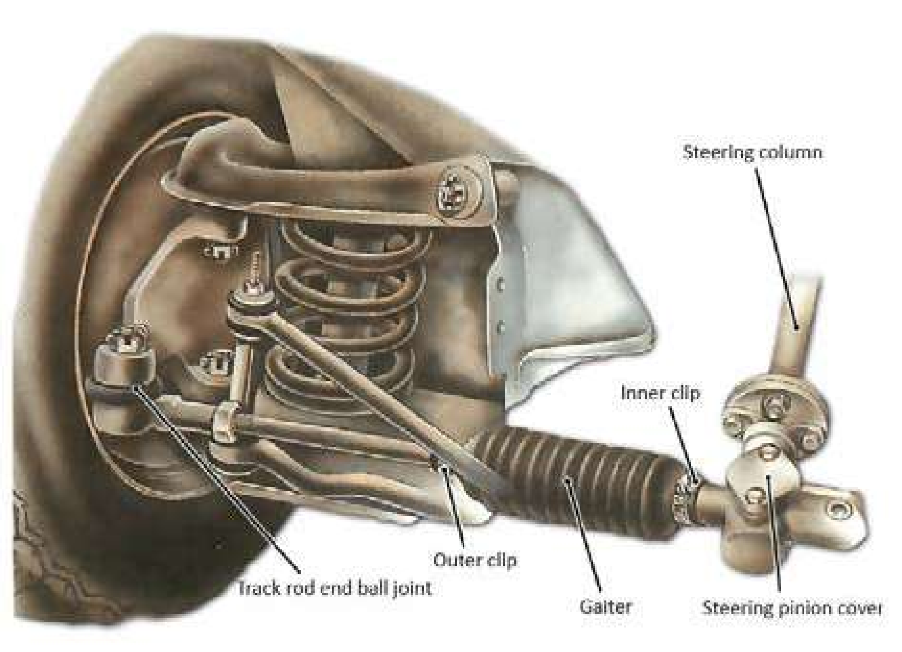


Fig 4.3.154: Rack & pinion steering

Steering rack is normally filled with oil / grease and regular topping up not required.

- Check if the rack has oil leaks, girt entry and simple wear..
- Also check other parts and assembly of steering system.
- Hard steering indicates loss of oil in rack.
- Refill the oil and clean the whole rack and gaiters.
- While cleaning the rack also check for other damages, such as cracks. Replace the rack if found damaged.
- You may replace gaiters if no grit has got into the rack and damaged it. Inspect the rack teeth while the steering is turned.

4.3.49 Checking Steering-box Mountings

Vital components and their mountings on body or chassis should be inspected at least once in a year. Thin metal sections used in the bodywork of modern cars are very likely to get corrosion which will further damage mountings. Steering system mountings may be affected.

The box is bolted on body. The idler arm is normally mounted opposite to steering gear box.

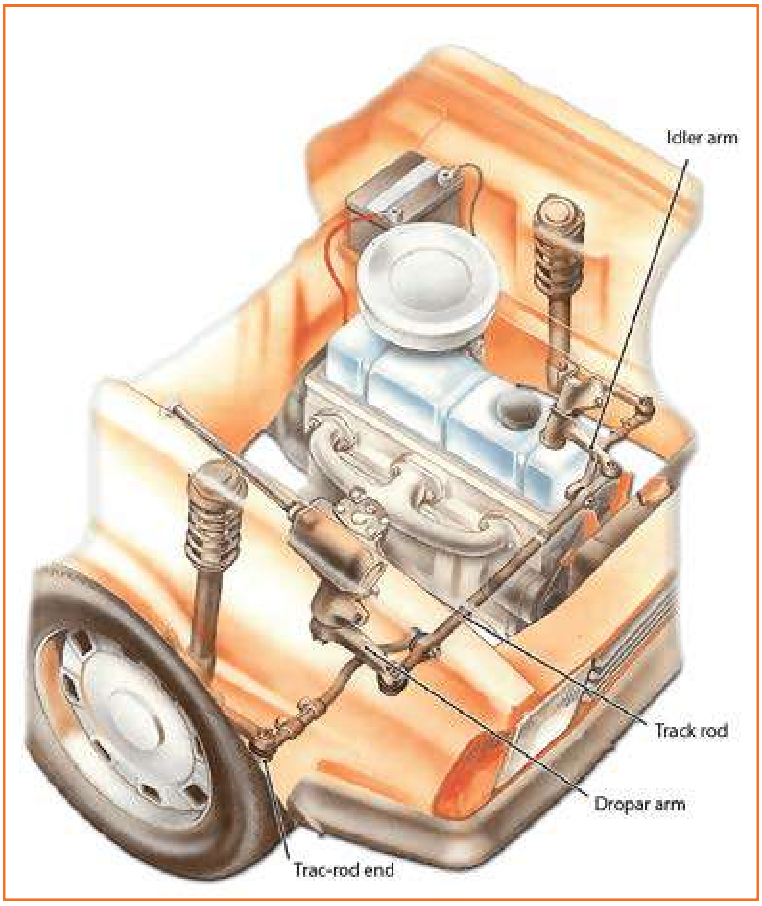


Fig 4.3.155: Steering-box system

Checking steering mountings:

Steering box mounting bolts should be checked & tightened using torque wrench. If loose, replace the washer lock or self-locking nut.

- Check the metal adjoining area for rust.
- Drop arm retaining nut should be tightened to recommended loading value using torque wrench.
- The steering gear box system is mounted in bay of engine, bolted to body side or to front cross member.

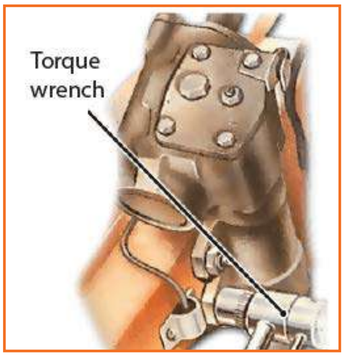


Fig 4.3.156: Steering mounting

Checking a macpherson strut:

- The upper swivel at the top inside the wing is not simply visible.
- Check the lower swivel joint for play. Raise front side of the car and ensure wheels are hanging free, now helper will hold wheel from backside and front side and shake from side.
- A defective joint will move vertically or horizontally should be replaced. The steering may deflect a bit during this test.

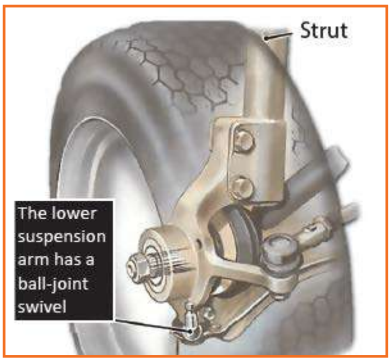


Fig 4.3.157: Macpherson strut

- Vertical movement will be checked by resting lever next to the inner wheel rim & pushing upwards against joint.
- MacPherson-strut front suspension may be used on both front wheel and rear wheel drive cars.
- We have shown here on a front wheel drive.
- Let the helper shake the wheel from side.

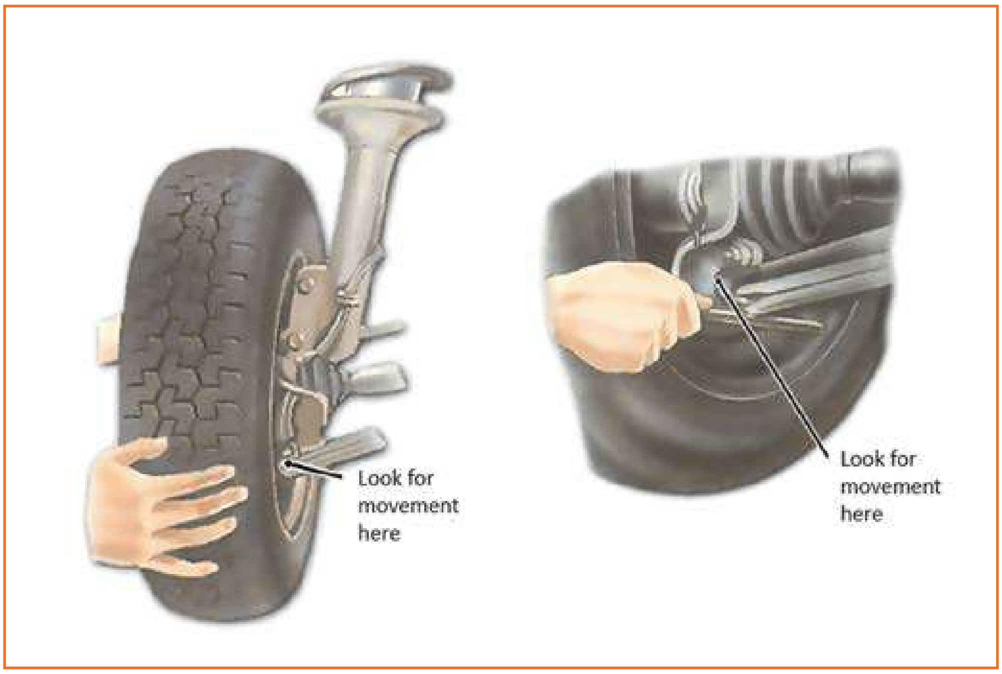


Fig 4.3.158: Macpherson strut check

4.3.50 Checking Steering Joints for Wear

Joints in steering system may wear slowly and become loose. Due to geometry of system, minor play or having looseness in joints makes the whole system noticeably shoddy and imprecise.

There are ball joints, track rod and track-rod ends in steering gear box system.

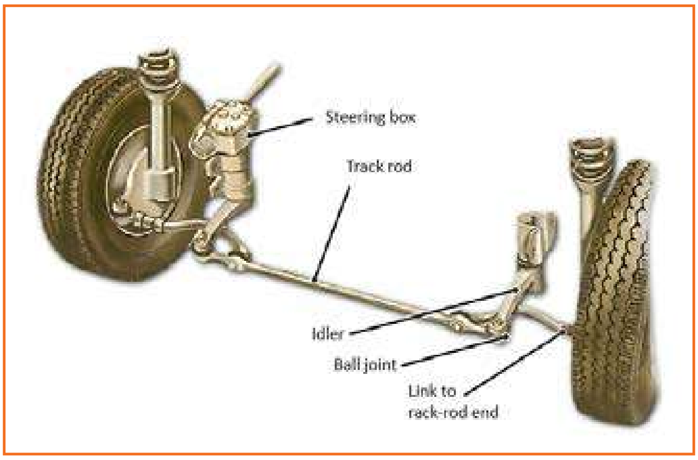


Fig 4.3.159: Steering-box system

Rack and pinion steering gear system has joints at the rack ends and track rod ends.

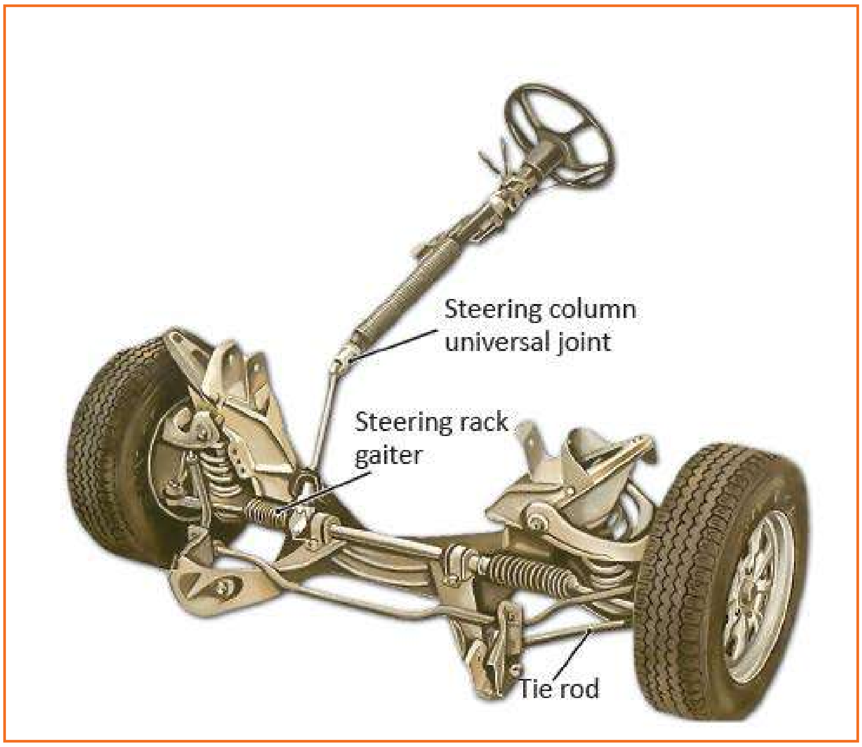


Fig 4.3.160: Steering-rack system

Checking steering-column joints:

Check the rubber joints to test the bond. Often there are 1 or 2 universal joints found in steering column shaft. They may sometimes be difficult to find. Check engine compartment / under the dashboard. Ensure to cover the entire length of steering column.

Fig 4.3.161: Steering-rack system

Joints are of Hooke-type. On cross-shaped inner piece two yokes are bolted. Check tightness of all bolts, including those that hold the joint to the splined shaft. Ensure, there is no play when the joint is turned, or during pushed or pulled. Let supporting person turn the steering wheel to & fro slightly.

Wheel should not be turned too far as it may injured finger or your fingers may get trapped.

In some joints flexible disc made of rubber layers to fabric with metal inserts is used for bolts securing.

Take care in attending to the flexible parts. They may deteriorate with age. Check using screwdriver to observe if they are sound otherwise replace them.

Check the rubber joints to test the bond.

4.3.51 Checking Steering Box

Steering gear box checking involves raising front of car, while maintaining weight on wheels and getting underneath it, while the helper slowly turns the wheels.

- Check the seals and gaskets for leakages. Moving part accuracy. Service and maintenance should be done at authorized garage only.
- During cleaning, if any damage is noticed, replace the box at a garage.
- Use ramp or proper inspection pit to do the work.
- Apply handbrake to lock the rear wheels.
- Ensure steering box leakages and wear
- Any leakage can make the steering hard. If you notice stiffness, check immediately.
- A low oil level in the box is a sure indication of a leakage. To check for leakage, using engine degreaser clean box, remove oil traces.
- Drive for some time before inspecting oil leaks.
- During cleaning, if any damage is noticed, replace the box at a garage.

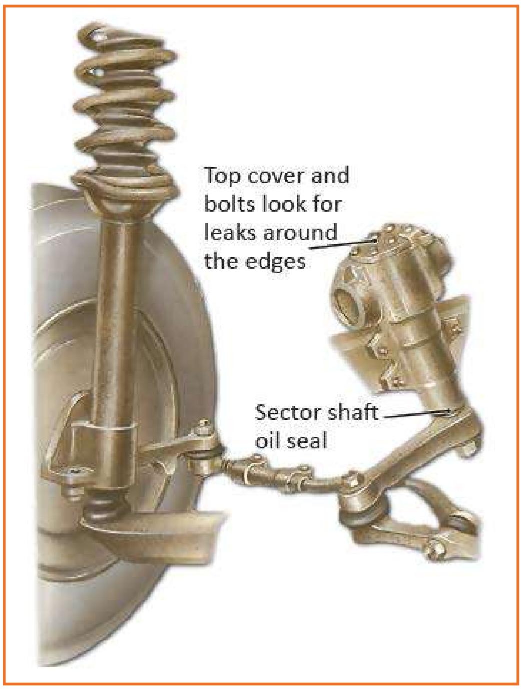


Fig 4.3.162: Checking steering box

4.3.52 Steering Geometry/Wheel Alignment

Wheel alignment is part of standard automobile maintenance that consists of adjusting the angles of wheels to the car manufacturer specifications. The purpose of these adjustments is to reduce tyre wear and to ensure that vehicle travel is straight and true (without **"pulling"** to one side)

Some of important angles are:

- Castor Angle
- King Pin Inclination Angle (KPI)
- Camber Angle
- Alignment (Parallelism) Or Toe-in Or Toe-out
- Castor Angle -The castor angle is the angle, viewed from the side, formed by the vertical axis and the steering pivot axis.
- The angle is positive when the pivot axis is tilted towards the rear of the vehicle.
- The castor angle values range from approximately +1° to +6°.
- The castor angle, which is usually positive, contributes towards vehicle stability in a straight line. The castor angle contributes towards

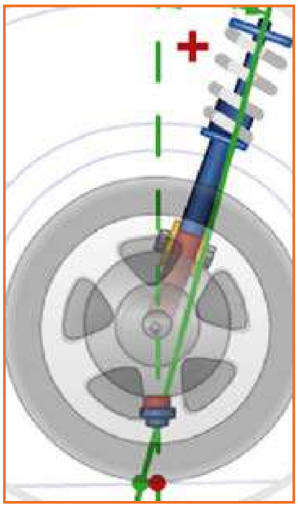


Fig 4.3.163: Caster Angle

returning the wheels after turning (Self Centring).

The king pin inclination angle (KPI) is the angle, viewed head on, formed by the pivot axis with the vertical axis.

- The king pin inclination angle is positive when the pivot axis is tilted towards the vehicle interior.
- The king pin inclination angle, which is usually positive, contributes towards returning the wheels to the centreline and assists in keeping the wheels in a straight line.
- The king pin inclination angle value ranges from approximately 11° to 14°

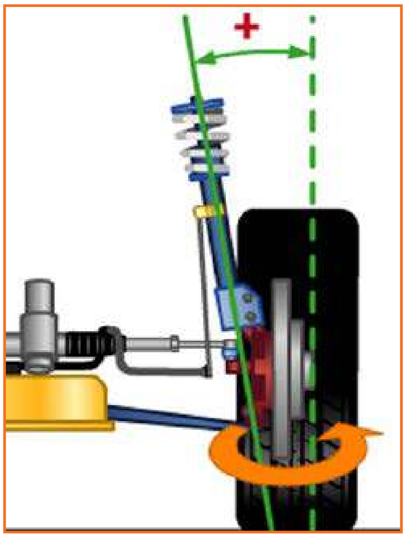


Fig 4.3.164: King Pin Inclination

Camber Angle - The camber angle is the angle, viewed from front, formed by the inclination of the hub-carrier and the horizontal plane or the angle, formed by the inclination of the wheel with the vertical axis.

The camber angle value ranges from approximately -1° to 1°

The camber angle is positive if the top of the wheel is tilted towards the vehicle exterior, and it absorbs imperfections in the road surface and improves stability when driving in a straight line and when cornering.

Fig 4.3.165: Camber Angle

Toe-in/Toe-out or (Parallelism): are the angle, viewed from the top. In Toe-in, the gap between front of the tyres is lesser than the rear of the tyres. Toe-out is just opposite to it.

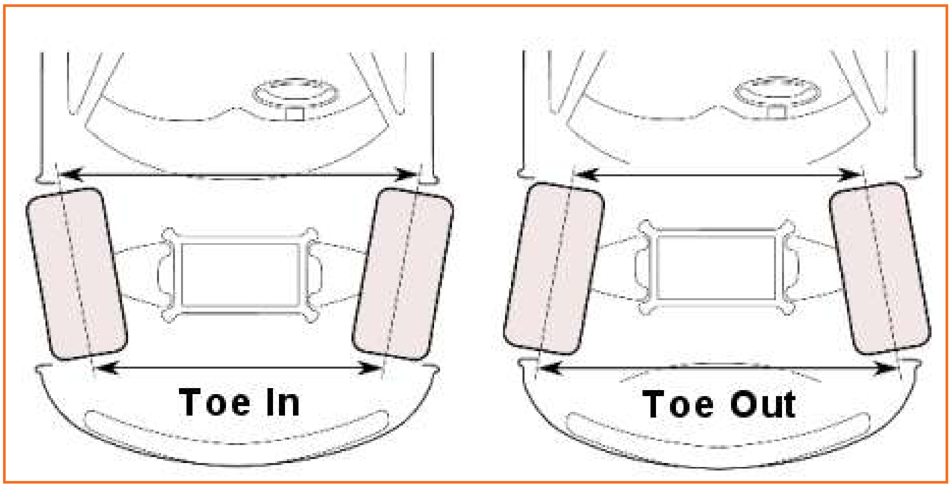


Fig 4.3.166: Toe-in/Toe-out

These angles are usually checked with the computerized wheel alignment machine. In most of the cars only Toe-in/Toe-out is adjustable.

4.3.53 Troubleshooting of Steering System

Problem1: Excessive play in steering

Classification / Probable Causes	Technical Details / Remedial Actions
Loose steering gear (rack or box) adjustment.	Adjust steering gear (rack or box) to specifications
Loose steering gear (rack or box) mounting.	Tighten steering gear mounting bolts/replace mounting bushes.
Loose wheel bearings.	Adjust or replace bearings.
Worn idler arm or pitman arm (where fitted)	Replace idler arm or pitman arm.
Worn rack ends.	Replace rack ends.
Worn steering coupling.	Replace steering coupling.
Worn tie rod ends.	Replace tie rod ends.
Wrong type of break pads / liners.	Replace brake linings, check for cause.

Problem 2: Front wheel shimmy (steering wheel shake)

Classification / Probable Causes	Technical Details / Remedial Actions
Bent wheel.	Replace wheel.
Incorrect wheel alignment (caster angle).	Adjust to factory specifications.
Loose steering gear (rack or box) adjustment.	Adjust steering gear (rack or box) to specifications.
Loose steering gear (rack or box) mounting.	Tighten steering gear mounting bolts/replace mounting bushes.
Worn or loose wheel bearings.	Adjust or replace bearings.
Worn rack ends.	Replace rack ends.
Worn steering damper (where fitted).	Replace steering damper.
Worn tie rod ends.	Replace tie rod ends.

Problem 3: Heavy / stiff steering

Classification / Probable Causes	Technical Details / Remedial Actions
Binding in steering linkage.	Check for interference, lack of lubricant.
Failure in power steering system.	Check fluid level, belt, pump, hoses, and pressure valve.
Incorrect front wheel alignment specifications (excessive toe in).	Adjust to factory specifications.
Low Tyre pressure.	Check and Inflate to recommended air pressure.
Tight steering gear (rack or box) adjustment.	Adjust steering gear (rack or box) to factory specifications.
Worn strut mount bearings.	Replace strut mount bearings.

Problem 4: Steering wheel pull when braking

Classification / Probable Causes	Technical Details / Remedial Actions
Excessive disc brake run-out.	Replace both brake discs.
Inoperative brake one side.	Check for brake faults.
Uneven braking force.	Check for mechanical or hydraulic problem.
Weak or broken spring.	Replace spring.

Table 4.3.10: Troubleshooting of steering sytem

4.3.54 Brake System

A mechanical device – Brake, absorbs energy from rotating system and inhibits the motion. Thus, it is applied for slowing down or stopping a running vehicle by virtue of friction.

- To reduce the speed of a vehicle
- To stop a moving vehicle
- To prevent a stationary vehicle from moving

The function of a vehicle's brake is to stop or slow it down when moving or stop it from moving when it is stationary. Brake system depends on friction forces for it's operation.

Types of braking systems

All four-wheeler vehicles have these braking management in

- **Service brake system:** The pedal-operated main brakes of the vehicle
- **Parking brake system:** The latching brake to maintain car stationary – also known as hand brakes or emergency brakes
- **De-acceleration of engine speed:** Removing feet from Accelerator pedal to slow down the vehicle

Types of brakes:

Brakes can be classified as:

- Mechanical brakes
- Hydraulic brakes
- Power assisted brakes
  - Vacuum assisted
  - Compressed air assisted
- Air Brakes

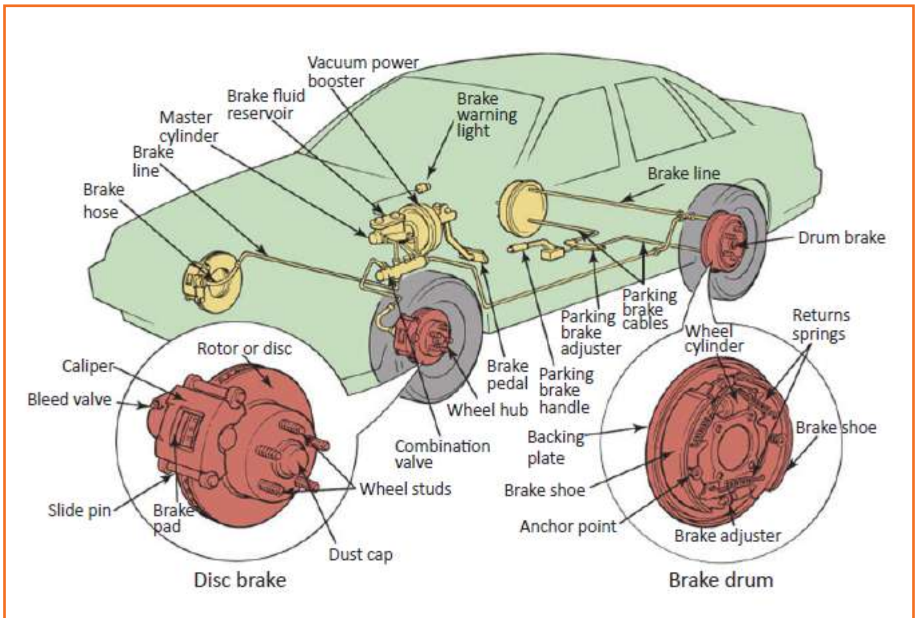


Fig 4.3.167: Brake system

Main components of the brake system

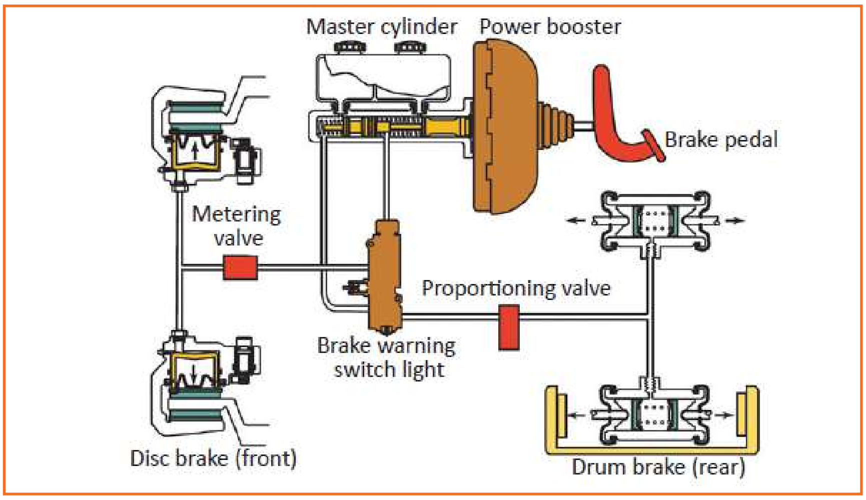
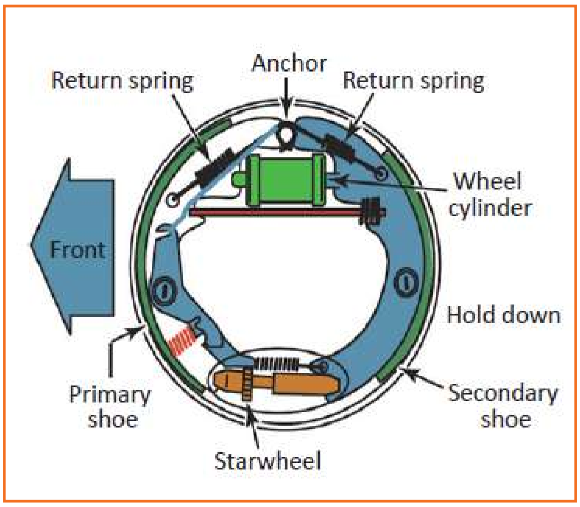


Fig 4.3.168: Components of brake system

- **Drum brakes:** Drum brakes are used on the rear of most of the vehicles. Drum brake has -



  - Shoes and a piston
  - An adjuster mechanism
  - An emergency brake mechanism
  - Many springs

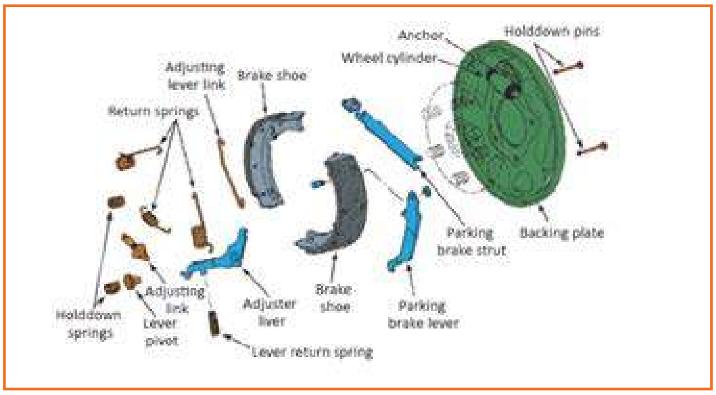


Fig 4.3.170: Drum brake assembly

Vacuum Booster

It is a type of master cylinder for reducing the pedal pressure required for braking. Together with the master cylinder, it gives a higher hydraulic pressure to the brakes.

It works with vacuum - usually from the engine intake. When off stage of engine brake pedal is hard.

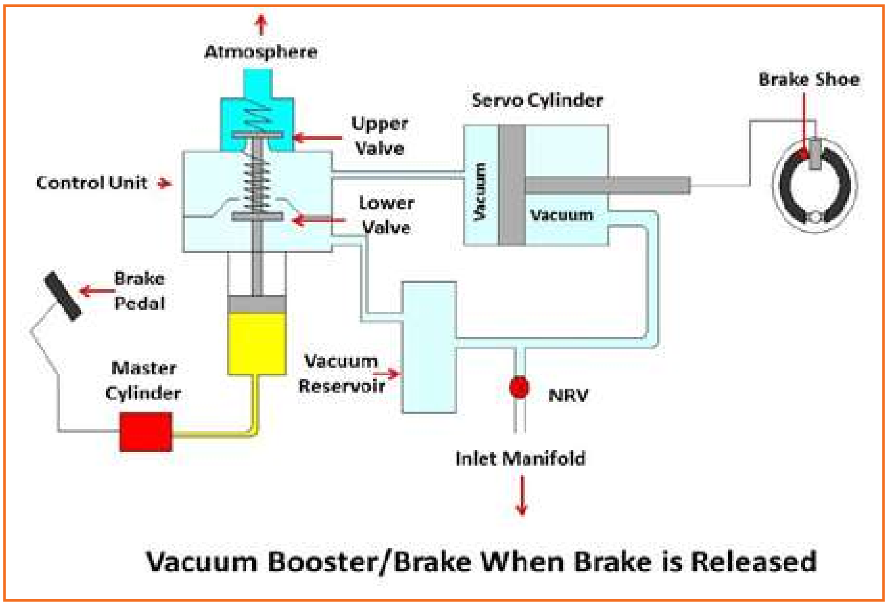


Fig 4.3.171: Master cylinder with vacuum Booster

- **Wheel Cylinder:** It's part of drum brake and fitted on each wheel to activate brake shoes. When pressure is applied, the pistons expand the shoes outwards, pushing them against the brake drum.

  Depending on brake type, it will have one or two cylinders and one or two pistons in each cylinder?

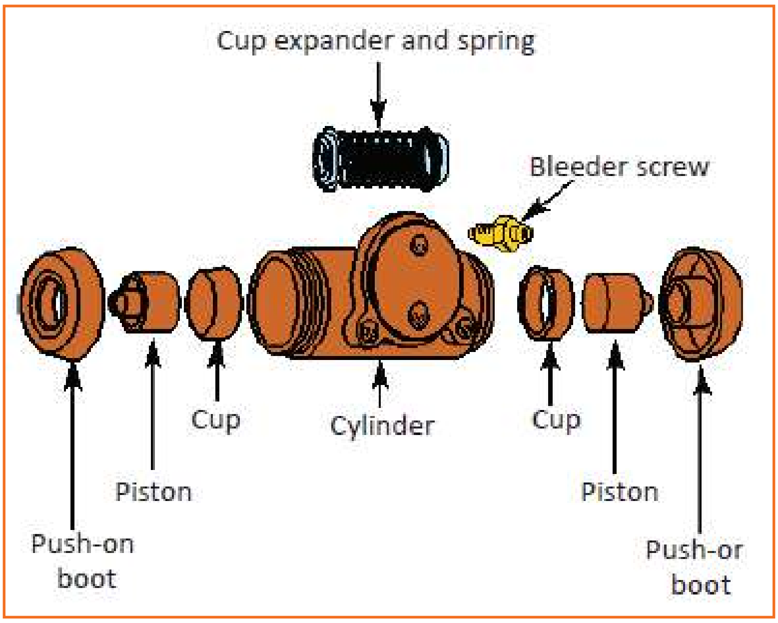


Fig 4.3.172: Wheel cylinder

- **Disc brakes:** They are mainly used in front wheel of most of the vehicles.

  Brake pads grip rotor instead of the wheel, when force is passed on hydraulically.

  Friction generated between pads and disc slow down the disc.

  The main difference between drum brake and disc brake is drum brake less efficient and when we stop the engine it takes more time but disc brake is more efficient and when we stop it stops fast as compared to the drum brake.

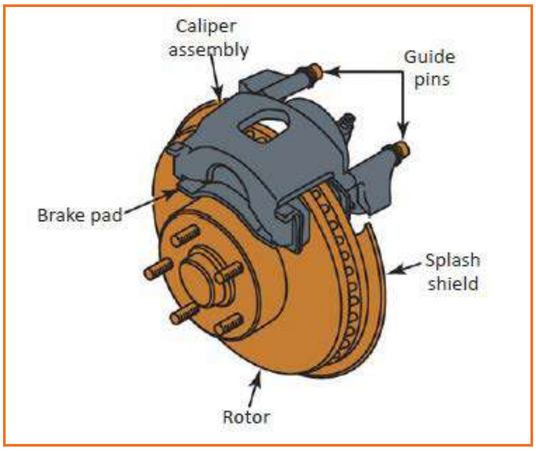


Fig 4.3.173: Disk brake

- **Master cylinder:** It is very essential component of braking system. Movement of brake pedal and force are transmitted to brake fluid and further to wheel cylinders (drum type brakes) or brake calipers (disc type brakes).

  Typically, brake pedal attached to push rod by bracket having U shape. To retain the clevis to the brake pedal clevis pin is used.

  Master cylinder components:

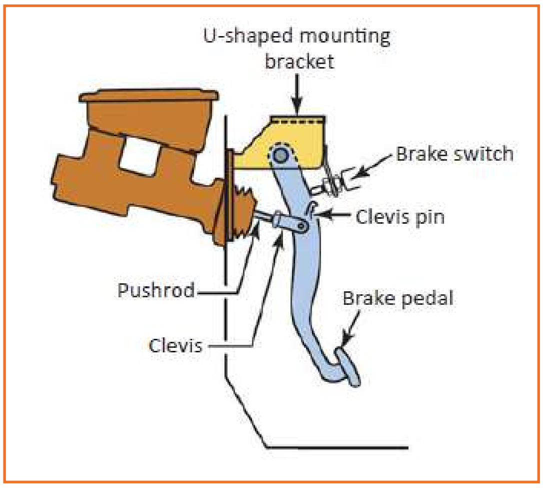


Fig 4.3.174: Master cylinder with vacuum Booster

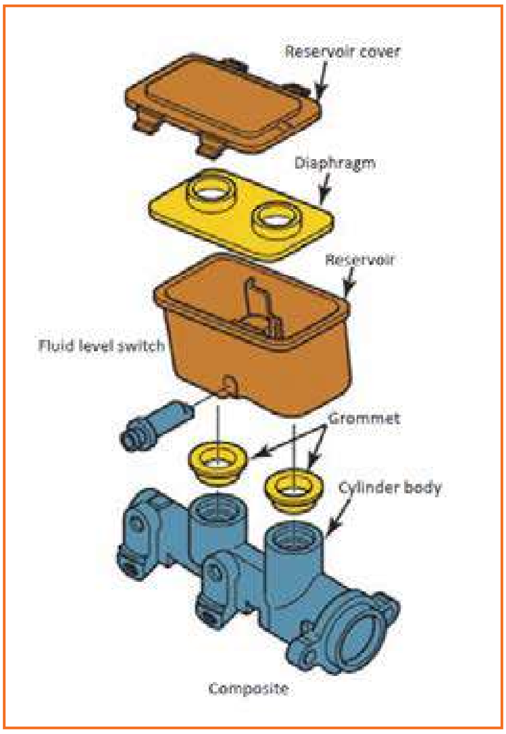


Fig 4.3.175: Components of master cylinder

- **Pressure control valves (PCV):** When brake is applied at high speed, the vehicle weight shifts to front axle.As both the axles have same braking fluid pressure, this weight shift may lead to rear wheel lock and skidding.

  PCV modifies brake fluid pressure to rear brakes so that early locking of wheels can be avoided. These valves are directly mounted on the master cylinder.

How PCVs work?

The proportioning valve typically connects the master cylinder to the rest of the braking system, but sometimes it is independent of the cylinder. This valve is necessary for optimizing front-to-rear bias, also referred to as brake balance. It is a spring-loaded component that activates when fluid pressure builds when you step on the brake pedal. Then, the valve's plunger unseats and fluid rushes into the calibrated range. Once this happens, the spring gets compressed and the plunger blocks the fluid from passing through. Even pressure distribution among the front and rear of your vehicle is important for safe and reliable braking performance.

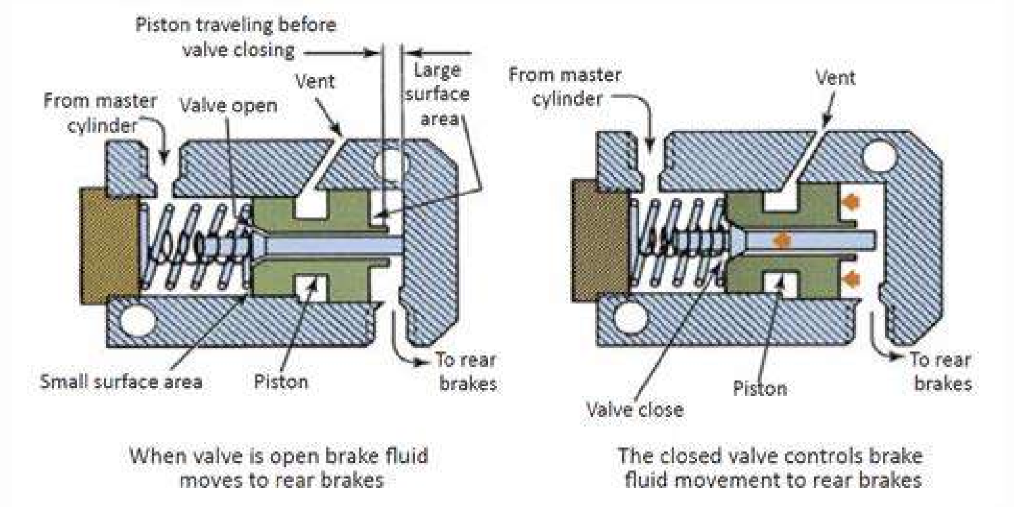


Fig 4.3.176: Working of PVC

- **Load sensing pressure valve (LSPV):** LSPV detects vehicle load and regulates fluid pressure to rear wheels.

  If the vehicle load is light, rear suspension is high, especially during braking. Thus, pressure allowed to rear brakes is reduced. This helps in preventing rear wheel lockup & skidding.Further, a light load vehicle requires less braking force to stop than a heavy load vehicle.Height sensing proportioning valve helps in providing variable brake balance.

  Thus higher pressure is applied to rear brakes when vehicle is heavy loaded and less pressure when vehicle is light loaded.

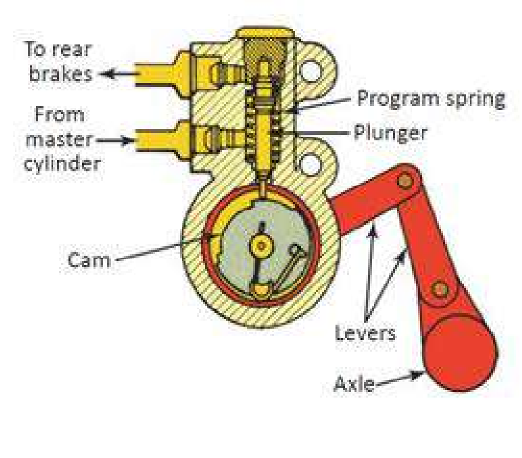


Fig 4.3.177: Load sensing pressure valve (LSPV)

How does the brake work

Function of brakes is to pass on the force to tyres by using friction, and by friction tyres also pass onthat force to road.

The following three principles are important in functioning of braking system:

- Leverage
- Hydraulics
- Friction

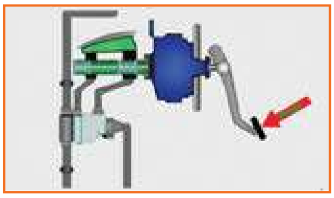


Fig 4.3.178: Brake system

On driver's applying brake by pressing the paddle, brake oil in the master cylinder gets pressurized. This pressurized oil pressure is equally transmitted to all the inlet of the four wheel cylinders through four metallic pipes and through rubber hosing pipe.

Fig 4.3.179: Brake system

Piston within wheel cylinder block will be pushed outside due to this pressurized oil, which in turn will make brake liner fly out and hold the rotating brake drum and thus brake will be applied equally on all wheels.

On driver's releasing pressure from brake paddle, loner retainer spring will p cylinder block back to original position.

Fig 4.3.180: Brake system

Due to inward pressure of the piston,oil from the wheel cylinder block is pushed back to the reservoir tank.

How does master cylinder work

Master cylinder provides separate outlets for front wheels and rear wheels. Advantage of separate outlets is whenever pressure leakage occurs in either one, front or rear wheels braking system, the other works fine. Thus provides a certain degree of safety.

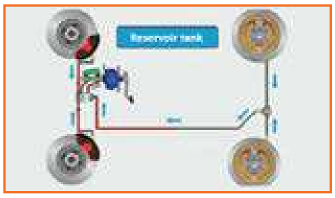


Fig 4.3.181: Brake system

When brake paddle is pressed, the master cylinderpiston moves forward to force the brake oilto go to the brake system with pressure.

This pressurized brake oil is transmitted to allfour wheel cylinders thru pipelines.

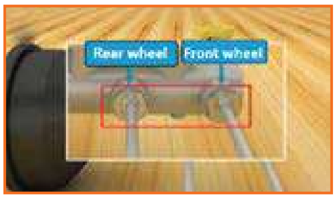


Fig 4.3.181: Brake system

Visual inspection:

The following points are important in visual inspection :

- Brake fluid has to be clear and thin, no dirt, rust contamination.
- Reservoir cover vent holes has to be open and clean.
- Diaphragm in the reservoir cover should be intact.
- No signs of external leakages in the lines or at the pushrod area.
- The pedal reserve distance should be adequate and not be too low.

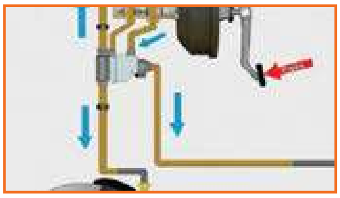


Fig 4.3.182: Brake system

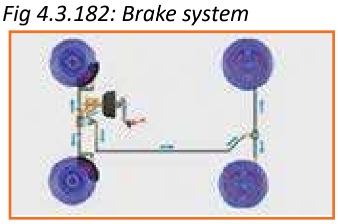


Fig 4.3.183: Brake system

Steps of inspection

1. Remove master cylinder from vehicle.
2. Remove the reservoir, if possible.
3. Remove retaining bolt holding secondary piston assembly in bore.
4. Depress primary piston with help of blunt tool like Phillips screwdriver
5. Remove snap ring.
6. Remove master cylinder. Tap open end of bore against top of work bench to force Secondary piston out of bore. Check master cylinder bore for signs of pitting / corrosion / wear.

4.3.55 Checking and Renewing Hand Brake Cables

Different car models have different handbrake cable layouts, but they have similar types of component. Generally handbrake layout has one cable leading to Y shaped equaliser and secondary cables.

Similar system works for cars with the handbrake on the front wheels. Cables may stretch a bit with usage. Hence, needing regular checking, lubrication, and adjustment if necessary.

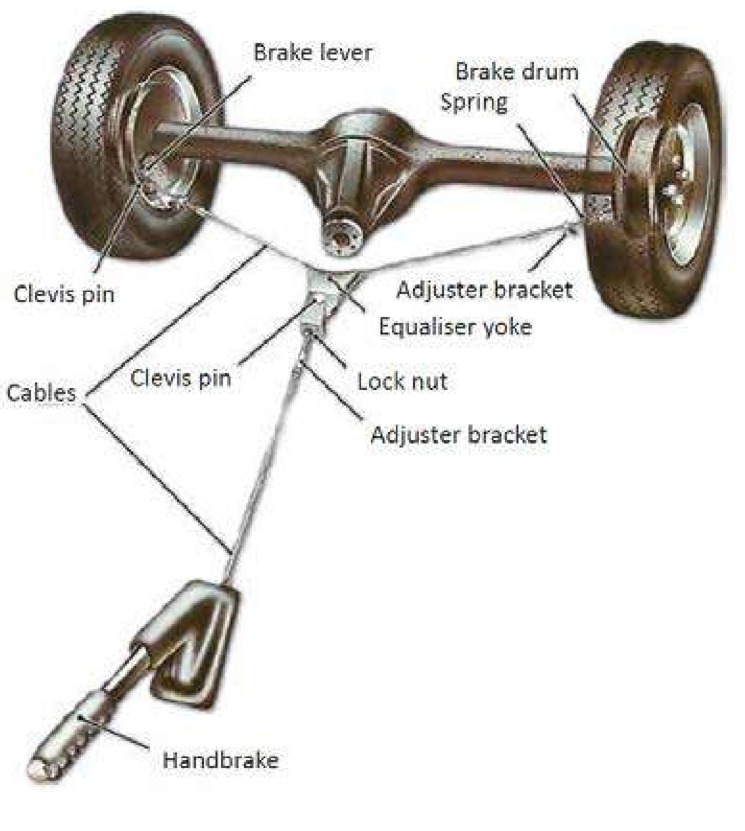


Fig 4.3.184: Handbreak layout

A handbrake layout shown here has a primary cable running to a compensating bracket which works the brakes through secondary cable.

Fraying cables is a major issue may result in sudden cable breakage. Ferrous parts may also rust andbecome sticky. Then the handbrake may not be applied or released fully.

- Check the entire cable, particularly observing at the sharp bends.
- Check the cables for cracks, including the flexible outer casing, water may get in causing rusting.
- Ensure all parts are clean and properly lubricated. If necessary, apply brake or anti-seize grease on these parts.
- Clean thoroughly and check for wear at any locations.
- Clevis pin becoming `waisted' or worn out in the middle is a common complaint resulting in ineffective braking & loss of braking power.
- Replace worn out clevis pin. Always use new split pin or spring clip, when reinserting new clevis pin.
- Greasing is recommended to entire unit while assembling back.

4.3.56 Brake System Leaks

A spongy feel or increased pedal travel as you apply the foot brake indicates possible leak or air bubbles in hydraulic brake system.

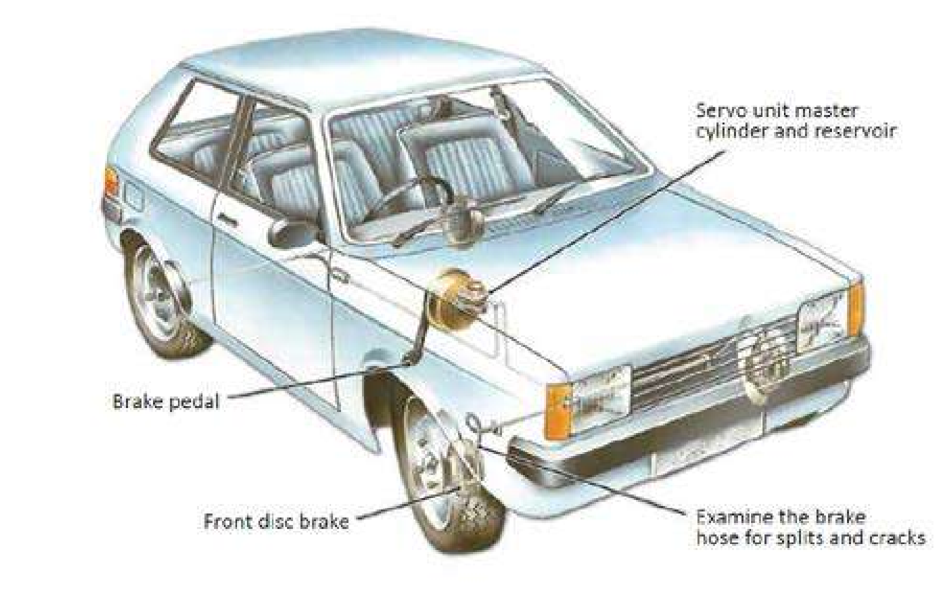


Fig 4.3.185: Break system

Hydraulic pressure is applied to brake pipes on all wheels. Brake fluid is supplied by master cylinder reservoir.

- If master cylinder reservoir shows low level, it indicates leak in the system.
- The master cylinder can be located near the bulkhead of the engine compartment. The recommended fluid level is indicated on reservoir.
- In plastic reservoir, fluid level is visible. In case of metal, remove reservoir cap to look inside.

- Regular inspection of fluid level is recommended. It could be your first warning, if the leak is only a slight ‘weep’ in the system.
- Any brake liquid leak must be traced and remedied at the earliest. Common reason of leaks is master cylinder seal or wheel cylinder.
- Less likely, but not unknown, is leak past piston seal on disc brake caliper.
- Other possibility of leaks may be due to flexible hoses, damage brake pipe or loose screw in pipe unions.
- Carefully inspect pipe unions and tighten nut in-case leakage is found. While inspecting the system brake pedal should be pressed hard. If more pressure required, indicates minor leak which is not simply visible.
- If no leak is found and even after bleeding problem is not resolved, then check master or slave cylinders.
- If brake fluid or grease noted on brake liner should be replaced. Do not try to clean them.
- Moreover, the opposite wheel linings must also be replaced. There may otherwise be different stopping power on the two brakes resulting in unbalanced & dangerous braking.
- Never replace one brake shoes.

Using a hose clamp:

Hose clamp is helpful in pinpointing doubtful faults in brake pipes.

- Seal flexible brake hose one by one using hose clamp.
- A bad leak from the wheel cylinder in drum brake will be seen by fluid strip on the back plate, the wheel or sometimes the tyre wall.
- If vehicle is pulling one side, it indicates other side brake linings is contaminated due to fluid and not working properly.
- Replace leaking wheel cylinder immediately.

Pipes and unions check:

- While examining brake pipes and unions, always remember those incorporating pressure switch to work on the brake lights.
- Also check the pressure regulating valve, which manage rear break hydraulic pressure, to balance the braking between front and rear.
- Look for the pressure switch in the engine compartment. It will have wiring attached to it. The regulator is normally underneath the car and at the back.
- If there is rust / corrosion, clean pipe / union with wire brush, before inspection.
- Rust on surface has to be cleaned & is not a problem, but deep pitting in a pipe mean they should be replaced. If wire brushing cleans up & brings it up bright and smooth, it is normally sound.
- Deep pitting weakens it seriously. Rust will return again and continue eating through the metal.
- Replacing brake pipes is best solution for specialist technician.
- Sometimes corrosion may have seized the union nut to the pipe or component. If tried for

loosening it may lead to break pipe.

- To avoid this, clean union and then soak it in penetrating oil and then try to remove it with proper care.
- Use proper size spanner otherwise nut may get damaged.

Inspecting hoses:

- Inspect Flexible brake hoses with care. Any issue in hoses will cause brake failure.
- Carefully check all hoses. If anything wrong should be repositioned & corrected. If there are signs of damages, should be replaced.
- Bending a hose sharply may reveal some tiny cracks in casing caused by aging / perishing. When hose is straight it is simply not visible. Even if not leaking, better replace it immediately.

Checking the master cylinder:

- Master cylinder leak can be traced on bulkhead or close by components in engine compartment.
- Slight leakage can be found after you peel back rubber dust seal & look at operating rod. Replace a leaking cylinder.

Fig 4.3.186: Master cylinder with reservoir

Checking disc-Brake pistons:

Brake fluid leakage past pistons in a disc brake caliper is unlikely, but possible. Check by removing the brake pad.

Fig 4.3.187: Peel back thr dust seal

4.3.57 Troubleshooting of Brake-Hydraulic

Problem 1: Brake pads worn at angle

Classification/Probable Causes	Technical Details/Remedial Actions
l.A. Corrosion in wheel cylinders.	Remove and install, repair or replace wheel cylinders.
2.B. Guide bolts damaged.	Replace guide bolts.

Classification/Probable Causes	Technical Details/Remedial Actions
3.C. Spring force insufficient.	Replace spring.

Problem 2: Brake Pedal hard and travel excessive

Classification/Probable Causes	Technical Details/Remedial Actions
2.A. Air in braking system.	Bleed brakes.
2.B. Wrong type of liners.	Replace brake linings or replace brake shoes.

Problem 3: Brake pedal motion too soft and spongy

Classification/Probable Causes	Technical Details/Remedial Actions
3.A. Air in braking system.	Remove Air from brake system.
3.B. Hard brake lines are bent, hindering smooth flow of brake oil	Adjust hard brake lines to ensure smooth flow of brake oil
3.C. Insufficient brake fluid in expansion tank.	Top up or change the brake fluid Bleed the brake system.
3.D. Overheated brake fluid - Vapor lock due to too much water in brake fluid or excessive brake loads	Top up or change the brake fluid Bleed the brake system

Problem 4: Brakes excessively hot while driving

Classification/Probable Causes	Technical Details/Remedial Actions
4.A. Clogged master cylinder.	Overhaul master brake cylinder, and replace if necessary.
4.B. Cross spring broken.	Replace cross spring.
4.C. Handbrake not releasing completely.	Check handbrake and handbrake cables, and repair if necessary.
4.D. No play between push rod and master cylinder piston.	Adjust push rod.
4.E. Swollen rubber parts because of use of wrong brake fluid	Overhaul master brake cylinder, replace if necessary.

Problem 5: Brakes pull to one side

Classification/Probable Causes	Technical Details/Remedial Actions
5.A. Brake pad glazed.	Replace brake linings.
5.B. Corrosion in wheel cylinders.	Remove, repair or replace wheel cylinders.
5.C. Incorrect wheel alignment.	Check wheel alignment.
5.0. Oil on break pads / liners.	Replace brake linings, check for cause.
5.E. Tire pressure incorrect.	Correct tire pressure.
5.F. Uneven tire wear.	Re-Balance or replace tires.
5.6. Worn shock absorber.	Check and replace shock absorber if needed.
5.H. Wrong type of break pads / liners.	Replace brake linings, check for cause.

Problem 6: Brakes squeal or rattle

Classification/Probable Causes	Technical Details/Remedial Actions
6.A Brake drums eccentric.	Grind or replace brake drums.
6.B Dirt and dust in brake drums.	Clean and check brake drums.
6.C Knocking brake drums.	Grind or replace brake drums.
6.D Liner wear excessive or one-sided.	Replace brake shoes.
6.E Spring force insufficient.	Replace spring.
6.F Wrong type of liners.	Replace brake linings.

Problem 7: Handbrake effect insufficient

Classification/Probable Causes	Technical Details/Remedial Actions
7.A Brake shoes/pads oil-spattered.	Replace brake linings, determined cause.
7.B Excessive dead travel between brake shoes and brake drums.	Adjust handbrake.

Problem 8: Poor breaking effect in spite of great force on pedal Brake pedal travel short

Classification/Probable Causes	Technical Details/Remedial Actions
8.A Brake booster malfunctions - engine vacum	Check brake booster - Check engine (valves, cylinder head gasket etc.)

Classification/Probable Causes	Technical Details/Remedial Actions
8.B One brake circuit failed due to leaks or damage	Repair / replace circuit
8.C Spring force insufficient.	Replace spring.

Table 4.3.11: Troubleshooting of brake sytem

4.3.58 Basics of Auto Electrical

Basic terminologies of electrical system

- **Current:** The movement of electrons along the conductor in a specific direction produce an electrical current. The more the electrons which move, the greater is the current.
- **Ampere:** The amount of electron flow is the current and measured in Amperes. The electric current or Amperes (abbreviated amps) is measured by an Ammeter. The Ammeter can be graduated to read in amperes, milliamperes or micro amperes
- **Direct and alternating current:** If the electrons flow continuously in one direction along the conductor, the current is called direct current (abbreviated D.C.). This type of current produced by a D.C. generator and can be stored in battery.
- If the flow of electrons is in one direction and then flow back again and continue this back and forth motion, the current is called alternating current (abbreviated A.C.). This type of current produced by an alternator or A.C. generator and is the type of electricity found in home electrical circuits.
- **Potential Difference:** Some device is required to apply the necessary pressure for electrons flow through the conductor. This potential difference normally maintained by battery or generator is called the Electro-motive Force(EMF). The unit to measure is volt. Voltmeter is used to measure voltage or electrical potential of a circuit. The voltmeter can be graduated to read in volts or kilovolts and millivolts.
- **Resistance:** The opposition in electrons flow is called resistance and itis measured in ohms. One ohm is wire resistance in which an electrical pressure of one volt causes one ampere electric current to flow. The relation in Voltage, current and resistance is Ohm's law which is V=I x R or I=V/R (V-Potential Difference in Volt, I-Current flow in Amp and R-Resistance in Ohms)
- **Power:** Power may be defined as the rate of doing work. Mathematically,

  Power = Work done / Time
- **Watt:** It is a unit of electrical power. A watt is equal to the energy expanded per second by current of one ampere under the pressure of one volt. It is denoted by the letter W and is measured by wattmeter. (**"wattmeter"** is generally not used in Auto Workshops. The common multimeter used in workshops does not have wattmeter. Power is generally calculated)

  Wattage = voltage x current **or** **W = V x I**

A bigger unit of power is the kilowatt KW, Megawatt MW.

1 KW = 1000 W and 1 MW = 1000 KW

Electric circuits

When electrical components are connected, they may be placed either end on end (called series circuit) or side by side (called parallel circuit).

- **Series circuits:** When circuit components are connected with only one conducting path, they are called connected in series. The same current is flowing in all components. With series battery connection, the voltage obtained in the circuit will be a total of the voltage in the batteries. This principle is used in car batteries and many radio batteries, where voltages larger than 1.5 or 2 volts are required. The cells are joined together in series. In series resistor connection resistance in the circuit will be equivalent to all resistors sum as depicted the schematic diagram below.

  i.e. R = R1+ R2 +R3 +R4

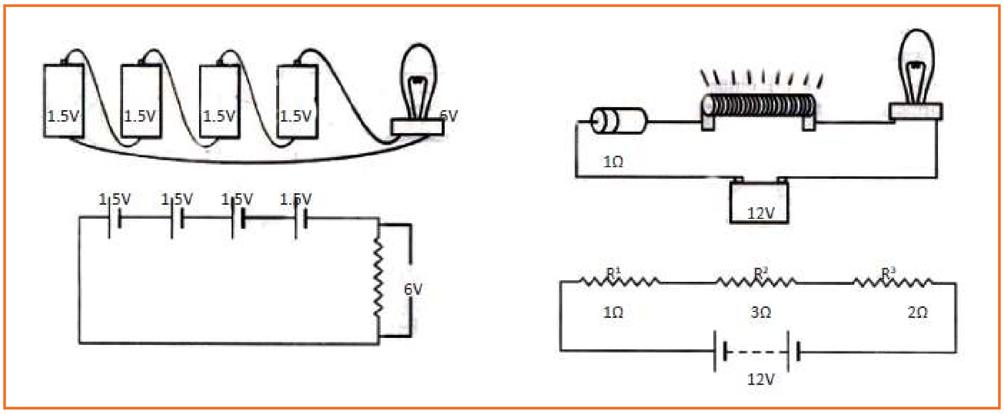


Fig 4.3.188: Series connection of storage cells Resistors in series

- **Parallel circuits:** When circuit components are connected with several conducting paths between the sources of EMF, they are called connected in parallel. During parallel connection of batteries the voltage remains the same as each cell. Parallel circuits are used in home wiring. If resistors are connected in parallel the resistance in the circuit will be equal to

  1/R =1/R1+1/R2+1/R3

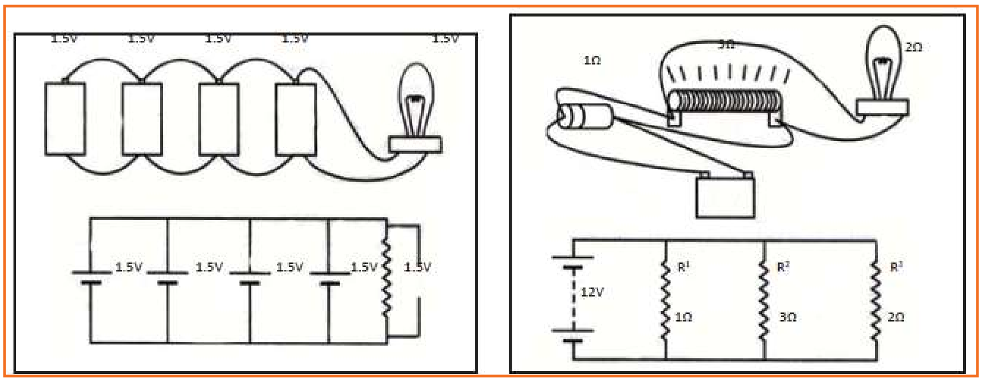


Fig 4.3.189: Parallel connection of storage cells & Resistors in parallel

Comparison of series and parallel circuits

Sl No.	Series Circuit	Parallel Circuit
1	There is only one path for the current to flow.	There is more than one path for the current to flow
2	Total resistance is equal to the sum of Its individual resistances, i.e. R=R1+R2+R3	The reciprocal of the total resistance is equal to sum of the reciprocal of sum of individual resistances. i.e. 1/R = 1/R1 + 1/R2 + 1/R3 $\frac{1}{R} = \frac{1}{R1} + \frac{1}{R2} + \frac{1}{R3}$
3	The current passing through all the resistances will be the same and equal to the main current	The current passing throught each resistance is different (if not equal). Greater the resistance, lesser the current flowing through it
4	The voltage in a series circuit is divided across each resistance according to the value of resistance. Greater the value of resistance, greate will be the voltage drop across it.	The voltage across each resistance is the same.
5	The total voltage applied is equal to the sum of the voltage drop in individual resistances, i.e. V = VI + V2 + V3	Circuit total current is equal to the sum of all the currents flowing through various resistances connected in parallel, i.e. I = iI + i2 + i3
6	The total resistance is greater than the greatest resistance connected in the series circuit.	The total resistance is less than the least resistance connected in the parallel circuit.

Table 4.3.12: Comparison between series and parallel circuit

Common gauges used to measure electrical quantities

- **Ammeter:** For measuring of current ammeter is used. Therefore, it should be connected in series to the load of which the current is to be measured.
- **Voltmeter:** For measuring potential difference voltmeter is used. It should be connected in parallel to the circuit of which the potential difference is being measured.

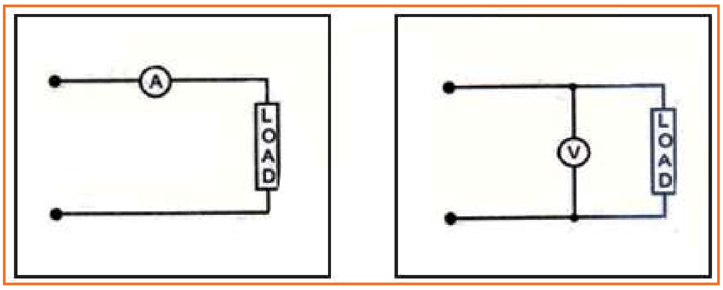


Fig 4.3.190: Ammeter in series & Voltmeter in parallel

- **Multimeter:** It is the most common instrument used fortesting and measuring current, voltageand resistance of insulators and conductors. Used to trace out faults of the electrical circuits such as opencircuit, short circuit, earth and continuity.

Fig 4.3.191: Multimeter

Open and closed circuits

It is necessary that the electrical circuit be used when required and the current stopped when not wanted. To enable this to be done without dismantling the circuit each time, a switch is placed in the circuit.

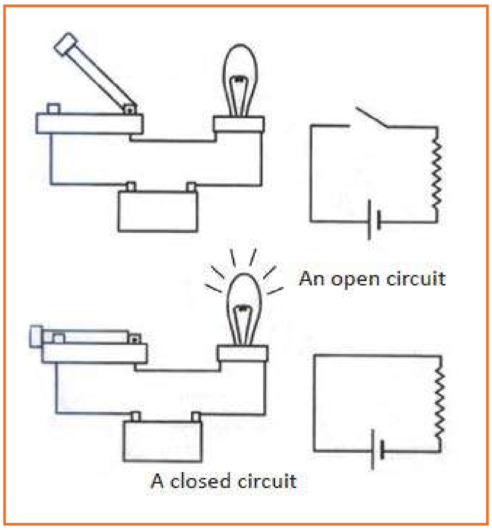


Fig 4.3.192: Ammeter in series & Voltmeter in parallel

- During off position, circuit is broken and the electrons cannot flow. This is called an open circuit.
- During **"on"** position electrons can flow and circuit is considered closed.

Colour coding – wires

There are standard colour codes for the covering of all types of conductors in a three-phase system for easy identification.

Wire colour coding for a 3-phase system in India for domestic wiring

Line	Colour
L1	Red
L2	Yellow
L3	Blue
Neutral	Black
Ground/protective earth	Green

Fig 4.3.193: Wire colour coding

Through marker and colour-coding the circuit various parts become easy to understand the circuit and diagnose electrical problems.

Basic components of electrical system

- **Conductors:** Substances through which allow of current i.e. electrons flow easily is called conductors. Conductivity determines the free electrons present in the substance. Most of the metals are electricity good conductors. Conducting wires or strips can be connected to create A conduction path for the current to flow.
- **Insulators:** Substances which do not easily allow the current flow are known as insulators.
- **Semiconductors:** Substance which is not good conductor and even not bad conductor is called semi-conductors. Free electrons in such substances is quite low in comparison to that in conductors, hence their resistance is quite high, e.g., germanium, silicon, carbon, boron etc. If a little quantity of any other substance is mixed in such substances as an impurity, then their resistance is reduced. These substances are used for making diodes, transistors etc.
- **Resistors:** When wire / piece of material is used as component for producing resistance in a circuit known as resistor. Resistors made of carbon / graphite are called carbon resistors.
- **Dynamo or generator:** Mechanical energy is converted into electrical energy using alternator, in the same fashion mechanical energy is converted into electrical energy using dynamo. The little difference in both the machines is this that dynamo generates D.C. while an alternator generates A.C. A dynamo employs a commutator in place of slip rings for supplying D.C. to the external circuit.
- **Motor:** Machine which is used to convert electrical energy into mechanical energy is called motor.

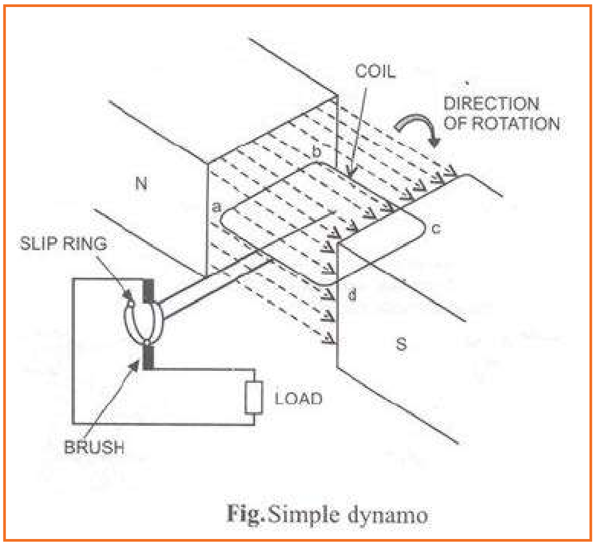


Fig 4.3.194: Simple dynamo

If a conductor current carrying is positioned in magnetic field, then it experiences force acting on it. The force direction is determined by using Fleming's Left Hand Rule.

Fuse and circuit breakers:

- For protection of wiring and equipment of vehicles.
- Every component uses electricity should connect with the power source using fuse.
- Marked with its specific capacity.
- Most fuses handle the load for several different powered objects. For radio, emergency flashers and brake lightsan effuse can be used.
- Generally, blade fuses are used in automobiles.
- Blade fuse made-up of a plastic body & two prongs that fit into sockets.

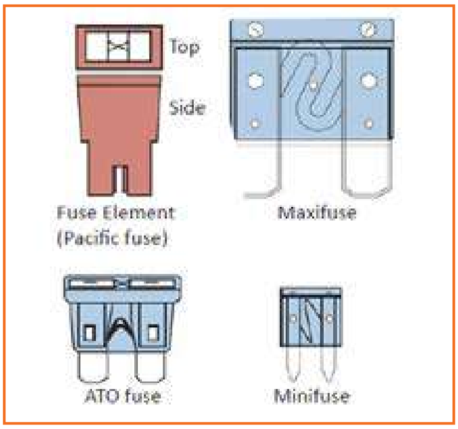
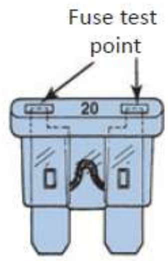


Fig 4.3.195:Fuses

- These types of fuses come in four different physical dimensions. Rated current in Amperes is printed on the top of each fuse.
- A blade fuse consists of a plastic body & twofuse test point.

Normal current in the circuit (Amperes)	Fuse rating
7.5 A	10 A
16 A	20 A
24 A	30 A

Chart 10-5



Blade-type fuses can be tested through openings in the plastic at the top of the fuse.

Fig 4.3.196: Fuse rating

Relays:

- It is magnetic switch which use movable armature for controlling high amperage circuit with help of low amperage electrical switch.
- A typical relay requires only about one tenth of current through relay coil. It's movable arm to complete a circuit during power at terminal and closes the contacts as designed.

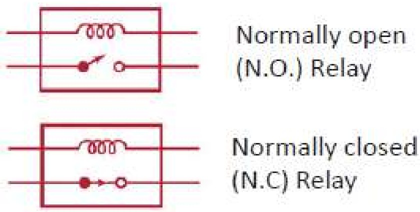


Fig 4.3.197: Relays

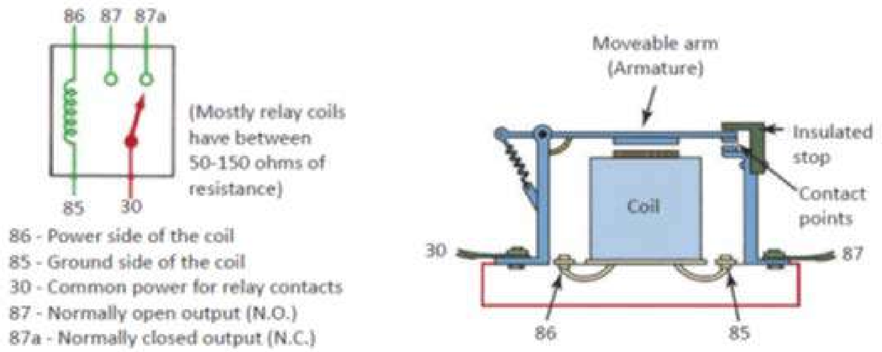


Fig 4.3.198: Relay cross-section view

A typical four terminal relay is shown here. Current flowing through coil (terminals 86 & 85) draws movable arm (called the armature) toward coil magnet. Contact point is complete when electrical circuit connected to terminals 30 & 87.

Relay - Diagnosis Tip:

Use marker and with help of circuit colour coding will it become easier to know the circuit and diagnose electrical problems.

- **High current portion:** Check by removing the relay that there are 12 volts at the terminal 30 socket. If yes,then the power side confirmed ok.
- **Control circuit (low current):** Remove relay from socket & check there is 12 volts to terminal 86 with the ignition on and control switch on. If not then check service information.
- **Check function ofrelay:** Check continuity between 30 and 87a (in Normally open type relay, there should not be continuity. There must be continuity across these terminals after applying 12 V across 86 & 85. Check resistance across 85 and 86 using ohmmeter. It should show certain amount of resistance and must not show open or short circuit.

4.3.59 Basics Auto Electronics

Basic components of electronic system

- **Diode:** A diode is an electronic component which allows the current to pass only in one direction.

  Biasing of diodes

  A diode may be forward biased or reverse biased.

  – For forward biasing a diode, the anode should be connected to battery positive terminal and cathode to negative terminal of battery. When a diode is in the forward biased condition, the resistance between the terminals will be few ohms to a tens of ohms. Hence, current flows freely when a diode is forward biased.

  – When a diode is reverse-biased, the resistance between the terminals will become high, several tens of mega-ohms. Hence, current does not flow when diode is reverse biased. Ratio of resistance in forward and reverse bias should be at the minimum in order of 1:1000.

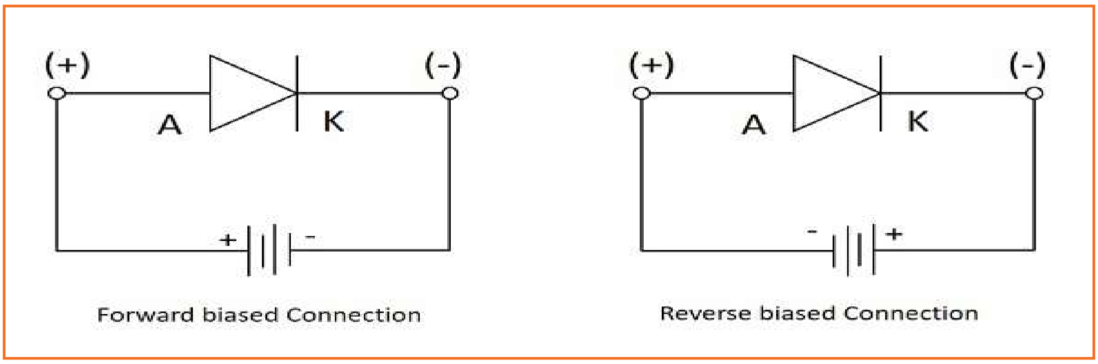


Fig 4.3.199: Biasing of Diodes

  The PN junction diodes discussed above are commonly known as rectifier diodes. This is because these diodes are used mostly in the application of rectifying AC to DC.

- **Transistors:** Put P and N material together to outline a PN junction, and you have a diode?.Carry this one step further and you can make a transistor?. Transistors are of two types - the PNP and the NPN types. Either one maybe used to amplify.

Both types have three parts -

a. the emitter,

b. the base and

c. the collector.

Their functions are:

a. **Emitter:** Emits current carriers (electrons / holes)

b. **Base:** Controls emitter to collector current flow

c. **Collector:** Collects current carriers

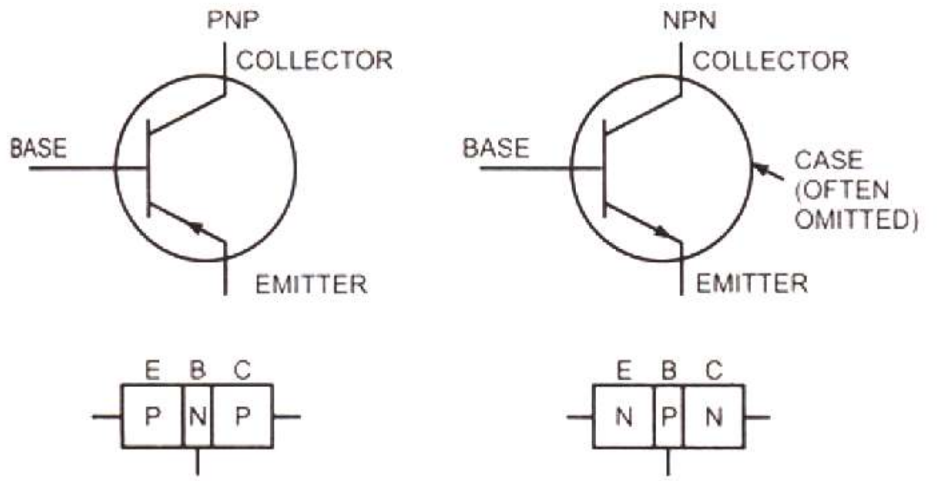


Fig. Two types of transistors both have three parts : emitter, base and collector. The direction in which the little arrow on the emitter points identifies the device as either NPN or PNP.

Fig 4.3.200: Transistors

Both NPN & PNP type of transistors are equally useful in electronic circuits. However, NPN transistors are used mostly because NPN has higher switching speed compared to PNP.

- **DC power supply:** The current that is supplied for domestic use is AC. This AC current is fine for electrical devices such as heaters, lights etc. Working circuits of radios, televisions, computers, or other electronic equipment is not using AC. Due to that, the first circuit in electronic items is usually a power supply circuit, which changes the 220 V AC current to a DC current of a certain required voltage.

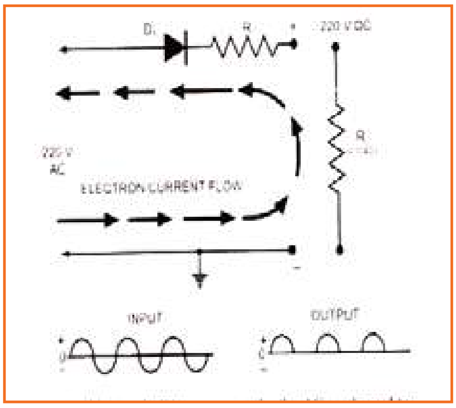


Fig 4.3.201: DC power supply

Power supplies perform two main jobs:

– They change the AC to DC, and they change the voltage level top provide the voltage needed. Most power supplies use diodes to change the

AC to DC.

- Transformers also change the voltage level, but use of resistors and Zener diodes are also very common in many power supplies. The below figure shows the simplest DC power supply. It produces 220 V pulsating DC.

- **Rectifiers:** Device which changes A.C. electricity into D.C. electricity is called rectifier. It works like valve, allowing single direction current flow along a wire but not in the other direction. The rectifier (sometimes called a diode) will cause the current to start-stop, because each half cycle will be eliminated. This is called a pulsating D.C. current. To produce a wave form similar to that produced by D.C. generator, a bridge rectifier is used. This is an arrangement of four diodes which direct current in single direction only, no matter from which direction it may come.

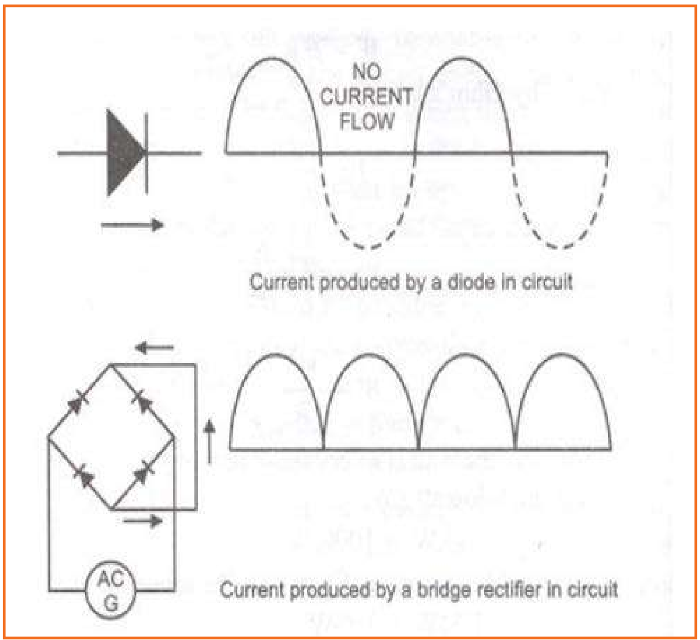


Fig 4.3.202: Rectifier

It is a device consists of a set of diodes for converting AC current into DC current (DC). The unique functionality of diode is it allows current to flow in one direction only thus acts like a valve. Rectification is the process of blocking current to flow in one direction.

There are several types of rectifiers, based on shapes and physical appearance like solid state diodes,vacuum tube diodes etc.

4.3.60 Active & Passive Safety System of Automobiles

For prevention of accidents and protection of passengers, modern cars are using various types ofdevices.

One may drive very defensively, but road user cannot be controlled. Accidents may happen any time. Fortunately, for prevention of accidents and protection of passengers, modern cars are using varioustypes of devices for the safety of car's driver and occupants during accident.

Categorization of safety devices:

Active driving safety devices

1. Passive driving safety devices
2. Tertiary Safety devices

Active driving safety devices and systems better control to for prevention of accident. They normally automated to eliminate for human errors. Human errors are the single largest causes of vehicle accidents.

Some of the examples of active devices are:

- **ABS:** Anti-lock brakes that avoid wheels from getting locked up when the driver brakes, to enable him safely steer while braking.
- Traction control systems that prevents the wheels slippage during vehicle acceleration.
- **ESP:** Electronic stability program or control that keeps the car under control on the road while driving at high speed and taking turns.
- Adjustable height steering wheel, Ergonomics, ground linkages, visibility, driver information system,voice synthesizer.

Passive driving safety systems in the car is used for protection of the occupants during an event of accident.

- Air bags that provide cushion and protect during a crash.
- Seat belts hold passengers in place, prevent being thrown forward or getting ejected from the vehicle.
- Pre-tensioners, Paddings, Reinforcements
- Roll cage that protects the car's occupants from injury during accident rolls over.
- Head restraints prevent from getting whiplash during a rear-end collision.

Tertiary Safety Systems refer to all methods in place to accelerate the vehicle's emergency procedures.

- Emergency cell systems
- GPS locating
- Hazard warning lights illumination
- Loading the vehicle, anticipating the accident spot, access to occupants

Airbags

Sensor(s) in the airbags determine whether deceleration rate can cause bodily harm to vehicle occupants. Airbag electrical connectors and conduits are yellow and all electrical terminals are gold plated for corrosion prevention.

Frontal airbags operate within 30 degrees from the center and do not set out during rollover, side, or rear collision. Two sensors must trigger simultaneously for airbag deployment.

Fig 4.3.203: Airbags

Many advanced systems have accelerometer type crash sensor which measures deceleration.

Components of air bag system:

SDM: sensing and diagnostic Module of airbags contain arming sensor and electronics for continuity check of circuit to set off air bag.

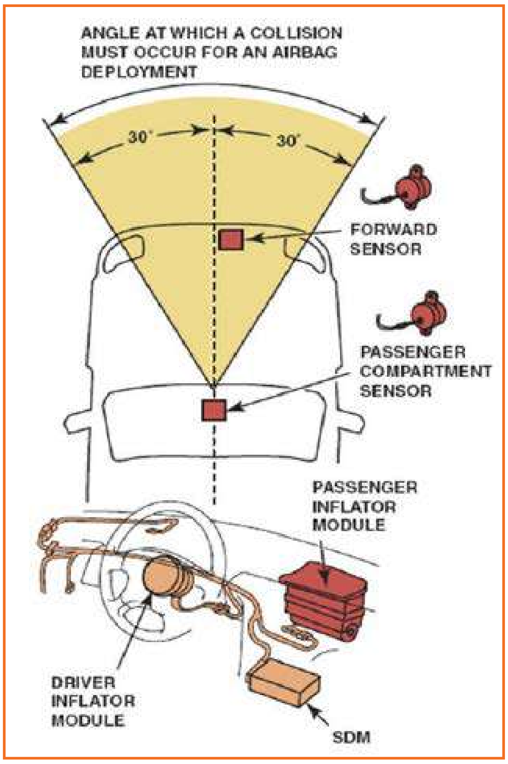


Fig 4.3.204: Air bag components

Safety module, arming sensor and at lone of the discriminating sensors must be activated at the simultaneously for airbag deployment.

Power is provided by the arming sensor and one discriminating sensors can provide for the grounding Of circuit.

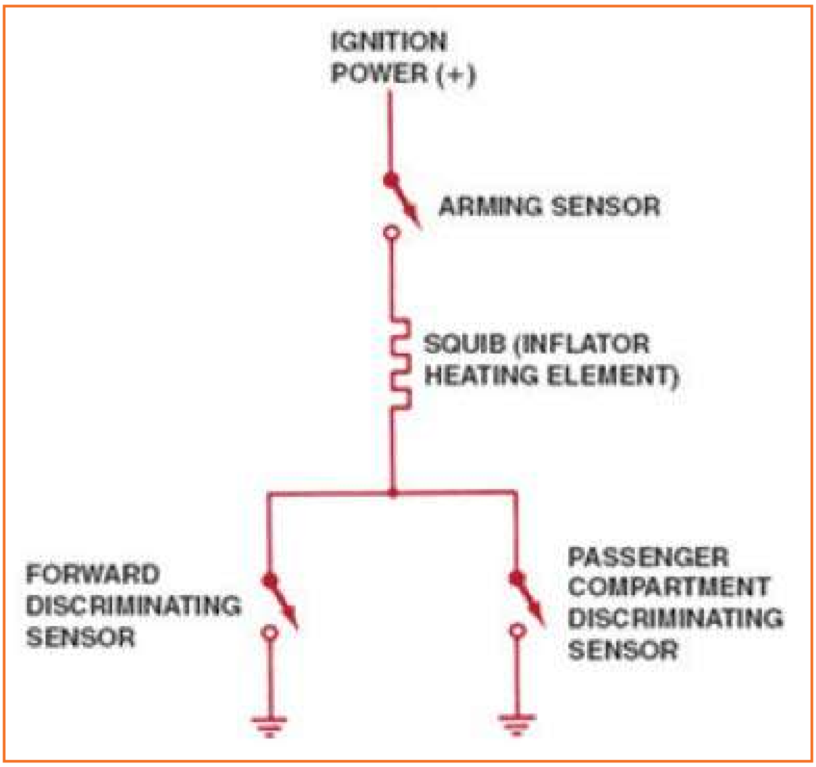


Fig 4.3.205: Air Bag Deployment Circuit

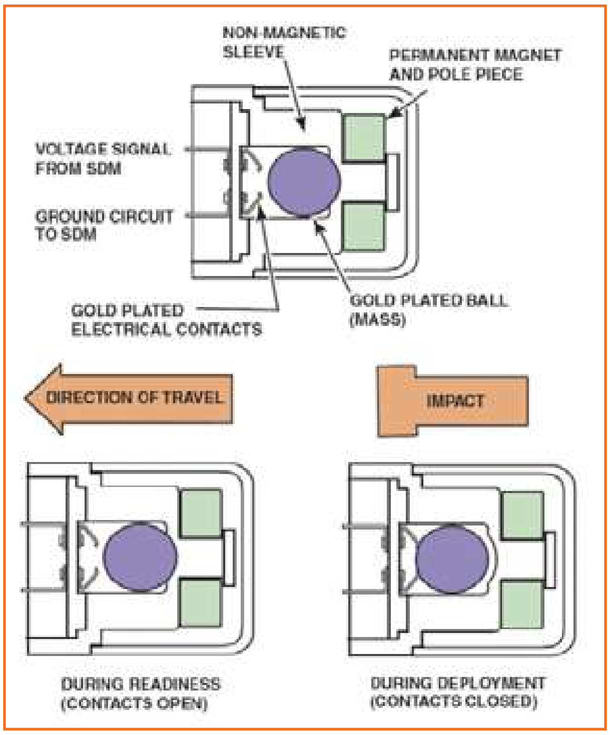


Fig 4.3.206: Airbag magnetic sensor

Two stage air bags: Most of the cars have two-stage airbags that contain two separate inflators, onefor less severe crashes and one for higher speed collisions.

Such a system is sometimes called the smart airbag system due to use of accelerometer-type sensordevice will deploy one or both stages.

N.B.: The airbags should be dis-armed, (temporarily disconnected), whenever performing service work on any of

- Steering wheel
- Dash or instrument panel
- Glove box (instrument panel storage compartment)

Caution: Diagnosis and servicing air bag system should be performed by trained and authorized technician only

Air bag servicing: Refer guideline for the exact procedure, which usually includes the following steps -

1. Disconnect negative battery cable.
2. Remove airbag fuse (has yellow cover).
3. Disable driver's side airbag by disconnecting the yellow electrical connector located around steering column.
4. Disconnect yellow electrical connector for passenger side airbag.

By disconnecting battery & yellow connector at base of steering column, remove airbag inflatormodule from steering wheel.

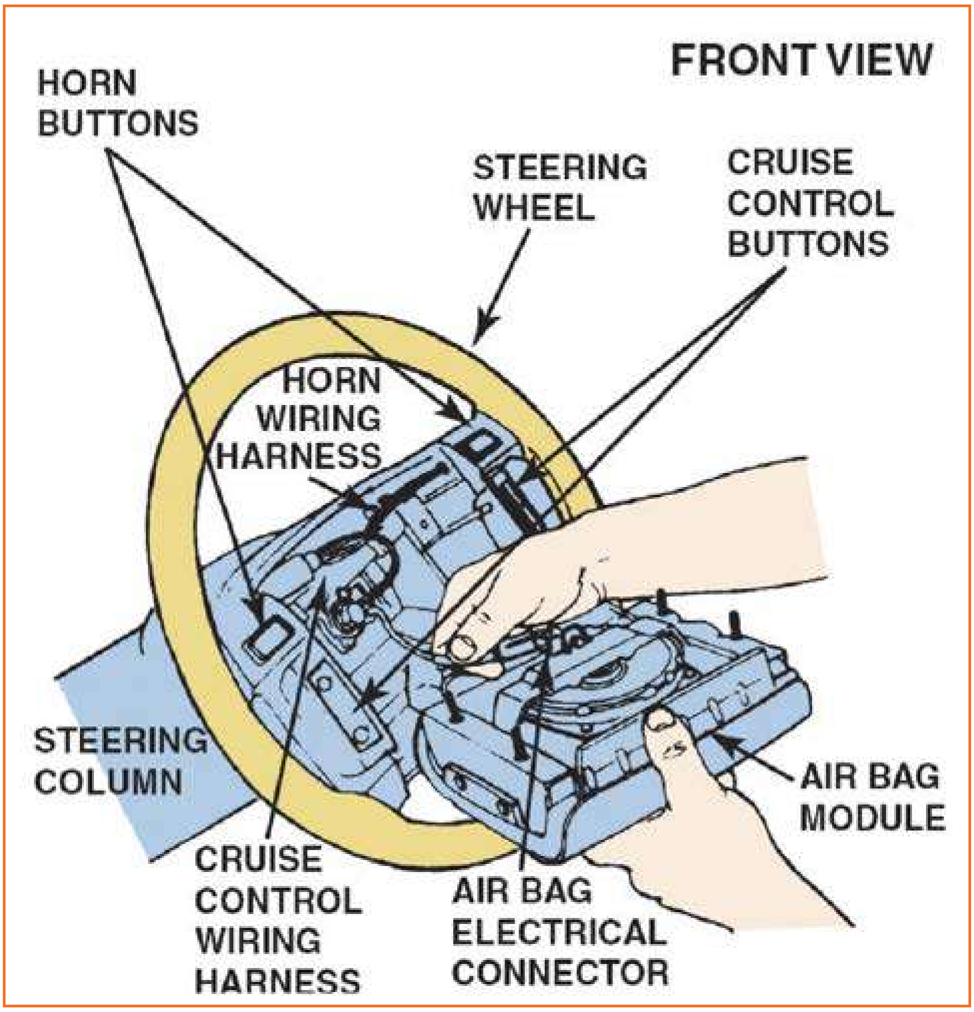


Fig 4.3.207: Airbag module replacement

Air Bag Deployment Safety Tips: Do the following to prevent injury when manually deploying an airbag.

- If it is possible, deploy airbag outside the vehicle.
- Follow vehicle manufacturer's procedures & equipment recommendations.
- Wear proper hearing & eye protection.
- Deploy airbag with trim cover facing upwards.
- Stay around 20 ft (6 m) from airbag. (Use long jumper wires attached to the wiring and routed outside vehicle battery.

Seat Belt: Pre-tensioners

Pre-tensioners are explosive (pyrotechnic) devices which is used for slack removal from seat belt and help position the occupant.

Seat belt warning light

Explosive Charge: A small explosive charge in the pre-tensioner forces seat belt down the tube, which removes any slack in the seat belt.

Fig 4.3.208: Seat belt indicator

Fig 4.3.209: Pre-tensioner cable

Seat belt pre-tensioner working principles: Seat belts are the primary restraint system. During acollision, seat belt pre-tensioners absorb the force generated during the collision.

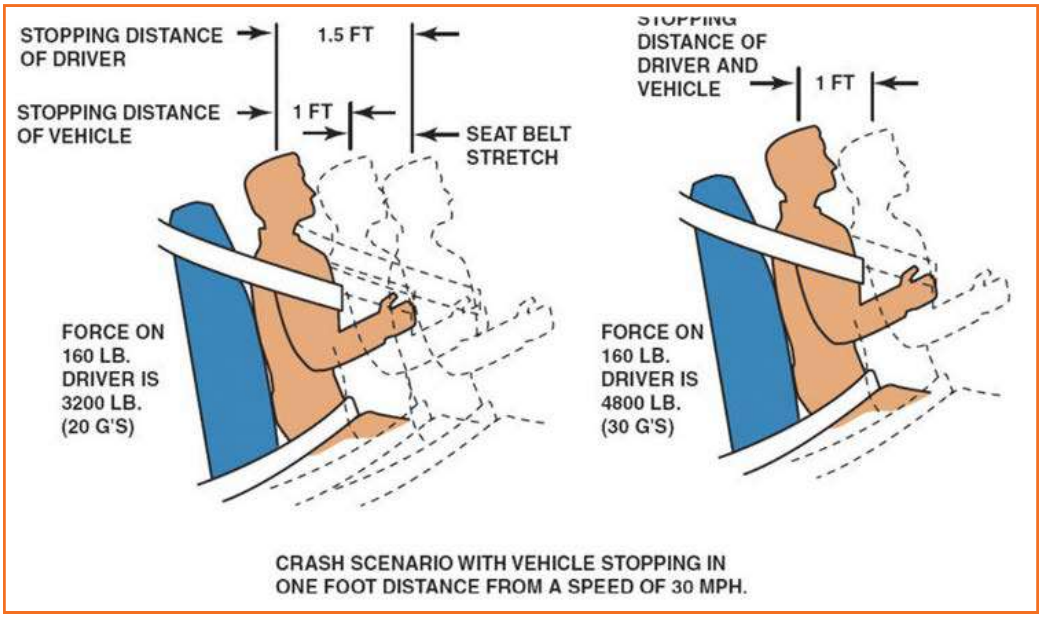


Fig 4.3.210: Seat belt crash scenario working

There are two category of seat belt pretensioners, a mechanical pretensioner and an electronic pretensioner. The mechanical pretensioner is typically connected to the seat belt buckle by a powerful spring that remains compressed in a tube prior to an accident. A latching mechanism is responsible for compressing the pretensioner until an accident occurs, upon which time the impact will result in a release of the spring. This will then tighten the seat belt and eliminate any slack from the belt to ensure the safety of the passengers.

An electronic pretensioner differs from the mechanical, in that it utilizes and ECU and a gas generator system, similarly to the airbag system. An electronic pretensioner is perhaps more effective due to the fact that it works in correlation with the airbag. This particular pretensioner uses an explosive charge to cause the gas generator to create a volume of gas, which then produces a sort of pressure that works on a mechanical linkage to tighten the belt.

While these two pretensioners are different in the manner in which they are operated, they certainly have important similarities. Around 30 milliseconds after the collision has occurred during an accident, both pretensioners will create a slight amount of slack so that the passenger is able to have controlled contact with the airbag.

Inertia type locking mechanism: Most safety belts have an inertia-type mechanism that locks thebelt in the event of rapid movement.

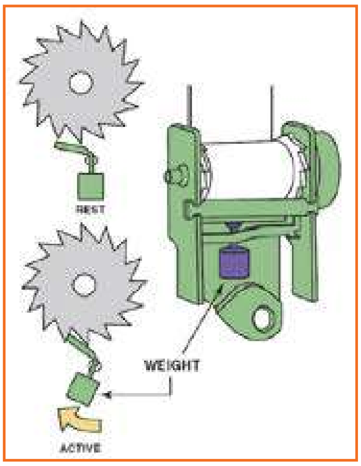


Fig 4.3.211: Locking mechanism

Clock Spring

Clock Spring allows steering wheel to turn, while still making electrical connection with horn & other devices and vehicle's electrical systems.

It is found between steering wheel and steering column and made-up of a flat multi-core cable in spiral shape like clock spring.


Fig 4.3.212: Coil spring

Reinforcements

Reinforcements are provided to reinforce meaning to strengthen or support. Today's manufacturersprovide added security to the vehicle and occupants by making reinforcing the structure and materialsused in the vehicle.

To enhance their characteristics features materials are used.

- Reinforced material
- Reinforced structure
- Reinforced external bars

Crash Test

Frontal collision: Crumple zone absorbs the impact, preventing the engine from moving inwards.

Side collision: The doors and sides get the impact. The 1, 2 and 3 pillars make vehicle side.

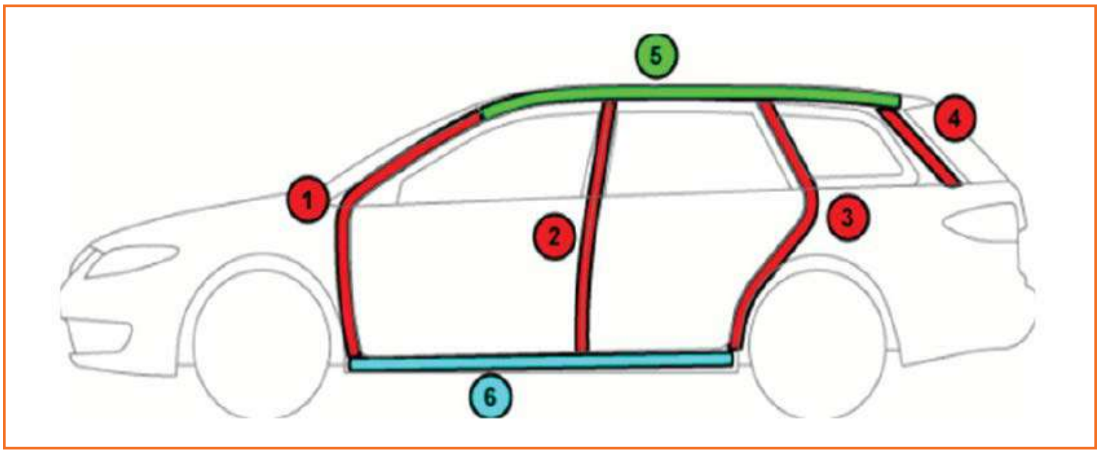


Fig 4.3.213: Car Body Reinforcements

1 = A-Pillar, 2 = B-Pillar, 3 = C-Pillar, 4 = D-Pillar, 5 = Roof rail, 6 = Door sill

(What is indicated by different colours in the above fig.)

Reinforced Materials: Steel is used in a vehicle to increase fuel efficiency, weight reduction is a majorfocus area in many parts where the crash impact is not much, other materials like aluminium, magnesiumand plastics and composites are being used. The preference of aluminium lies in its low weight; itis almost three-times lighter than steel.

Instead of steel for increasing strength alloys are being used in many parts, such as support pillars and wheels.

Reinforced Structure: At times, increasing the strength of a metal makes it brittle. Therefore, parts are designed so that the forces from a crash gets divided over the vehicle.

For reinforcements, the B-pillar is very important. This includes thicker plates and tubes.

Tubes used in doors to avoid deformation dues to crash.

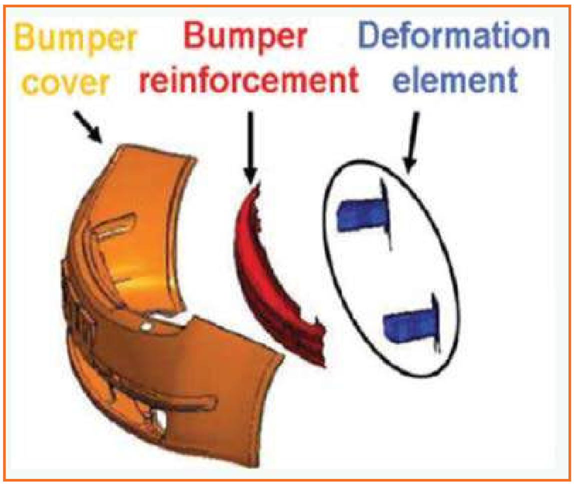


Fig 4.3.214: External reinforcements

External Reinforcements

Add-on reinforcements:

- Frontal and rear Bumper Reinforcement
- Side Bar Reinforcements

Frontal and rear bumpers get deformed and absorb collision force.

Bumper reinforcements are consists of steel springs and joints that collapse under pressure and reduce crash force. They are generally made of steel or a stronger composite material

Inspect steel bumper for following signs:

- Corrosion
- Any break or visible damage
- Loosened or damaged mounting fasteners

In the first two cases, it should be immediately replaced.

Note: Some manufacturers do not allow steel bumpers and side bars. Many allow only cold straightening. Refer to the service manual before proceeding with any repair.

4.3.61 Battery

- Automotive battery is used to supply power to everything electrical.
- Battery also acts as stabilizer to voltage for entire electrical system.
- An automobile battery contains sulfuric acid electrolyte and +Ve & -Ve electrodes in several plates.

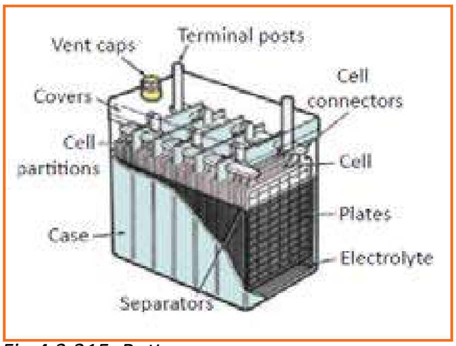


Fig 4.3.215: Battery

How a battery works:

- Think of sulphuric acid solution in the electrolyte being deposited; removed from plates.
- **During discharge:** The acid (H2SO4) leaves the electrolyte and gets onto both the plates.
- **During charging:** The acid (H2SO4) is forced from both plates, and it enters the electrolyte.

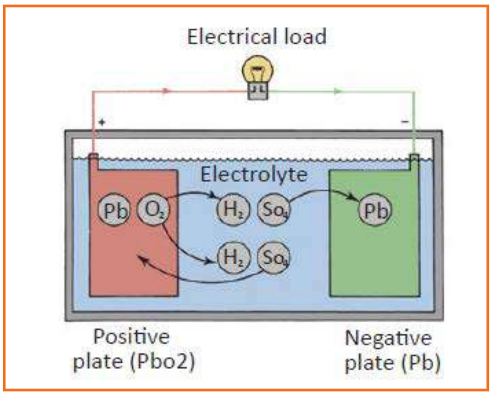


Fig 4.3.216: Working of battery

Safety procedures:

- While working on electrical component in a vehicle disconnect -Ve battery cable from battery,.
- Use eye protection, while working around any battery.
- Wear protective clothing to protect acid contact.
- Always follow all safety precautions, as stated in service procedures for battery service & testing.
- Never burn and avoid open flame around any battery.

To check if a battery is weak or defective:

The following warning signs indicate that a battery is near the end of its useful life -

- Needs water in cells
- Shows excessive corrosion on the battery cables or connections
- Engine cranking becomes slower than usual

4.3.62 Inspection of Battery Leads & Connections

When starter key is turned and it indicates weak click or total silence, it means battery is flat. In case battery is functioning properly, problem is possibly in between battery and starter circuit.

1. Loosen the clamp connector bolt.
2. Flat cable connector is bolted to flat battery post.
3. Connector on battery should be clean.
4. Remove greenish or whitest powdery corrosion deposits and then brighten the metal surfaces.

5. Similarly, remove such deposits from the battery carter and other metal parts. These parts are very prone to corrosion.
6. After this terminal cleaning, if the problem is not solved, then examine the earthing attached to the body / chassis. Clean, if necessary.
7. Starter motor and solenoid should be checked for loose connections, which may cause sparking.

Fig 4.3.217: Inpsection of battery

4.3.63 Alternator - Charging System and Circuits

What does alternator do?

- Automobile has charging system to supply power to headlights, ignition coil, engine cooling fans, radio & AC fans etc.
- The power to run all of this electrical equipment comes from alternator via battery.
- Alternator is link to battery. It converts engine mechanical power to electrical power and keeps battery charged
- It works on electromagnetic induction principle for generating electrical power from mechanical power. In electromagnetic induction, electrical current is generated in a conductor, when conductor is moved through magnetic field.
- Due to current running through slip rings fingers of rotor becoming alternating north and south magnetic poles.

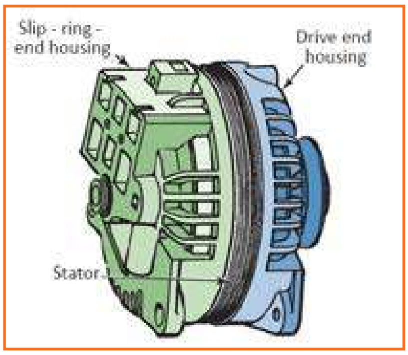


Fig 4.3.218: Alternator

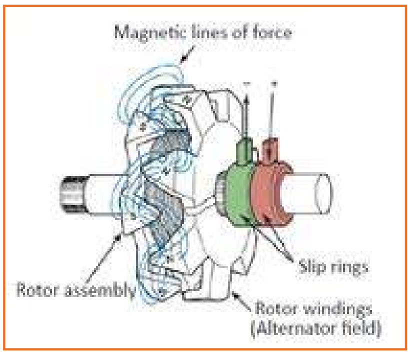


Fig 4.3.219: Alternator

Why is alternator better than dynamo?

- The earlier vehicles used dynamo for converting mechanical energy into electrical energy.
- The alternator is more efficient and does a better job at

providing electricity to the battery.

- The dynamo does not charge when in idle speed/low rpm whereas, an alternator charges even at idle speed/low rpm.
- Alternator contains smaller diameter pulley for driving at faster speed compare to dynamo, thus offer output is better.

Alternator defects and remedies to be added

4.3.64 Starting Motor - Starting System and Circuits

- The starter motor works for engine rotation at 85-150 rpm that is required for the engine ignition process.
- It uses a 12 volt electrical system to start engine via a flywheel.
- During turning on ignition key, bendix extends and interlocks with flywheel.
- It leaves the flywheel when the key is turned back

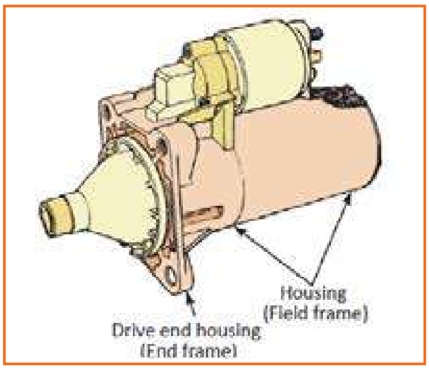


Fig 4.3.220: Motor

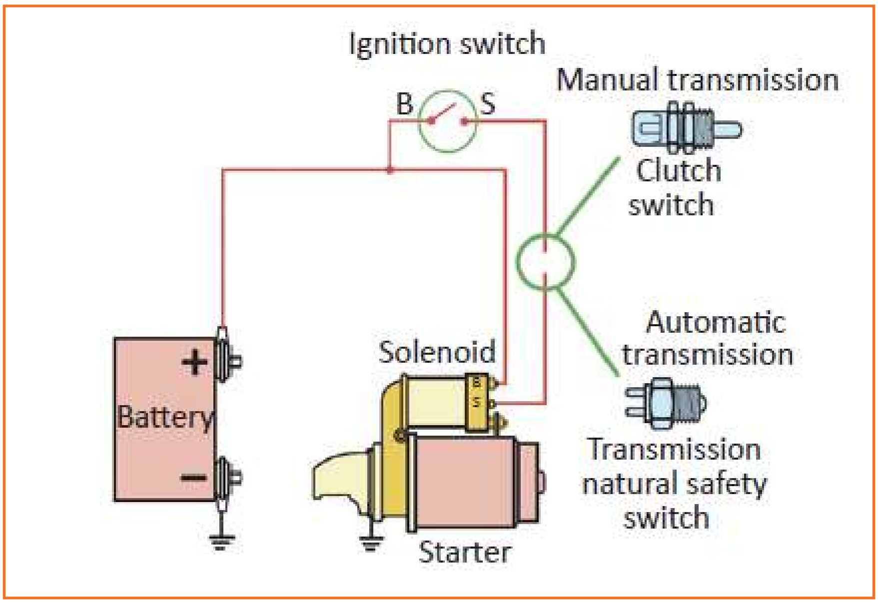


Fig 4.3.221: Starter motor function

4.3.65 Electrical Devices in Vehicle

Lighting systems:

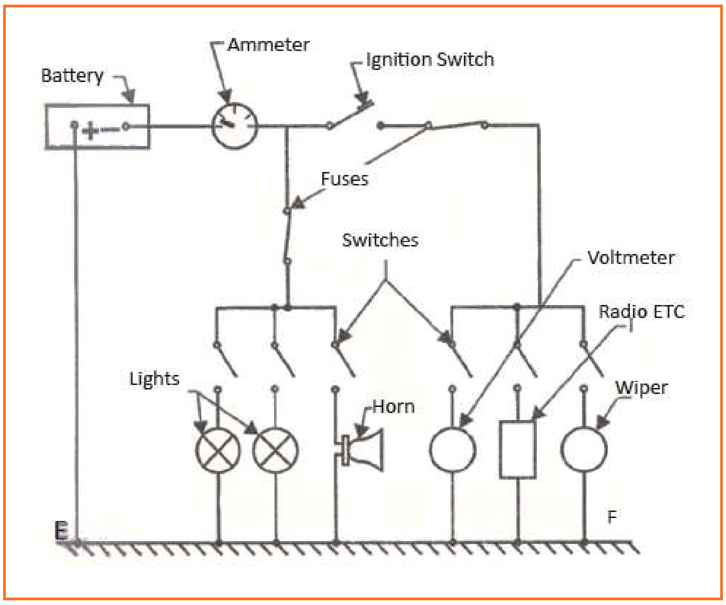


Fig 4.3.222: Lighting system diagram

Car lighting system consists of headlights arranged to give the driver visibility at night, as well as parking, stop, and directional signal lights and provide other drivers with information about the intentions or actions of a vehicle. Each of the various lighting circuits is controlled by switches linked in series with battery and lights. When a circuit has multiple light bulbs, they are connected in parallel. The grounded type of circuit is used wherever possible.

Fig. above shows a schematic circuit diagram of both the lighting and accessories circuit. In this only windscreen wiper, horn and radio have been included.

A four wheeler has mainly following lightings:

- **Headlights:** Most cars have two head-lights. They are placed at same level and at equal distance from center of the vehicle.

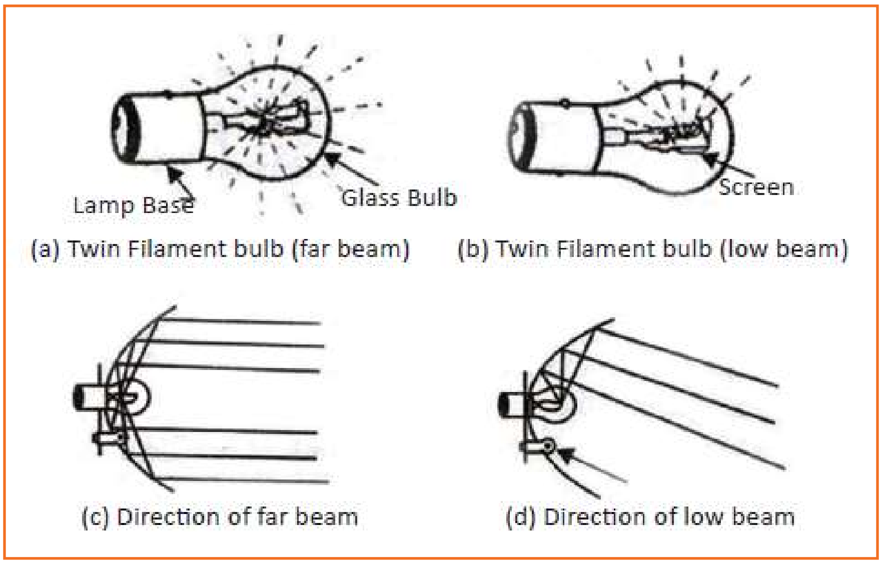


Fig 4.3.223: Headlights

A headlight consists of a housing, the reflector, the light diffusing glass and the bulbs along with their sockets. The reflector concentrates the light, which is emitted by the bulb in all directions and then directs it ahead of the vehicle.

The bulb contain coil or **"coiled-coil"** filament which is accurately located at the focus of the reflector. The first filament i.e. for high beam or **"far beam"** is placed at the focus of the reflector. The other filament i.e., for low beam or **"dimmed light"** is located a little in front of the focus and slightly above. The light emitted by low beam filament is reflected in the form of downward directed spreading beam. Rays from the filament, which strike the lower part of the reflector are intercepted by the screen and so there is no upward directed spreading beam.

- **Side lamps:** The side and tail lamps are very small having reflectors. Their covers are opalescent or fluted so that light is dispersed. They are needed not only under driving conditions but also during night parking.
- **Brake warning light:** When brake is applied by pressing the foot paddle, a switch is closed. It completes the circuit having two rear warning red lights. It gives an indication to the rear side indicating vehicle is slowing down.
- **Dash light:** Available at dashboard for making the different gauges and meters easily visible.
- **Cab and body light:** These are required in the interior of the vehicle for the convenience of the driver and the passengers
- **Ignition warning light:** Battery discharge takes place during rest state of engine or is idling at very low speed. This is shown up by the ignition warning red light on instrument panel during switching on ignition.
- **Flashing direction indicator:** It is based on hot-wire principle. The thermal elongation of a thin resistance wire under current control passing through is controlling the blinker contacts

Windshield wipers:

A windscreen wiper or windshield wiper (American English) is a device used to remove rain, snow, ice, washer fluid, water, and/or debris from a vehicle's front window.

The blades of a wiper are actuated by low capacity electric motor. Types of motors in use -

- **Reciprocating wiper motor:** In this the motor shaft rotary motion is transformed into return motion of one blade by means of gear system with crank. The second blade is made to move through suitable linkage.
- **Rotating wiper motor:** As shown in figure, the drive shaft rotates and this motion is transformed into return motion outside the motor and transmitted to the blades of the wipers. Mostly the motors are of the full-cycle cut-out type i.e. they stop only when the blades reach their end positions.

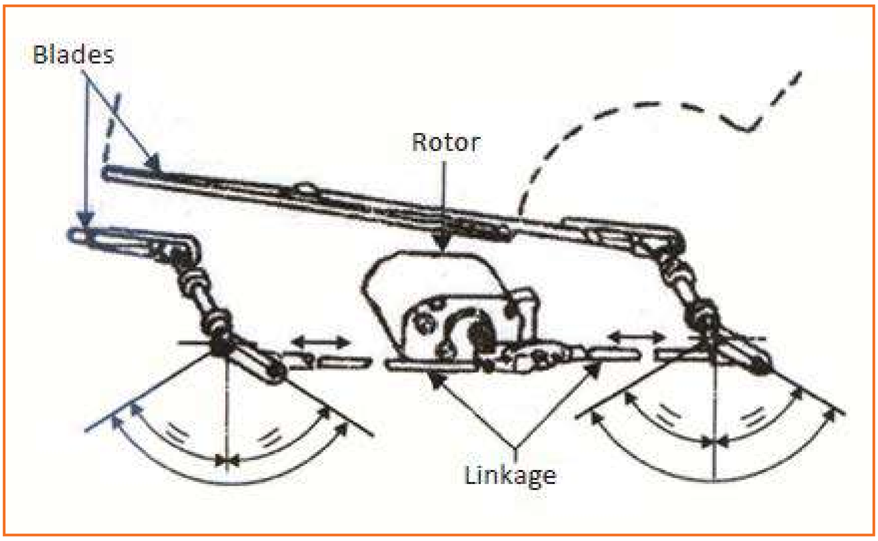


Fig 4.3.224: Wind shield wipers

Electric horn:

As horn is used as a warning device on motor vehicles, it should be such that -

- The note emitted by it is neither too musical nor too hoarse
- It is able to make itself heard above the general noise of the traffic
- It requires little maintenance and adjustment

Fig. below shows double diaphragm gaps electric horn. Inside the casing there is an electromagnet within which there is an armature attached to a wavy section low-frequency (300 vibrations per second) diaphragm. The diaphragm is fixed to the hosing around its edges. On left side of the diaphragm, the armature rod is fixed to a `metal' tone disc, which produces frequency of approximately 200 vibrations per second.

The contact breaker sets the armature into vibrations as the horn switch is pressed. When the armature moves right side, the circuit breaker is struck by a projection on the armature and the electric circuit breaks. The guide springs pushes the armature to left side which restarts cycle.

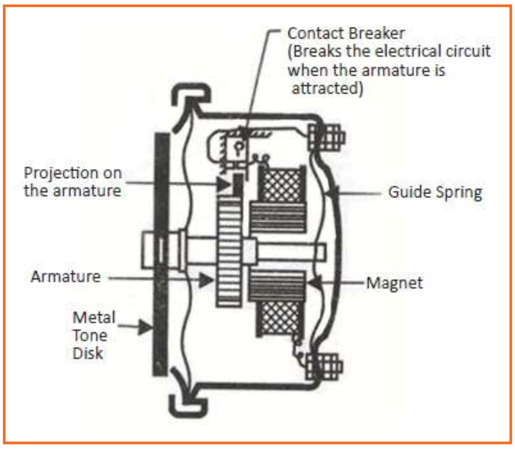


Fig 4.3.225: Electric horn working

Switches:

Switches make it possible to open and close the circuit, having series connection to control the circuit. There are many different types, which can be operated by pulling, pushing, or turning.

Instruments:

The car driver is provided with multiple instruments and indicators on the dashboard to give him information about the car and its engine.

Speedometer:

Most speedometers used earlier were of mechanical type. Now, electronic models are used in most of the cars.

Mechanical type Speedometer: flexible drive cable consisting of a strong outer sheath containing a rotating wire core is operated by the gearbox. At dash board end, core is connected to speedometer. It spinsa circular magnet at a speed of car. The magnet exerts a pull on an aluminium disconnected to the speedometer pointer, which is lightly sprung towards the zero stop.

Pull depends on magnetic turns speed, and needle moves accordingly. Speedometer failure is mainly due to broken drive.

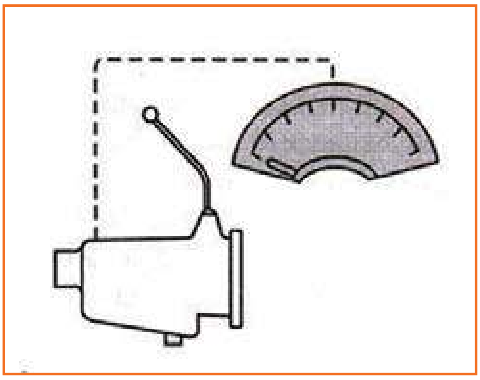


Fig 4.3.226: Speedometer

Odometer:

Sometimes called a 'milometer', records the total distance traveled by the car since manufacture. It is invariably built into the same housing as the speedometer.

A simple gear-driven counter is used. Odometer can't be reset to zero; the distance recorded soften used as an indication of the amount of use a second-hand car has received. A trip-recording odometer is fitted to some' cars, supplementing the main instrument; with a reset device. The trip-recording meter can be reset during journey, making it possible to record the distance traveled in any particular journey or part of a journey. Now a days in modern vehicle it is now converted in electronics device.

Fig 4.3.227: Odometer

Fuel gauge:

Fuel gauges are electrically operated. A float, rather similar to the ball-cock float used in domestic water tanks, is mounted inside the fuel tank. The float arm operates the variable resistor, which control the flow of current according to float position. A wire connects this to the dashboard indicator, which is simply a device to measure electric current. The usual type of meter, which is used, consume more time to react — it thus records the average position of the float, giving a steady indication of fuel level.

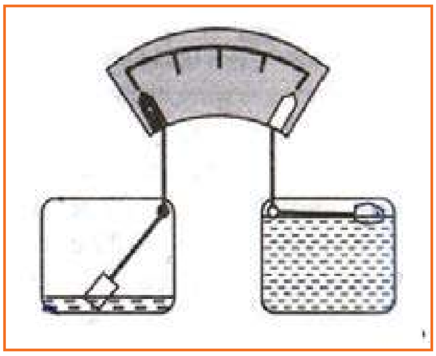


Fig 4.3.228: Fuel gauge

Temperature gauge:

Water-cooled engine temperature will become dangerously high if cooling system is faulty. Temperature of the cooling water is measured by temperature gauge at its hottest point, which is usually in the return flow from the cylinder head.

The gauge may not always be fitted; in some cars there is a warning light that comes on if the temperature is too high.

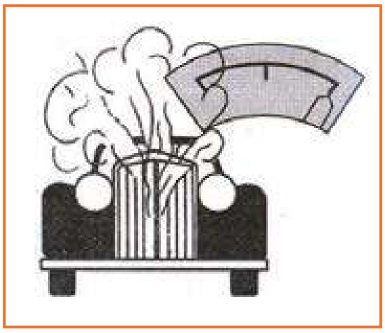


Fig 4.3.229: Temperature gauge

Oil-pressure gauge:

Nearly all cars have a low-pressure' oil warning light, which comes on if the pressure drops too far. Often a pressure gauge is fitted as well, particularly in sports cars or expensive models.

Fig 4.3.230: Oil pressure gauge

Warning light is operated by a pressure-sensitive switch connected to the main oil gallery. The switch is held open by oil pressure, but if it drops below a minimum value, the switch closes and oil light is turned on. Similarly, the oil gauge measures the oil pressure in the lubricating system.

Battery charging light:

When the battery charging system fails. An indication of this is provided by the 'generator' or 'ignition warning' light. If the generator is feeding power to battery, light remains out. If power is flowing out light will come on. It therefore, gives a warning that the battery is not being charged; It comes on suddenly during driving, due to broken fan belt.

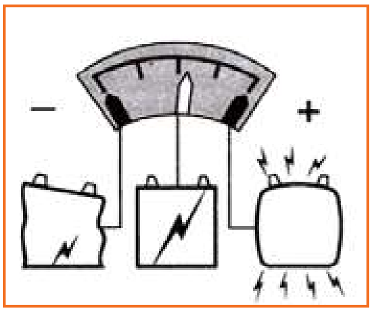


Fig 4.3.231: Battery charging light

Ammeter:

An ammeter is a meter designed to measure electric current and is occasionally fitted. This meter shows the rate of flow of electricity either into or out of the battery. It has a pointer with a centre zero position, and shows '+' to one side (battery charging) and '-'to the other (battery discharging). The horn and starter motor are not connected through the meter because of the very high current consumption of these devices.

4.3.65 Ignition System

Ignition system is the electrical circuit necessary to ignite fuel and air mixture in different cylinders at different times.

Now most of the cars are having electronic ignition system. These systems use electronic parts, such as capacitors and transistors, to produce the ignition voltage and to control it

Electronic ignition system

Electronic ignition system uses timer in distributor, instead of contact breaker, in the. It may act as a pulse generator or a Hall wave switch, to trigger the ignition module also referred as E.C.U. (Electronic Ignition Control Unit). This control unit primarily contains transistor circuit in which current is triggered off and on by timer, which results in the stopping and starting of the primary current.

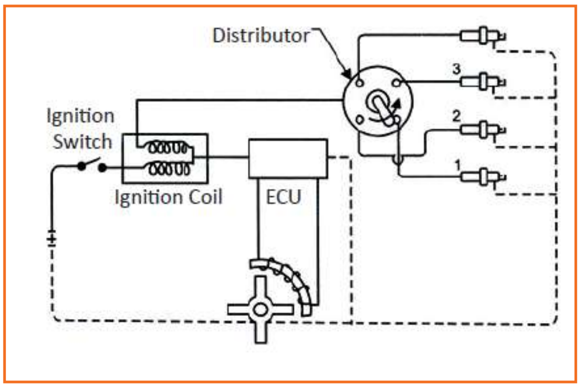


Fig 4.3.232: Ignition system

Apart from this, the EIS works similar to the conventional electrical point type system. Electronic ignition systems provide better ignition (spark at spark plug) during all engine operating speeds and loads. Since it has no distributor points to burn or wear, less maintenance is required.

4.3.66 Spark Plug

Function of spark plug

A spark plug is a device for producing spark in a -spark ignition engine to ignite the compressed fuel/ air mixture by applying a very high voltage in the range of 12000 to 30000 Volts. A spark plug has a metal threaded shell, electrically isolated from a central electrode by a ceramic insulator. The central electrode, which may contain a resistor, is connected by a heavily insulated wire to the output terminal of an ignition coil or magneto. The spark plug's metal shell is screwed into the engine's cylinder head and thus electrically grounded. The central electrode protrudes through the porcelain insulator into the combustion chamber, forming one or more spark gaps between the inner end of the central electrode and usually one or more protuberances or structures attached to the inner end of the threaded shell

Spark plugs in automobiles generally have a gap between 0.6 and 1.8 mm

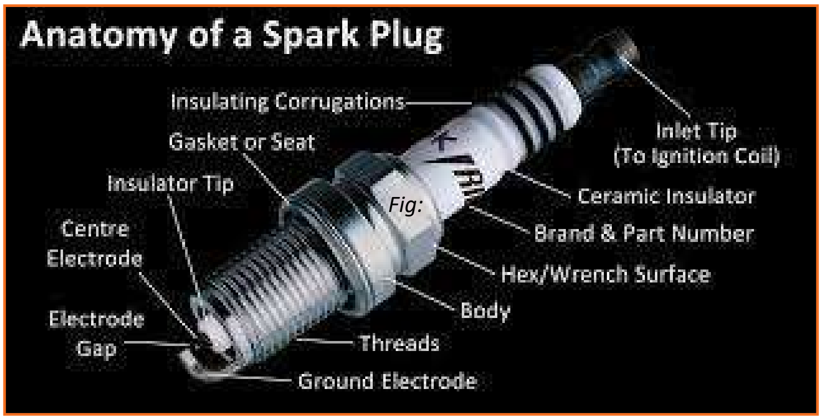


Fig 4.3.233: Spark plug parts

Fig 4.3.234: SPark plug

A spark plug consists of mainly three parts:

- Centre electrode
- Earth electrode
- Insulator separating the two electrodes

Spark plug defects and remedies

Defect	Remedy
Plugs fouled by engine oil entering combustion chamber.	Clean plugs with solvent; if fouling is frequent, use a hotter type plug

Defect	Remedy
Plugs fouled by too rich mixture	Clean plugs; adjust carburetor; reduce excessive choking
Plugs badly covered with carbon from poor ignition	Tune-up ignition system. Clean plugs
Burnt electrodes or broken lower insulators caused by overheating	Check cooling system, ignition timing, etc., for causes of overheating. Use new plugs
Red, brown, or yellow oxide deposits on plug interior that short the insulator	Clean off deposits with sand blast. Re use plugs if they tell well
Plug gap incorrect	Adjust plug gap to specified value

Table 4.3.13: Spark Plug Defects and Remedies

Misfiring: Misfiring sometimes occur at certain engine speeds or under heavy loads. Possible reasons are -

- Defective plugs
- Low primary voltage
- Insufficient timing for primary growth
- Defective condenser
- Breakdown of H.T. insulation

4.3.67 Automobiles Air Conditioning System

Five main components of vehicle air conditioning system are:

1. Compressor,
2. Condenser,
3. Receiver &dryer,
4. Expansion valve,
5. Evaporator.

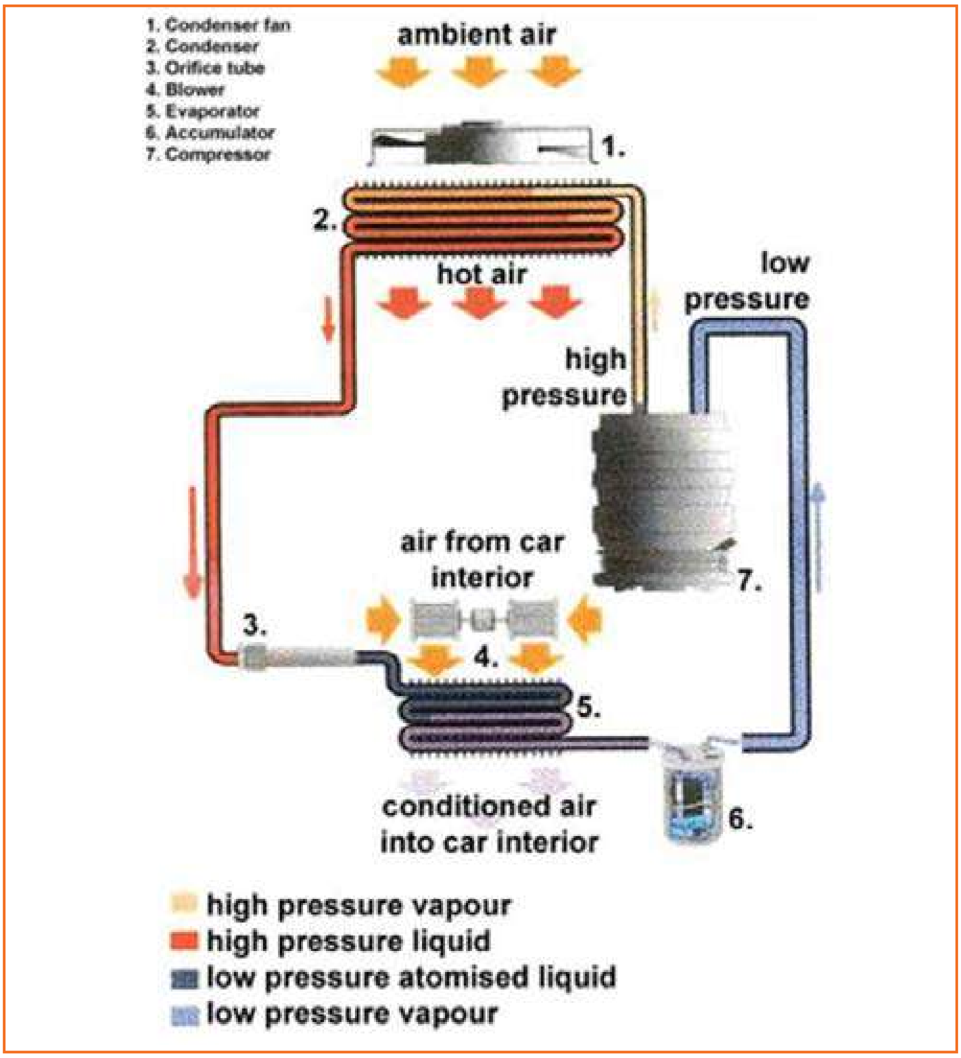


Fig 4.3.234: Air conditioning system

Refrigerant is fluid which is circulated around entire system. At low temperature refrigerant is evaporatedand at higher pressure it again get condensed.

Earlier, R12 refrigerant was used in cars due to ease of availability. Belonging to family of chlorofluorocarbon(CFC), it was found to contribute to the depletion in the earth's ozone layer.

These refrigerants were discontinued. In all cars after 1996, non-CFC refrigerant called R-134 A is used. Itis environment friendly.

Working of Air Conditioning system:

- **Compressor:** The compressor is the work horse of air conditioning system, deriving power through drive belt connected to crankshaft of engine. When a/c is switched on, compressed refrigerant is pumped in to condenser by compressor.
- **Condenser:** The condenser is used to change compressed refrigerant to liquid. It is placed on front side of engine radiator and are looking like radiator. Lot of heat is generated in this process, which get removed from the condenser due to flow of air through the condenser tubes on the outside.
- **Receiver dryer:** It receives liquefied refrigerant to removes moisture. Moisture in AC system

results in havoc, because of ice crystals, causing blockages & mechanical damage.

- **Expansion Valve:** Refrigerant further flows from receiver dryer to expansion valve which releases pressure from liquid refrigerant to get it expanded & turn into vapour refrigerant in evaporator.
- **Evaporator:** Evaporator also look like car radiator having tubes & fins. It is normally mounted inside passenger compartment, behind fascia above foot well. When low pressure refrigerant is circulated into evaporator, it vaporises absorbing heat from inside. Blower fan pushes air over outside of the evaporator.
- Thus, cold air is getting circulated inside car. On ' air side ' of evaporator, moisture in air is reduced, the ' condensate ' is collected & drained away.
- **Compressor:** Compressor then draws in the low pressure refrigerant vapour to start another refrigeration cycle. Refrigeration cycles then run continuously. Expansion valve regulator setting controls the refrigeration cycle.

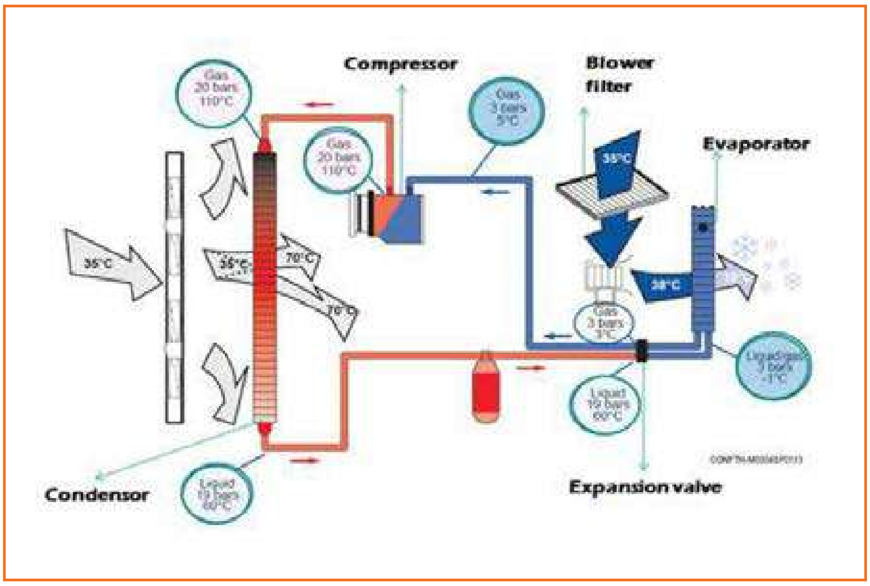


Fig 4.3.235: Working of air conditioning system

AC Performance Testing

Test Method- Open door Test

1. Open all the doors and the windows-2 people to sitinside the vehicle
2. Gear in Neutral-AC "ON"-Engine RPM = 1500
3. After 10 minutes note all the Vent temperatures. The average of all the vents value is the open door test temperature
4. At the end of 10 mins average grill temperature shall be less than 15 degree C of ambient temperature or less than 20 degree C

Test Method-Closed door Test

1. Close all the doors and windows and park the vehicle in shade.
2. Start the engine and bring it to optimum working temperature.

3. Switch on the AC.
4. Keep the AC control knob at the maximum cool position.
5. Turn on the blower to the maximum speed.
6. Press accelerator till the engine RPM operates between 1500-2000 RPM for about 5-7 minutes.
7. Place a thermometer at the dashboard louver/AC vent and check the temperature.
   - If it's less than 15 deg. C, the system is functioning okay. Look for any faults that may cause an intermittent problem.
   - If over 15 deg. C, go for pressure gauge testing (Step 9).
8. Identify the refrigerant presently in the system.?
9. Connect the gauges to the service ports. Start the engine, tune the AC to the maximum and compare the readings from the following chart

Low Side	High Side	Possible Cause
25-35 PSI	170-200 PSI	Normal
Low	Low	Low refrigerant charge level
Low	High	Restriction in high —side line
High	High	System is overcharged Expansion valve stuck open
High	Low	Restriction in the low-side line

Table 4.3.14: AC gas pressure readings

10. If readings are normal, try to find other issues like bad switches / bad fuses / broken wires / broken fan belt
11. In case cooling is not enough, it could only be low pressure.

AC Troubleshooting & diagnosis:

Blower Motor Problem	Problem Causes and or Solutions
Blower motor does not operate	1. Blown Fuse 2. Poor ground connection on blower motor 3. Defective motor (Use a fused jumper wire connected between the positive terminal of the battery and the motor power lead connection (lead disconnected) to check for blower motor operation) 4. Defective control switch 5. Register block open

Blower Motor Problem	Problem Causes and or Solutions
Blower motor operates only on high	1. Open n the resistors located in the box near the blower motor 2. Stuck or defective high speed relay 3. Defective blower motor control switch
Blower motor operations in lower speed(s) only, no high speed.	1. Defective high speed relay or blower high speed fuse **Note:** If the high speed fuse blows a second time, check the current draw of the motor and replace the blower motor if the current draw is above specification. Check for possible normal operation if the rear window defogger is not operation; some vehicles electrically prevent simultaneous operation of the high speed blower and rear window defogger to help reduce the electrical loads.

AC not cooling enough:

Blower Motor Problem	Problem Causes and or Solutions
Incorrect Refrigerant charge	• The manufacturer installs the exact amount that is required for the system. • Full charge will cause a compressor clutch to cycle on and off faster than usual. • If the system is overcharged, it can cause damage to AC compressor and noisy operations.
Clogged radiator or condenser	• If radiator or condenser is blocked by dust or debris airflow which passes through then get reduces • It can cause high-pressure readings, which knocks several degrees off of output temperature in interior cabin. • Radiator and condenser fins should be cleaned every 30,000 km.
Plugged evaporator/ ice build up	• AC filter is used to reduce dust accumulation on the evaporator coil, located in the indoor fan section. • A build-up of dust on the evaporator coil would restrict airflow and reduce efficiency of the air conditioner. • The evaporator requires sufficient air supply. If dust collects between the fins of the evaporator coil, the heat would be trapped in the evaporator.

Blower Motor Problem	Problem Causes and or Solutions
Perforated ducts	• Air conditioning delivers cold air through air ducts. Though these ducts are durable, they can get perforated (formation of holes by penetration of an external object). • The air will then leak through these holes, affecting the cooling efficiency, but increasing the energy consumption. • For this you need to locate the perforation and then determine possibility of holes repair or replacement of duct.

Table 4.3.15: AC troubleshooting

4.3.68 Antilock Braking System (ABS)

What is the ABS?

- It is an **"add-on"** to the existing base brake system.
- Its heart is the electronic controller (computer).
- Wheel speed sensor produces an electrical frequency proportional to speed of wheel.
- In case of fast slowing down of wheels, pressure is controlled by controller of the wheel brake through an electro-hydraulic unit.

ABS Features:

- During sudden breaking prevent the wheels from locking
- Increases safety because as they eliminate lock up and minimize danger ofskidding
- Help in maintaining steering control during heavy braking
- Optimizes braking when road conditions are less than ideal.

Electronic brake- force distribution system (EBD)

Electronic brake-force distribution system also called as Electronic brake-force limitation is an automobile brake technology that automatically varies the amount of force applied to each of a vehicle's brakes, based on road conditions, speed, loading, etc.

EBD system is always coupled with anti-lock brake-force system. The most important function of EBD is to maintain vehicular control with variation in braking pressure applied to each wheel in order to maximize stopping power. Generally most of the weight of all vehicles is carried by the front end so the EBD ensures less braking pressure at the rear end to avoid skidding. But in some EBD's the distribution of braking pressure at the rear end is more initially when the brakes are applied before the effects of weight transfer comes into play.

Working of EBD system

An EBD is a subsystem of the ABS and its function is to control the effective adhesion utilization by the rear wheels.

The Antilock brake force system releases pressure in different brake lines at the time of heavy braking to prevent locking-up. The action comes in the form of releasing pressure from the braking circuit when it detects extreme and rapid deceleration in any of the four wheels in order to make sure that the driver maintains control over the steering during panic or emergency braking. For example if the wheels of a vehicle are on snow as well as asphalt then in case of emergency braking the ABS will monitor the speeds and eventually the EBD system will release less pressure for wheels on snow and more pressure for wheels on asphalt to prevent wheel lock-up.

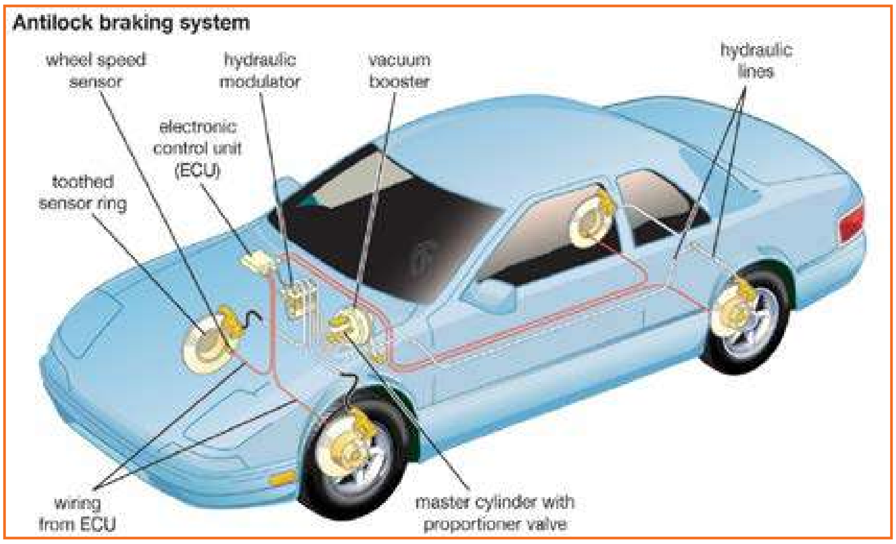


Fig 4.3.236: ABS system

ABS Control:

During emergency braking, it is effective to repeatedly depress and release the brake,preventing the tires from getting locked and then losing the ability to turn the steering wheel. But,there is no time to do this, during emergency braking.

A computer is used in ABS, to determine the rotating condition of the four wheels during braking and can automatically apply and release the brake pressure.

Slip ratio is ratio between vehicle's body speed and speed of wheels. Slipping occurs between tires and road surface occurs, when difference between wheel speed and vehicle speed is very large. Thus friction is created and acts as a braking force to reduce the vehicle speed.

Force of breaking is not relative to slip ratio. During slip ration between 10 and 30% it is maximum. After 30%, it slowly declines.

ABS is designed to boost breaking performance by maintaining a slip ratio of 10-30%, irrespective of the road conditions, and also maintain cornering force as high as possible to maintain stability.

Skid Control ECU:

It senses signals from speed sensors, rotational speed of wheels, as well as, vehicle speed.

Though speed of the wheels drops during breaking but deceleration varies on vehicle speed and the road surface.

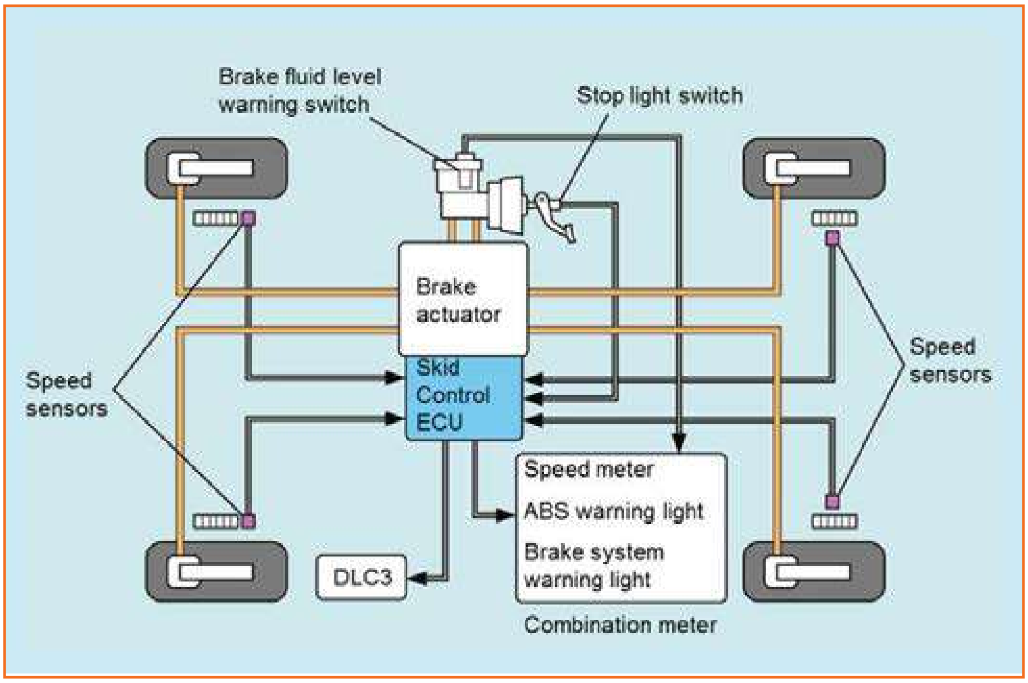


Fig 4.3.237: Skid control ECU

Brake Actuator: During normal braking, when you press the brake pedal, brake fluid from master cylinder flows through port on solenoid and passed on to the wheel cylinder, ABS system is not activated.

Speed sensor: Speed sensors detect the speed of each of the four wheels and send signals to the Skid Control ECU.

ABS warning Light: When the ECU detects a breakdown in ABS or brake assist system, ABS warning light became on to give alarm.

Warning light - Brake system: When this turns on at same time as ABS warning light, it is a warning fordriver, of a breakdown in ABS & EBD system.

Stop light switch: Stop light switch detects depressed brake pedal and then sends signal to the Skid Control ECU. ABS uses the stop light switch signal. Even when the stop light switch signal is not input, because of some failure, ABS control is performed, when the tyres become locked up. In this case, control begins after the slip rate has become high and wheels became locked.

Deceleration sensor (Some models only): The Deceleration sensor are provided in some cars to sense the vehicle's deceleration rate and send signals to Skid Control ECU.

The ECU judges precise road surface conditions using these signals & takes appropriate control measures.

4.3.69 Diagnosis of Common Complaints

Engine does not start - Check:

- Battery charging condition
- Restriction in fuel supply system/Air/vapour block
- Ignition system for functioning
- Availability of fuel in fuel tank
- Engine electrical

Engine starts but stalls - Check:

- Fuel system for air trapping in system
- Fuel filters and fuel strainer
- Electrical couplers in system
- For any external damage in fuel lines/ fuel tank
- Solenoid switch in fuel pump (Diesel engine)
- Quality of fuel for adulteration

Engine overheats - Check:

- Coolant level in the radiator
- Leakage/damage of coolant hoses & radiator
- Water pump fan working/ loose fan belt
- Function of Thermostat in cooling system
- Blockage of radiator/defective temp. gauge
- Condition of radiator cap

Engine cranks, but does not start - Check:

- Battery for full charging
- Current supply/ ignition system
- Fuel supply for, if any restriction
- For Spark plug's spark intensity
- For damage of fuel tank/ under body fuel lines for damage
- Sensors with Diagnostic tool

Crashing noise in gear engagement - Check:

- Clutch pedal free play/ clutch cable adjustment
- Clutch fork bent/ damage
- Clutch plate worn out
- Pressure plate diaphragm wear and tear/slipping
- Gear engagement linkages looseness
- Engaging sleeve / dog teeth for worn out

Steering wheel wanders - Check:

- Tyre pressure
- Wheel balancing
- Worn out ball joint and linkages
- Steering wheel play and adjustment
- Wheel alignment
- Loose components

Steering wheel does not return on its own - Check:

- If there is excessive steering wheel free play
- If there is uneven pressure in front tyres
- If there is different wear patterns in front tyres
- For damage or bent in steering linkages
- Wheel alignment

Poor braking - Check:

- Brake fluid quantity in master cylinder
- For any fluid leakage from hose pipes
- Fluid leakage from master cylinder/ wheel cylinders
- Vacuum hose for twist or damage or kink
- Air trapped in the braking system
- Stickiness of wheel cylinder/ calipers

Vehicle pulls to one side - Check:

- Pressure in front tyres for same pressure
- Wear or same make of tyres at front
- Wheel alignment
- Bend or damage of steering linkage
- Loose components

A/C cooling is poor - Check:

- Belt tension of compressor
- A/c switch working
- Quantity of gas in cooling system
- Blockage of condenser
- Blower motor functioning
- Electrical connections/couplers

Exercise

Mark True or False

1. Auto service technician is responsible for the routine servicing of four wheeler.
   a. True   b. False
2. Good communication and interpersonal skills is required for the auto service technician.
   a. True   b. False
3. 3. Auto service technician should have a better understanding of social aspect for repairing the vehicle.
   a. True   b. False
4. After collecting the vehicle customer's personal belongings in the vehicle should be handover to service agency office.
   a. True   b. False
5. Job card can be filled in absence of customer.
   a. True   b. False

Fill in the Blanks

6. During vehicle booking appointment is taken by the .... from the customer for the service job.
   a. Service advisor
   b. Workshop supervisor
   c. Technician
7. Vehicle receiving and job card opening process is done by ....
   a. Service advisor
   b. Workshop supervisor
   c. Technician
8. Job allotment in the workshop is done by.....................................
   a. Service advisor
   b. Workshop supervisor
   c. Technician
9. During repairing process if additional job has to be done on the vehicle, should be intimated to ....
   a. Service advisor
   b. Workshop supervisor
   c. Technician
10. Final inspection of the vehicle before delivery is done by ....
    a. Service advisor
    b. Workshop supervisor
    c. Quality tester

11. Service technician should carry out repair jobs as per ………………………………………
    a. Job card
    b. Customer input
    c. Advice from quality tester
12. The job card has details of………………………………………………
    a. Customer
    b. Vehicle
    c. Instruction of service advisor
13. The primary function of the vehicle chassis is ………………………………….
    a. To carry the weight of the vehicle and its passengers
    b. To carry the weight of vehicle
    c. To carry weight of passengers
14. Disc brakes consist of a ……………………. disc
    a. Steel braking
    b. Copper braking
    c. Brass braking
15. Disk brakes works on …………………………….
    a. Pneumatic pressure
    b. Hydraulic pressure
    c. Both
16. Engine converts the …………………………………. energy to mechanical energy
    a. Chemical
    b. kinetic
    c. Thermal
17. Almost all automotive engines are using ……………………………………….
    a. Rotary engine
    b. Reciprocating engine
    c. Both

Summary

This module covers how to diagnosing repairing, servicing and maintenance (including electrical and mechanical aggregates) requirements in a 4 wheeler vehicles. In this module, participant knows about fucntioning of various components and systems of four wheeler vehicle. This module also covers various how to diagnose various defects and issues, their causes generally occur in various components and systems of four wheeler vehicle.

Scan the QR code or click on the link to watch related videos

www.youtube.com/watch?v=5ziWx5tjLvs
Job Card

www.youtube.com/watch?v=x70VqMrXrbs
Engine

www.youtube.com/watch?v=eYBdjc3dOgM
Types of Four Wheeler Engine

www.youtube.com/watch?v=ZMs1e7GvOvY
Working of MPFI System

www.youtube.com/watch?v=jWW0BsIQ2mQ
Fuel System

www.youtube.com/watch?v=vSJB5vEdTtk
Cooling System

5. Perform Routine Service and Repairs

Unit 5.1 – Maintenance of Four Wheeler Vehicle

Unit 5.2 – Service and Repairing of Four Wheeler Vehicle

ASC/N1403

Key Learning Outcomes

At the end of this module, participants should be able to:

1. Discuss how to gauge misfits or issues in the previous repair.
2. Identify the parameters for inspection/routine service/non-routine repair work.
3. Discuss the checklist for tasks to be performed for routine or non-routine service/repair.
4. Explain the specifications w.r.t. quality and type of material/consumables/components required for routine service.
5. Discuss the importance of using appropriate spare parts and other material for service/ maintenance such as grade of oil, lubricants, grease, etc.
6. Discuss the symptoms of wear and tear w.r.t. components needing replacement such as filters, belts, wipers, etc.
7. Apply basic maintenance techniques to ensure that the tools and equipment are functioning as per SOP.
8. Perform the process of routine service/maintenance as per standard operating procedures.
9. Employ different corrective actions to be taken for common faults and failures.
10. Demonstrate how to dismantle the aggregates that require servicing/repair as per SOP.
11. Apply suitable cleaning techniques for cleaning and conditioning the dismantled aggregates.
12. Perform final inspection at each stage to ensure completion of work as assigned by the service technician.
13. Demonstrate how to record the basic repair and service inspections performed on the vehicle.
14. Prepare a schedule for carrying out inspection, calibration and repairs of the tools, equipment, workstations, etc. to maintain workshop.
15. Apply ways to maintain the workshop by conducting properly scheduled check/calibration/repairs of tools, equipment and workstations.

Unit 5.1 - Maintenance of Four Wheeler Vehicle

Unit Objectives

At the end of this unit, participants will be able to know about:

1. Apply basic maintenance techniques to ensure that the tools and equipment are functioning as per SOP
2. Perform the process of routine service/maintenance as per standard operating procedures
3. Record the basic repair and service inspections performed on the vehicle

5.1.1 Maintenance

Maintenance is what you get regularly done on your vehicle to make sure it stays in reliable and roadworthy condition. Maintenance is something that's scheduled – like an oil change.

Preventive maintenance:

1. Check the anti-freeze/coolant level, and top up, if required.
2. Check engine oil for correct level.
3. Ensure air filter is clean.
4. Inspect belts for wear, glaze or fray and hoses for bulges, rot, brittleness or loose clamps. Also check the tension.
5. Ensure fluid level in brake master cylinder .
6. Check clutch and brake pedals forfree play.
7. Check fluid level in transmission system.

1. Check leaks throughout the system.

8. Check fluid level of windshield washer reservoir level.
9. Inspect battery for corrosion, electrolytes and cable condition.
10. Check fluid level of power steering..
11. Inspect windshield wiper blades for wear, brittleness or hardness.
12. Inspect all the lights for cleanliness and workability. Check and functioning of horn, wipers and all warning lights and gauges. If a lightor any other component is not working, check the cables and fuse.
13. Inflate Filltyrespressure to recommended pressure.
14. Check for cuts / bulges / excessive or uneven tread wear in tyres.
15. Inspect oil leakage in shock absorbers.
16. Check for loose, broken exhaust clamps or supports and check for holes in the muffler or pipes.

17. **Statutory Check:** Before closing bonnet & handing over vehicle, perform the following statutory checks -
    - Check the radiator cap is closed.
    - Check terminals of battery are tightly secured.
    - Check engine oil dipstick is in place.
    - Check the wiper liquid bottle cover is on.
    - Check cover of air filter is fastened with clips.
    - Check the bonnet rod is securely placed.

Schedule maintenance:

- Always refer the owner's manual for specific items related to the make and model of vehicles.
- Owner's manual information and instructions supersede the this schedule. If the manual suggest timing belt replacement at 50,000 km, inform the customer accordingly.

Lubrication:

Why to lubricate

- Lubrication is important as part of any Scheduled or Preventive Service.
- It not only makes the vehicle more comfortable, but also ensures vehicle safety and occupants.
- Modern day cars have fewer lubrication points.

Where to lubricate

There are certain lubrication points in a vehicle that are fitted with grease nipple, which must be lubricated by grease bucket or hand grease gun.

1. Front end ball joints
2. Tie rod ends
3. Propeller shaft Universal Joint (UJ) cross with front flange
4. Prop shaft UJ cross at rear flange
5. Centre bearing at prop shaft
6. Spring shackle pins

Emergency handling:

How to change a wheel

1. Park the car on level ground and apply hand brake.
2. Remove the spare wheel and place it near the side body under the car.
3. Place the jack on special jacking points under the car.
4. Refer service manual for the jacking points.
5. Check both sides of wheel, diagonally opposite to the one which is changed.
6. Remove trims to reach wheel nuts.

7. Unfasten the wheel nuts just a little, before the car is lifted on jack. Jack the car till wheel is above ground level.
8. Remove the nuts & slide the wheel off, lifting the wheel with hands in a 'ten minutes to four' position.
9. Place the spare wheel on hub and put back the wheel nuts, tightening them as far as you can.
10. Lower the car & tighten the nuts again, using crisscross pattern i.e. tighten the nuts opposite to each other first, rather than going around in a circle.

How to start a car in emergency:

1. For vehicle having manual gear box, you can push-start the car. Vehicle should not be push started if fitted with catalytic convertor. Modern cars with MPFI or CRDI system can't be started if the battery voltage is too low.
2. An alternative method is by using another vehicle battery and jump start the flat battery
3. Check related fuse (main/solenoid/immobilizer).

How to tow a vehicle:

- Put the vehicle in neutral gear.
- Tow chain or strong cable should be fastened between trailer and vehicle.
- Passenger should not sit in towing vehicle.
- Place a signage so that other drivers get informed that the vehicle is getting towed, and may need extra pace on the road.
- Do not drive more than 45 kmph.
- (Vehicles fitted with Automatic transmission should not be towed as mentioned above)

How to check fluids – Engine oil:

- Should be checked once the vehicle is cools down so that oil is drained down.
- Take out the dipstick, should be cleaned using cloth, and insert into its opening and push it inside firmly till end. Pull it out to so that oil level and its condition can be checked.
- Maintain the maximum oil level for efficiency. If required do the Top up.
- Check the colour of oil. If blackish, it needs to be changed.
- Check the km specification / limitation.
- Wipe the dipstick with a clean soft cloth and put it back.

How to check fluids – Transmission fluid:

- It lubricates the transmission/gear system.
- Refer to your service manual to check the procedure & location of the dip stick for measuring the transmission fluid levels. In several vehicles there is plug for oil level checking and filling.The procedure for Automatic Transmission & Manual Transmission may vary on whether engine is to be kept running in the neutral gear position or in not running condition.

As with the oildipstick:

- Find it in engine compartment and take it out, clean it then insert it till end and pull it out to read oil level.
- Check the level it should be between the min and max marking.

How to check fluids – Brake fluid:

- Find its location in the compartment marked with brake fluid.
- Fluid level can be easily checked from container. It should be at the maximum level.

Caution: Ensure that you replace/add the same grade of brake fluid (DOT-3/DOT-4). Do not mix grades.

How to check fluids – Power steering fluid:

- Ensure level is in-between minimum and maximum marks.
- Top up, if required, by opening the lid and pouring the same brand power steering fluid. .
- Check container condition for leakage.
- If there is leakage, replace the hoses by opening the clips.

How to check fluids – Coolant:

- Notice level of the coolant in the bottle. It can be seen from outside. There are markings on the bottle -
  - ❑ F stands for full and L stands for low level. Maintain coolant level between F and L.
- To check condition of the coolant, open the cap.
- Ensure that the colour of coolant is green.

How to check fluids – Windshield washer fluid:

- There is generally no harm in having washer fluid low. This is used only during windshield cleaning. It is simply refilled it before it is completely emptied out.
- For very cold weather, ensure to use anti-freeze washer fluid so that it will not freeze at low temperature.

How to clean - Air filter:

1. Remove the Filter.
2. Clean the Filter with vacuum or soap solution (if permitted in the service manual).
3. Clean the Canister with a soft cloth or paper towel. It should be dry before you put it in.
4. Paper type air cleaner may be cleaned by low pressure (not exceeding 2.5 bars)dry air jet by blowing air from cleaner side (if allowed by the OEM)

Warning: Do not leave any moisture as it can damage the engine.

How to clean - Fan belt:

1. Use vacuum cleaning, light brushing for dust removal or dirt accumulated on the fan belt.
2. Removal of the fan belt and rinsing with soap solution is normally not recommended, as putting

it back requires special skills & equipment to tighten at proper tension.

Warning: If the belt is worn out should be replaced. No amount of cleaning can improve its performance.

How to clean - Undercarriage:

1. Ensure that the vehicle has cooled down as heated parts may dry the cleaning agents
2. Place the vehicle on jack or axle stands.
3. Apply degreasers/cleaning solutions if there is strong build-up of dirt/mud.
4. Wait for some time and rise off with high-pressure water through hose pipes.

How to clean - Wiper blades:

1. Lift the windshield wiper and move it away from the glass.
2. Use a damp cloth to wipe the rubber blade and clean it properly.

Note: In case soil is found and cannot be cleaned with damp rags or if the rubber is deteriorating -- ripping, crumbling or tearing, blades should be replaced

How to clean - Lights:

1. Outer portion lights should be cleaned with soap solution.
2. Dry well with a soft and clean cloth.
3. Use some polish for increased shine.

5.1.2 Service Schedules and Records

Periodic servicing & maintenance is very vital for the long life & safe running of the vehicle. All vehicle Original Equipment Manufacturers do specify these requirements specifically for the model in their respective Owner's Manual.

Auto Service Technician has to carry out, monitor these specified maintenance activities at the scheduled frequencies & record them in Owner's Manual. A typical vehicle service record may look like -

Record of Service Perform

Recommended Service	Date	Odometer reading Kms	Repair Order No.	Servicing Dealer's Signature and stamp
At Km				
FDI				
1,000-1,500				
5,000-5,500				
10,000-15,000*				
20,000-20,500*				
30,000-30,500				
40,000				
50,000				
60,000				
70,000				
80,000				

Table 5.1.1: Service record

Typical vehicle periodic maintenance schedule looks like:

Miles (in Thousands)	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
Kilometers (in Thousands)	8	16	24	32	40	48	56	64	72	80	89	97	105	113	121	129	137	145	153	161
Engine Oil - change	x	x		x		x		x		x		x		x		x		x		x
Engine Filter - change	x	x		x		x		x		x		x		x		x		x		x
Timing Belt - check		x		x		x		x		x		x		x		x		x		x
Timing Belt - replace																				x
V Belt/Ribbed Belt - check tension/condition								x								x				
Air Cleaner - replace filter								x								x				
Water Separator - drain	x	x		x		x		x		x		x		x		x		x		x
Fuel Filter - replace				x				x				x				x				x
Windshield Washer Fluid - check level		x		x		x		x		x		x		x		x		x		x
Automatic Shift Lock - check operation		x		x		x		x		x		x		x		x		x		x
Brake System - check damage/leaks, pad thickness, fluid level		x		x		x		x		x		x		x		x		x		x
Wheels - rotate from front to rear		x		x		x		x		x		x		x		x		x		x
Air Bag System - check function/damage		x		x		x		x		x		x		x		x		x		x

Table 5.1.2: Sample maintenance schedule

	Instructions: Write Initial In Appropriate Boxes Below			
TASKS TO BE PERFORMED	Inspected Okay	Repaired & Adjusted	Greased & Lubed	Comments & Parts List
A. Engine				
1. Change oil and filter				
2. Change fuel lines and tank cap				
3. Check fuel filter (25,000 mil)				
4. Check air filter if needed				
5. Check spark plugs				
6. Check distributor cap & rotor				
7. Pressure test cooling system				
8. Check all hoses under pressure				
9. Check all belts & tens loners				
10. Check water pump and fan bearing				
11. Check complete exhaust system				
12. Check for engine oil leaks				
B. Under The Hood Fluid Levels				

Table 5.1.3: Sample maintenance checklist

Notes

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Unit 5.2 - Service and Repairing of Four Wheeler Vehicle

Unit Objectives

At the end of this unit, participants will be able to know about:

1. Discuss the symptoms of wear and tear w.r.t components needing replacement such as filters, belts, wipers, etc.
2. Demonstrate how to dismantle the aggregates that require servicing/repair as per SOP
3. Perform service and repairing of the vehicle components

5.2.1 Servicing Air Intake System

Cleaning Air Filters

Wet Type (oil bath type) Air Filter cleaning:

Remove the filter assembly form the vehicle. Remove oil pan of the filter. Drain the old oil from the pan and clean it with kerosine. Clean the wire mesh filter element with kerosine or other suitable solvent. Fill fresh engine oil in the bowl up to the mark and refit over the vehicle.

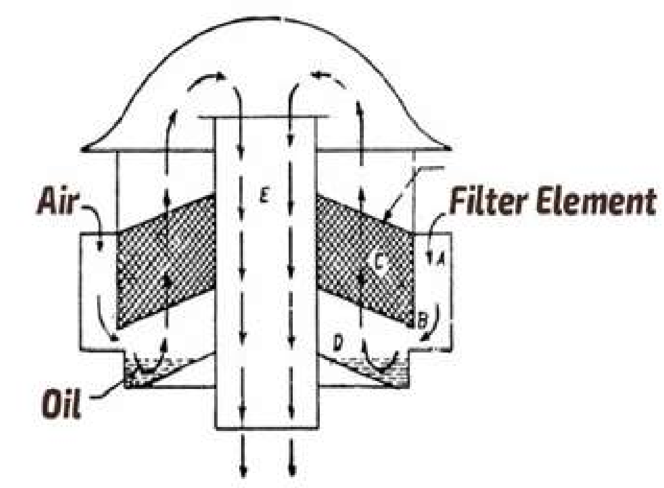


Fig 5.2.1: Oil bath type air filter

Dry Type Air cleaner (Paper element):

Remove the cover of the air cleaner and the paper filter element. Check and replace it with a new filter element as per the guidelines given in the OEM manual. If it is not excessively dirty and allowed by the OEM, it may be cleaned with dry compressed air jet with low pressure(not exceeding 2.5 bars) and blowing air from clean side.

Fig 5.2.2: Removal of filter element

Fig 5.2.3: Cleaning with compressed air

5.2.2 Valve Clearance (Tappet) Setting

The valve clearance (tappet) needs to be adjusted in the vehicles as per the guidelines given in the OEM's manual. It may be adjusted in as per the procedure given-

a. Set No. 1 cylinder to TDC compression position (when both valves are closed. There will be gap in both (inlet and exhaust) the rocker levers and the valve tips.

b. Rotate the lock nut of valve anticlockwise with a suitable tool to loosen it. Adjust the valve clearance by rotating the adjusting screw clockwise or anticlockwise as needed. Check the clearance intermittently with the help of feeler gauge.

c. When the adjustment is completed hold the screw in place so that clearance does not change. Tighten the nut slightly and check the clearance using feeler gauge.

d. Tighten the lock nut to the correct torque specification. Finally, again check the clearance using feeler gauge. Similarly adjust valve clearance for all the free valves. Turn the crankshaft by one revolution (360◦) and adjust the clearance for the remaining valves.

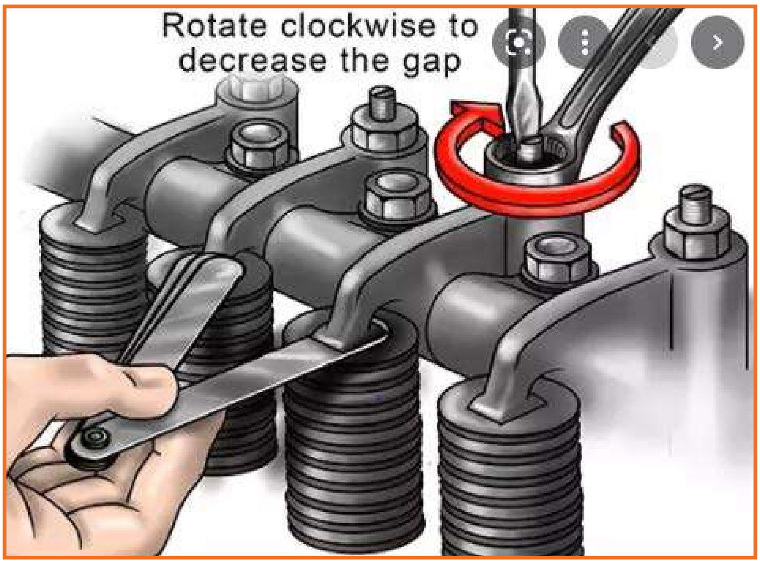


Fig 5.2.4: Tappet setting

Hydraulic tappets or Hydraulic Lash Adjuster (HLA) type of tappets are used in most of the modern cars for maintaining zero clearance and no adjustment required in it.

5.2.3 Servicing and Repairing of Fuel System

Replacing a flexible fuel pipe:

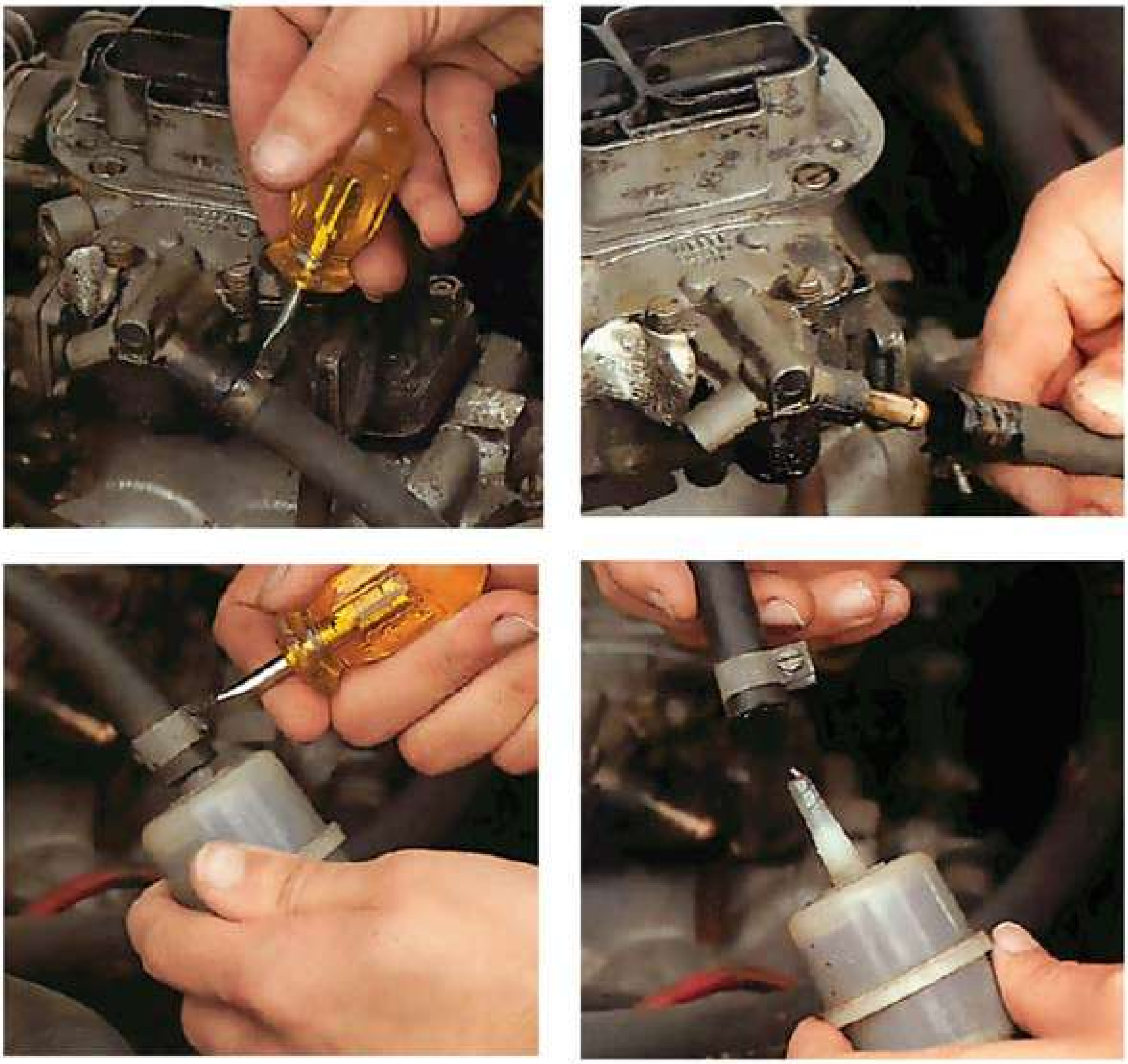


Fig 5.2.5: Replacing flexible fuel pipe

The fuel line is mainly made up of stiff metallic pipe. This pipe along with hoses made-up of either rubber or plastic connect tank with fuel pump and further to carburetor. As the hoses are flexible it helps in little movement between components. Some cars are also using reinforced plastic pipes instead of metal pipes.

1. Pull pipe from bottom. Make sure it should not stuck otherwise remove it by side to side twisting. Never apply force as it may dislodge the stub.
2. Hold the pipe on other end and release the clip. In the image you can see the attachment with disposable fuel filter. Now pull it gently without applying much pressure.
3. Be Careful while fitting the pipe because if it is over tightened it may damage the stub.

Replacing a rigid fuel pipe:

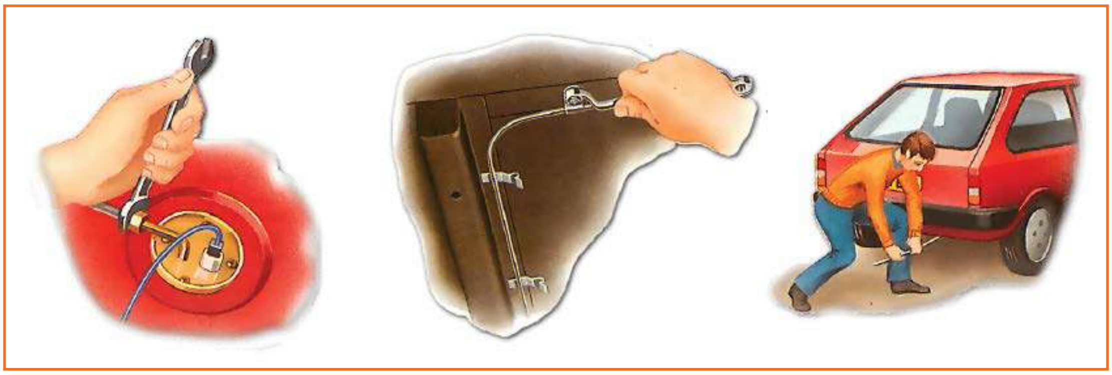


Fig 5.2.6: Replacing fuel pipe

1. First disconnect pipe from the fuel tank
2. Slide the clip down so that pipe can be removed
3. Now pull the pipe carefully because it may have petrol in it.
4. From both the end loose the joints of stiff pipe. For releasing pipe from floor remove securing clips.
5. Now remove the pipe form the car. Be careful while doing the process as this pipe is bit long and also have fuel inside.
6. Loosen the joint of pipe using two spanners and completely unscrew it.
7. Pull the olive out using hand. New one should be placed in reverse order. Be careful while doing this process because over tightening of joint may damage olive.

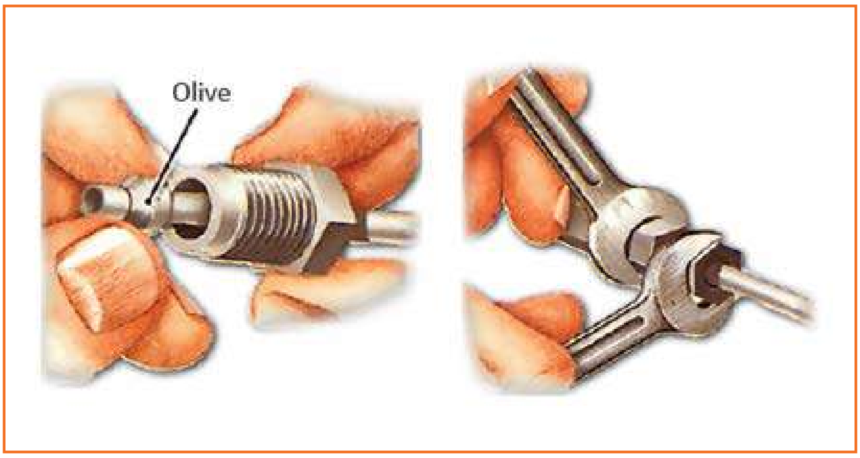


Fig 5.2.7: Replacing an olive

New hoses:

Jubilee clips are mainly used to secure the end of flexible hoses. Using a screw driver loosen the clips and then after slide them along the hose. If spring clips are used in hoses fitting, remove it by expanding using pliers. All spring clips should be replace with jubilee clips.

To remove the hose firstly twist it and then after pull it out. In case it is not coming out you need to expand it by pouring some water on it. Never apply heat to loosen the hose. After applying all effort if hose not coming out the only solution is to cut it using side cutters or a hacksaw.

While replacing the hose you should ensure that diameter of old one and new one is same. To place it back slide it gently and tighten the clip. Over tightening may damage the part.

New pipes:

For replacing a stiff pipe fuel tank needs to be drained first. In case of problem in draining the fuel tank pipe has to be disconnected from the tank and open end should be closed quickly using a plug.

From back side of car loose the clips or nut used to connect pipe with fuel tank and also chassis. From front side disconnect the pipe and then after remove it.

Make sure in case pipe connection is having union joints both should be replace together. Place the new pipe on its place and then after connection should be tighten further using securing clips also. While doing the fitting ensure that pipe is not touching other components and should be away from hot components.

Pipe repairs:

In case there would be a minor damage in metal pipe it has to repaired by cutting the damage pipe length and joining it using flexible hose. Cutting of pipe can be done using hacksaw while cutting the pipe make sure both the end should be cleaned properly. After cutting the pipe place a correct diameter hose and further use clip to secure it.

If the damage is not more than 15cm long it can be repaired but in case damage is longer in length it is advisable to replace it.

Filters: (Petrol Engines)

Dirt, dust, debris clog the fuel filter after some time, resulting in fuel pump to work harder, which may lead to its break down. Engines can also be damaged from contaminated fuel. Various type of filters are used in automobile, plastic in-line type is commonly used now a days. Filters should be checked while checking the fuel pipe usually shape of filter is barrel shaped and many such filters are transparent, thus blocked filter can be observed by visual inspection.

Fig 5.2.8: Replacing filter

Jubilee clips are used to secure plastic in line filter. Unscrew the clips using screwdriver. Certain filters may be made up by metal and in such case union nuts are used to secure it, in case of union nut it needs to be open using spanner.

The in line disposable filters are usually placed between carburetor and fuel pump under the bonnet. If the condition of filter is not looking satisfactory it is suggested to replace it, as it not an expensive part.

Filters are usually secured using either jubilee clips or union nuts based on body material used in manufacturing. Hold the pipe for releasing fixing arrangement and then remove it then after fix the new one. While fixing the new one ensure that arrow on filter is in-line with fuel flow direction.

Servicing a glass-bowl filter:

Fig 5.2.9: Glass-bowl filter

1. Open the nut using your hand
2. Filter element should be pulled out from filter body
3. Now bowl should be removed from body of filter

There are other types of filters also used in the vehicle and mainly found in engine bay. Filters element of these filters are mounted inside glass bowl and placed in inner wing and secured using bolts. It is compulsory to confirm from the dealer that filter elements are disposable or can be cleaned. In case it is disposable it has to be replaced with new one.

Before removing the glass bowl filter in order to secure the wastage of petrol a container needs to be placed under it. Under glass bowl open the nut, take the bowl out and collect the petrol in the container.

In case during removal if it is getting stuck remove it gently with your palm. Now filter element can be removed and it can be either dumped or if cleaning is supported can be cleaned using soft brush and petrol. After cleaning or replacing the filter, clean filter bowl also and tighten the nut to fix it properly.

Filters (Diesel Engines)

There may be single or duel filter elements. In case of Duel filter the first filter (towards fuel entry) is known as Pre-filter and the filter towards fuel injection pump is known as Micro filter.

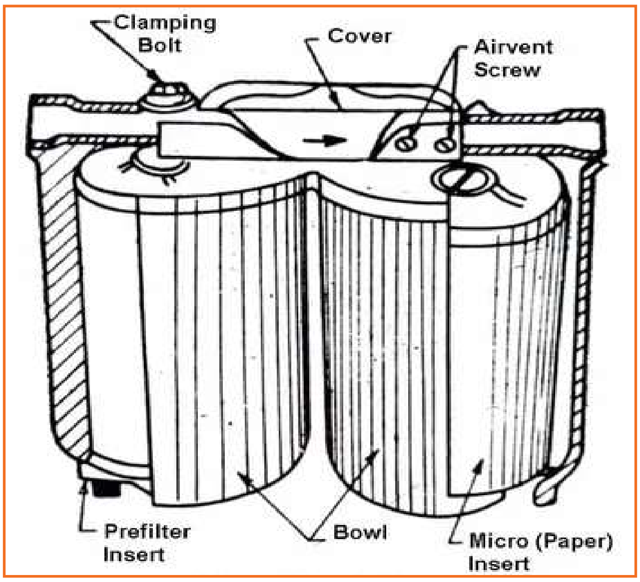


Fig 5.2.10: Duel filter assembly

Fig 5.2.11: Clean and dirty diesel filters

As per the guidelines of the OEM, it needs to be replaced only. In between replacement interval water is to be drained periodically.

Draining the water: drain screw is generally provided at the bottom of the filter bowl. Loosen the screw and allow water to drain.

Replacement of the filter element/elements:

1. Remove the filter element/elements from the filter body.
2. Clean the bowl/bowls
3. Replace the filter element along with the new sealing ring. Ensure that pre filter element is fitted in pre filter side and the Micro filter element is fitted towards Micro filter side, if it is duel filter elements.
4. Bleed the air from the fuel system

Air Bleeding from the fuel system: After replacing the filter element or whenever there is any doubt of air in the fuel system air bleeding needs to be done.

There are different ways of bleeding air from the fuel system. Please follow the procedure suggested in the OEM's workshop manual.

Fig 5.2.12: Air bleeding from fuel system

A typical procedure is given here for air bleeding-

1. Place a tray under the fuel filter body to collect the spilled fuel.
2. Loosen the bleed screw available at the top pf the filter body
3. Bleed the air using the hand primer available either at FIP or at the fuel filter body.
4. Bleeding can also be done by switching on ignition switch if electric low pressure pump is fitted.
5. Tighten the bleed screw
6. Start the engine and ensure normal performance.

5.2.4 Servicing and Replacement of Drive Belts

Drive belts are always stressed, due to strain by water pump, generator & fan in the system. Aging & continual flexing also result in stretching belts, cracking and deterioration.

V pulleys are used to run belt as it drives generator & water pump from crankshaft pulley.

Stretching slackens a belt, makes it loose so that it starts slipping on the pulleys. A crack on belt will lead to its breakage. Therefore, the belt tension and its general condition should be checked periodically.

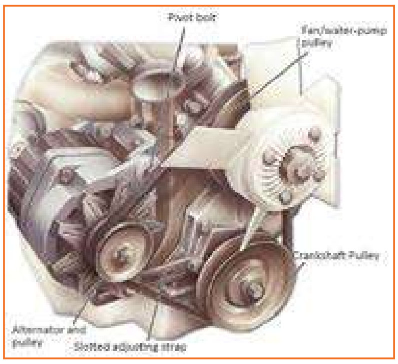


Fig 5.2.13: Drive belts

Instrument panel show ignition light on, giving immediate warning of a broken belt, as the generator stops working.

First warning symptom of belt slippage is overheating of engine or flat battery or both.

The belt slippage starts during high load on generator, like when the head lamps and rear-window heater both are on.

If fan or the water pump not working due to slippage will cause engine overheating.

Heat generated as the belt starts slipping wears it more rapidly. The inner face is usually first to cracks.

If belt is too tight generator and water-pump bearings will get more strain leading to their premature failure.

Always remove the ignition key before you start checking the belt, to avoid any chance of the engine turning over and injuring your fingers.

When belt tension is loose, grip generator tightly out and tightens adjusting strap bolts. Again check belt tension if found correct, tighten pivot bolts.

Loosen pivot bolts to slacken belt to move generator by hand. Move generator away from engine a little at a time, while feeling tension on belt with your other hand.

Tighten the adjusting strap bolts and the pivot bolt, when the tension is correct.

Fig 5.2.14: Servicing drive belt

How to replace a fan belt

This is a basic guide on how to replace a fan belt in a car. A belt that needs replacing will be visibly frayed, cracked and worn.

Most modern cars have automatic belt tensioners, making this process much simpler. This guide assumes the presence of an automatic tensioner

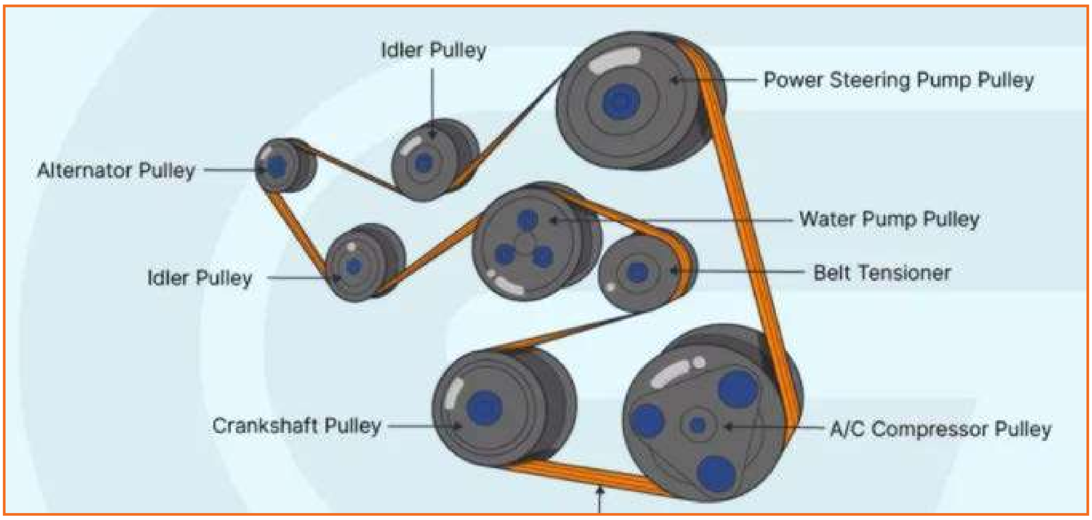


Fig 5.2.15: Fan belt layout

1. Disconnect battery. This should be done before any engine repairs. Use a wrench to loosen the

black (negative) cable. There is no need to disconnect the red (positive) cable

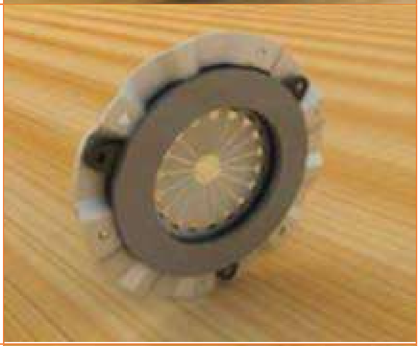
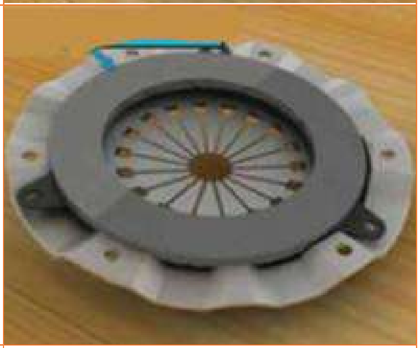
2. Locate the belt. The belt might be behind an engine cover at the front or side of the engine. To be sure of its location, consult your user manual.
3. Find the belt routing diagram in your user manual or take a photo of the belt still in place so you know how the new one should run. Some engines have a diagram sticker on the cover.
4. Release the tension on the old belt. Auto tensioners have either a hole for a ratchet or a bolt to hold a socket wrench. Either way, twist your wrench away from the belt to relieve the tension
5. With the tension relieved, you can now pull the old belt from the various pulleys, starting with the auto tensioner. Remove any pieces that come off the belt as well
6. Compare the old belt to the new to make sure they match in width. The old might be slightly longer due to stretching
7. Route the new belt through the pulleys just like the old one was.
8. Finally, apply pressure to the auto tensioner and put the belt over the pulley. Once in place, release the pressure so that the tensioner holds the belt in place.

5.2.5 Servicing and Repairing of Clutch

Clutch assembly

Let us learn how to fit a clutch assembly to the engine

Step 1: Ensure the flywheel face is clean and without dust or scratches. Also, check the condition of starter gear ring	
Step 2: Use input shaft for centering the assembly for fitting the clutch assembly	

Step 3: Fit clutch plate on the flywheel surface, while fitting ensure that proper surface of clutch plate is fitted on flywheel	
Step 4: Fit pressure plate assembly the above clutch plate	
Step 5: Fit all the bolts on flywheel with pressure plate assembly	
Step 6: While fitting the plate pressure plate for any scratches, make sure It is clean. Do not forget to remove input shaft which taken for centering assembly	
Step 7: Fit clutch bearing with yoke on the input shaft	

Step 8: Ensure clutch housing is properly fitted on the crankcase. Ensure proper alignment of all plates with input shaft	
Step 9: Yoke is then connected to clutch paddle through cable rod	

Table 5.2.1: Clutch assembly procedure

Lubricating of clutch cable:

- Moulding clay is used to make channel in proximity of outer cable. ThenPour oil into the funnel, as it to drain down. Silicone lubricant is used on nylon-coated cables.
- Regular cable lubrication should be done. Pump-type oil can is used at pedal.
- Nylon coated inner cable have to be lubricated with silicone lubricant and ordinary oil should never be used, as it attacks the nylon covering resulting in sticky cable. Aerosol cans are available for these lubricants. Extension nozzles are supplied for oiling inside the outer cable.
- The cable needs regular lubrication. Metal inner cables may need about once in a month or so to keep it operating smoothly. Pump type oil can is required get the oil pedal.
- Nylon coated cables may need to checked once a year, as they are self-lubricating.

Silicone grease:

Silicone based clear grease can be used for lubrication of both ordinary cable as well as nylon coated cables. Also lubricate the exposed parts of the clutch cable. It lasts much longer than oil or silicone aerosol lubricant.

Lubrication of clutch connections:

Clutch cable fits to the clutch operating lever at the clutch housing. The connection if covered with a rubber cover, may be pulled back along cable.

Most of inner cable connections are with threaded end, having adjuster nut and locknut placed on it. Inner cable passed through clutch lever and fitment is done using a nut.

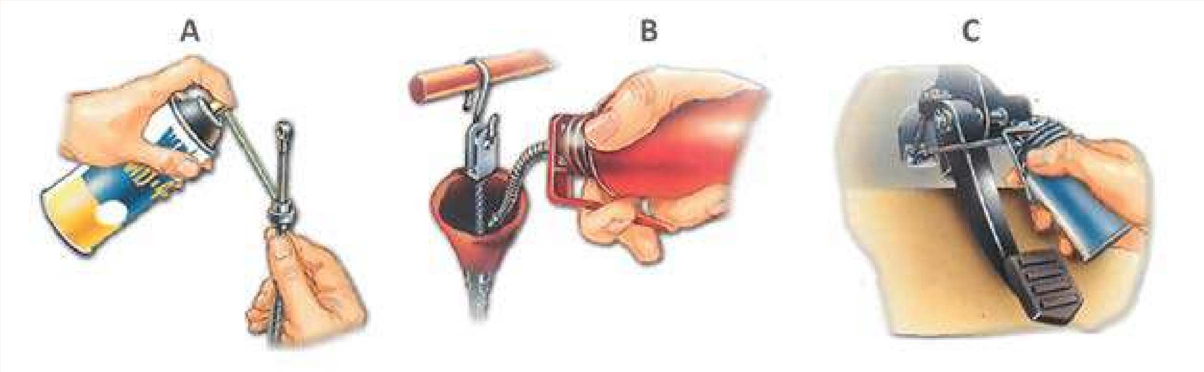


Fig 5.2.16: (A)Lubricating process 1 (B) Lubricating process 2 (C) Lubricating process

Disconnect cable from clutch lever:

1. Remove the rubber dust cover and expose the connection.
2. Remove the adjuster & locknut to make the cable free.
3. Take the cable sideways out.
4. Remove rubber cover fitting from cable & lever assembly connection, take it away and it will be hanging on the cable, while you work on the cable.
5. If it is having threaded end with adjuster & locknut at the end, pull out the cable by removing them.
6. For nipple connection, push the clutch lever and then pull out the cable with using pliers.

Bleeding clutch:

Many cars are provided with hydraulic clutches. It's mechanism is sturdy & long lasting. By occasional look it can be ensure that the fluid level in reservoir is correct.

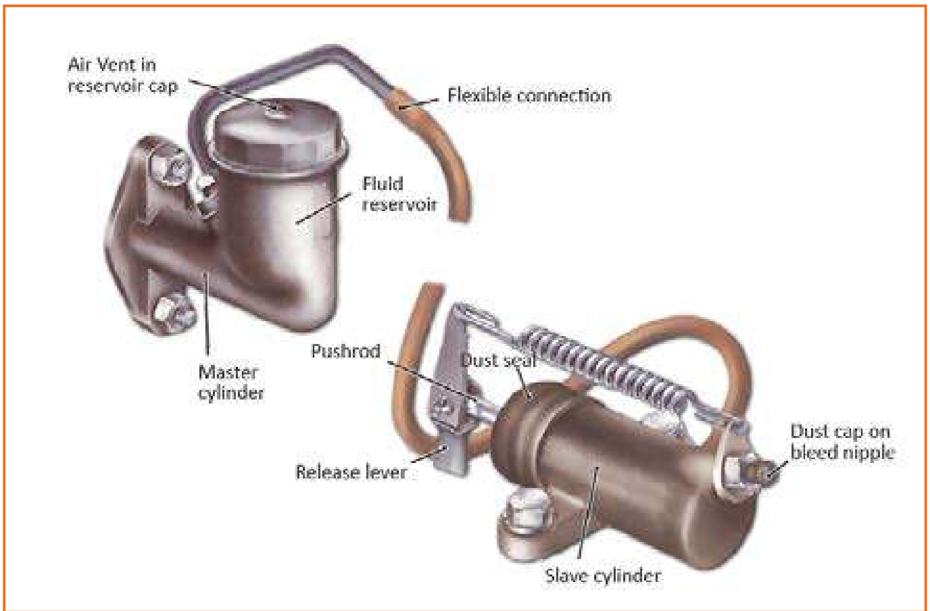


Fig 5.2.17: Clutch bleeding process

Master cylinder fluid is forced to save cylinder, during depressed stage of clutch pedal mechanism engage and disengage clutch plates.

Air gets entrapped into the system through leakages, making the pedal response erratic. When you find this problem, set it right by bleeding the clutch to expel the entrapped air and then fill it with clean fluid.

Bleeding sequence:

- Air will be sucked into the system during pumping, in-case bleed tube is not submerged in brake fluid.
- Pour about 500 ml of new hydraulic fluid in a clean jar, and put it on the level ground under the slave cylinder.
- Place one end of bleed tube in jar inside fluid. Air and fluid from the system will now be pumped into the jar.
- Remove bleed nipple nylon cover on the slave and put other end of the bleeding tube over it. The nipple may get easily damaged. Use correct size spanner to unscrew around 3/4th turn.
- Get the clutch pedal pressed down completely and quickly remove it. Bubbles will be seen coming in the jar indicate entrapped air is getting released. Pump the pedal till the bubbles coming out stop.

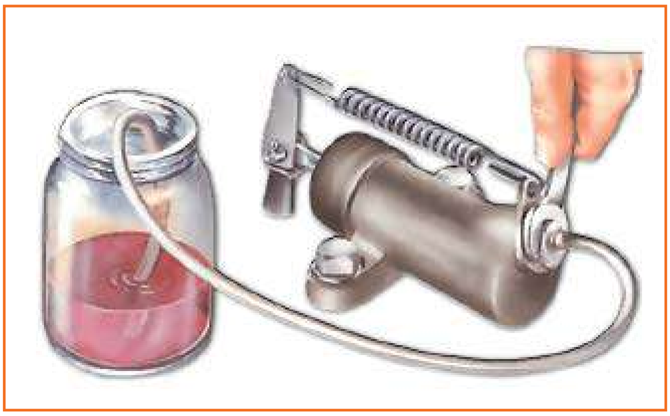


Fig 5.2.18: Bleeding procedure

- After 6 pedal strokes, if bubbles still continue, then top up the reservoir, before pumping further.
- When the system gets free of air, the helper will hold the pedal down and nipple should be tightened properly.
- Depress the clutch pedal and then remove bleed tube and jar.

Fitting a bleed tube:

1. Place bleed tube one end to bleed nipple on slave cylinder.
2. Use around 2 ft long and 5mm diameter rubber tube.
3. Rubber or plastic protective cover may be found on bleed nipple of clutch slave cylinder for dust protection.
4. Push and properly fit bleed tube firmly on the nipple to ensure it is tightly fitted.
5. A plastic tube warmed up by immersing in slightly hot water will soften and be easier fit in.

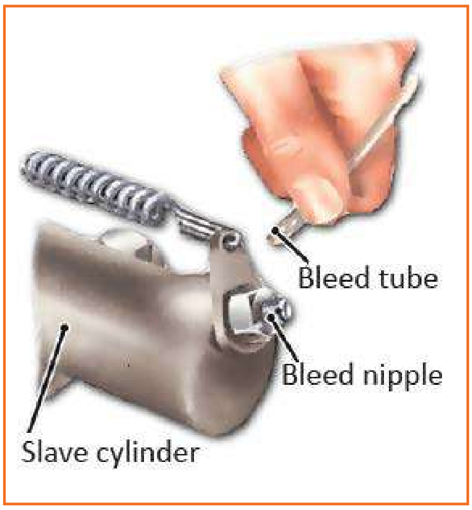


Fig 5.2.19: Fitting bleed tube

Reservoir top up:

- Ensure to use high quality fluid for master cylinder fluid reservoir.
- The container must be airtight.
- New clutch fluid should be allowed to stand still, unshaken for at least 24 hours before using. This is to allow any bubbles to dispel.
- Any dirt collected around the reservoir cap should be wiped clean to avoid any specks dropping in when you unscrew it.
- Check if the sealing ring is ok. Remove the cap to ensure clear air hole.
- Fill new fluid up to correct level. Tightly replace the container lid, to avoid moisture getting into the liquid to spoil it.

Fig 5.2.20: Tapping reservoir

5.2.6 Servicing and Repairing of Steering System

Lubrication

Most of the modern cars have steering system with sealed for life joints. They do not normally need any maintenance. They are simply replaced with new ones, if found damage.

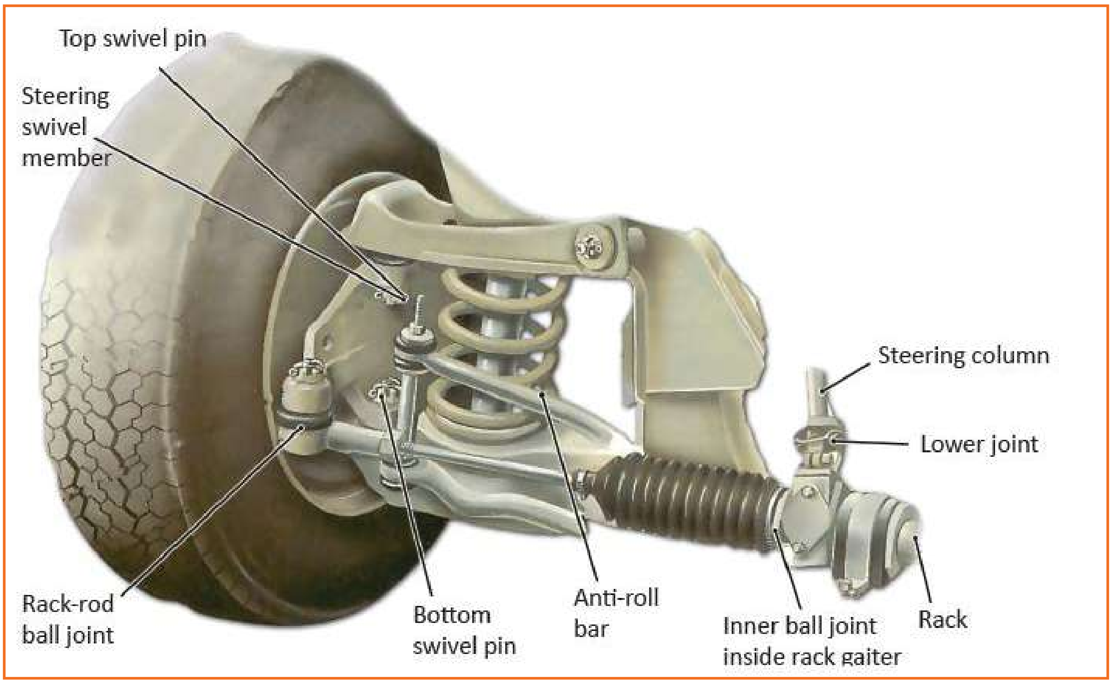


Fig 5.2.21: Lubricating the steering system

Sealed rack contains the inner tie rod in the gaiter of the in a rack system. Leave it untouched, unless you want to remove the gaiter for some other reason.

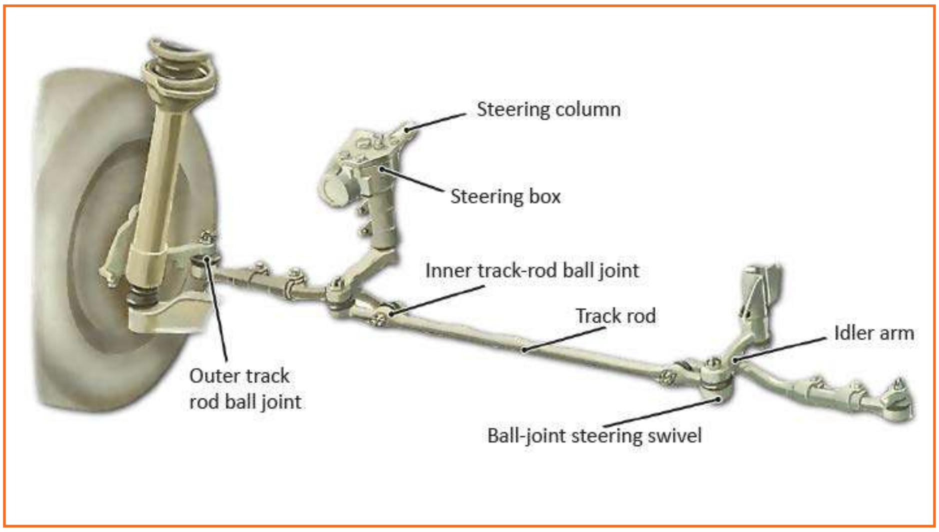


Fig 5.2.22: A Macpherson-strut suspension system with a steering box

In steering gear box system, the extra joints on track rod and idler arm may need attention.

Grease nipples and / or oil-filler holes are provided in different parts of new cars.

It's position depends on type of steering system.

Let's discuss where & how to lubricate.

Lubricating rack & pinion:

The rack is normally filled with oil / grease and does not require regular maintenance. It needs re-lubrication, if you remove / replace the rack gaiter, or if there is leakage through a loose or damaged gaiter clip.

Topping up steering box:

1. Identify steering box filler plug on steering gear box.
2. Steering box filled with oil does not require regular topping. However, it is suggested to check oil level during routine maintenance. If oil seal is having leakage then topping up is necessary.
3. Filler plug is found on upper section of steering gear box.
4. Do not get confused with the adjusting screw or bolt, or the cover retaining bolts, which are also on same location.
5. Service handbook help in finding filler hole and also deciding level of oil.
6. Plastic filler capon steering box is provided in some cars. After topping up, the cap has to be pressed properly.

5.2.7 Servicing of Gear Box

Lubrication of transmission gears:

- Need to be lubricated regularly.
- Lubricated by gear oil of a specification as per manufacturer recommendation.
- Transmission oil dipstick is used to check oil levels. In some vehicles level and lubricant filling plug is provided at the place of dip stick. Use same grade oil to top up.
- Change gear oil during the schedule maintenance (approx. at 40000 km) or as per manufacturer's recommendations.

Draining and refilling the gearbox:

1. Before drain plug removal surrounding area should be cleaned properly to avoid dirt particle entry in the hole.
2. The best practice of draining the oil is when engine is hot as it helps flow of oil quickly and completely. For oil draining vehicle should be on level ground, and be ready with the required volume of new oil for filling.
3. Always use correct tool for removal of drain plug, which is under side of the gearbox, use of improper tool may also damage the plug.
4. Place a container below drain hole to collect oil. Use container having sealing facility so that oil can be easily disposed.
5. To fill the new oil filler plug needs to be loosed and removed.
6. Squeeze oil from a soft plastic bottle fitted with a flexible tube into the filler hole, which is often hard to reach. In cold weather better use warm oil.
7. In case metal debris is observed coming from drain hole it indicates gearbox his having certain trouble and needs take the vehicle in garage.
8. Better use new washer and avoid over tightening of plug.
9. Fill oil till the marked level and after filling filler plug should be tighten back. Always use manufacturer recommended oil.

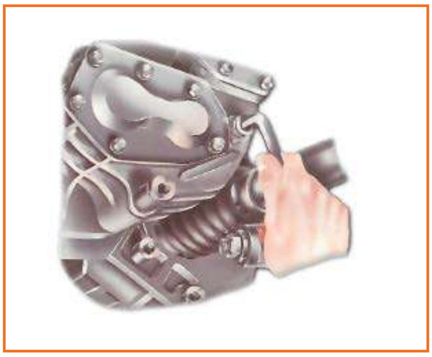


Fig 5.2.23: Gear box

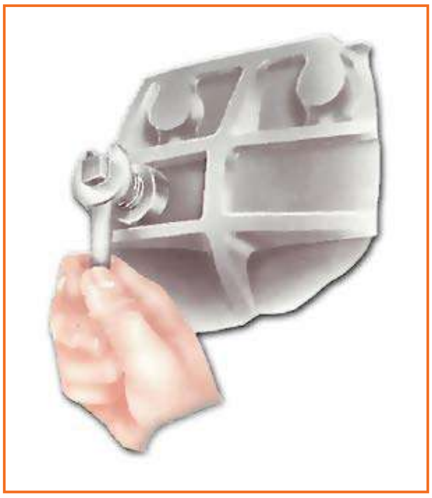


Fig 5.2.24: Servicing gear box

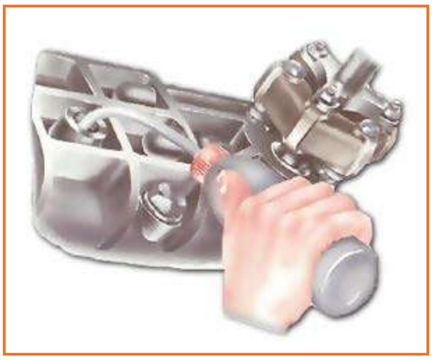


Fig 5.2.25: Servicing gear box

5.2.8 Servicing and Greasing Wheel Bearings

Wheel bearings lubrication and re-assembly

Removing the outer races:

- Use socket & extension bar to thrust out inner races. Clean hub & races well with paraffin or white spirit. Then drive the races away from one other. The inner & outer races may be different sizes. If they are, begin with smaller one.
- For same size races, thrust out one using punch or chisel and thrust out another using socket.
- Use extension piece for lengthening socket & tap gently with heavy hammer to remove race. Use a bigger socket to force the other race out in opposite direction.
- Some hubs are provided with channels to take a punch. For same size races, first one has to be removed using flat faced punch & hammer, alternate side drumming and ensuring not to tilt and jam it.
- Avoid scratching inner portion of hub.
- After removal of first race second one should be freed through socket as a drift.

Fig 5.2.26: Inner races

Fig 5.2.27: Races out

Checking and cleaning the bearings:

- Clean all parts well with paraffin or white spirit. Avoid getting grease on the brakes when cleaning the stub axle.
- During routine lubrication, the outer races remain on the stub. Inspect them. Very small indentations may be allowed, but if pitting or scoring is noticed replace bearings.
- For inner races, rollers or balls, is not granted. Any blemish is not acceptable and bearing should be replaced. Then lubricate the bearings.

Fig 5.2.28: Punch channels

Lubrication of ball bearings:

- In some cars, ball bearings are used. Ensure that the balls are packed with grease, and that all the balls are present.
- In bearings outer races should be filled with grease and after that balls should be pushed inside. Gently hit inner races back to its place. Put more grease into the bearing while turning it.

Fig 5.2.29: Ball bearing

5.2.9 Checking of Wheel Rims

When wheels are taken off, inspect tyre walls. Clean wheels thoroughly and look for cracks carefully.

- Loosen wheel nuts, before jacking up vehicle.
- Cracks could be due to corrosion or loose or very tight wheel nut. In case of such damages replace wheels.
- Check for deep scuff marks, buckling or denting on steel rims.
- Due to damaged rim maintaining vehicle balance become difficult.
- In case chips or scrapes on alloy wheels are minor it can be ignored but cracks are serious.
- Magnesium alloy wheels corrode badly, if protective coating is disturbed. Flying grit may also damage it. Inspections should be done more frequently for such damages. Re-lacquer the wheels, if necessary, before corrosion sets in. Proprietary lacquers are available, especially for car wheels, giving clear instructions on the container, about their application & usage.
- Rusting is possible in steel wheels due to use of thick metal strong enough to withstand all.
- Rusty wheels are unattractive to sight but can be easily painted to look more prominent.

Checking valves:

Faulty valve may lead to slow & persistent, loss of pressure from the tyre. Whenever tyre is taken off, new valves should be fitted.

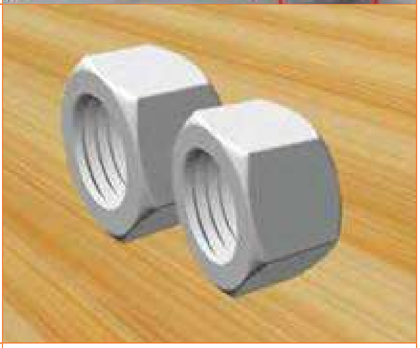
The inner core of valve became worse with age, more so, if the valve cap is missing dust / grit can easily enter.

- Check each valve carefully for cracking / hardening of rubber covering around stem.
- Check for dirt after removing cap and then after do the replacement. Remember, it is pressure seal & protective shield.

5.2.10 Servicing and Repairing of Brake System

Wheel cylinder assembly

Step 1: Wheel cylinder is a impotent component in vehicle hydraulic break system. Place wheel cylinder assembly on the back plate	

Step 2: Make sure bleeding nozzle is on bottom side	
Screw tightening hole on wheels cylinder and back plate matches with each other tighten the bolts	
Step 4: Fix Break shoe on both side slots of wheel cylinder	
Step 5: Tension Spring - to be attached to both side liners	
Step 6: Loner retainer spring - Fix it now	

Step 7: Rubber hosing pipes: Fix end of rubber hosing pipe on break oil inlet hole of wheel cylinder and another end of the metallic pipe for the break oil attached to master cylinder	

Assembling of double piston brake wheel cylinder

Clean the wheel cylinder housing & make sure oil holes are clean & clear	
Ensure the piston sealing rubber cap is fitted properly, then insert piston	
Rubber Boot - Fit rubber boot on neck of the wheel cylinder body	
Another side of the housing - insert tension spring and then insert another piston	

Rubber Boot - Fit rubber boot on the neck of the wheel cylinder body	
Fit bleeding screw properly	

Master cylinder assembly

Step 1: Properly clean the master cylinder body. Make sure that all holes are clean Dust free and no rust should be inside	
Step 2: Make sure all rubber seals are properly fitted on piston	
Step 3: Before inserting piston, make sure to apply break fluids on piston as well as inside the body of Master Cylinder	

Master cylinder is central component of the braking system. Its connection to the brake paddle is through a lever arrangement, which provides considerable mechanical advantage. The piston movement, when the brake paddle is depressed, creates a pressure in the chamber behind it. The pressure is passed on through the hydraulic fluid to wheel cylinders.

Step 4: Fit the locking screw on the body for piston no. 1	
Step 5: Now insert **"long piston"** along with spring keeping the spring in front side	
Step 6: Adjust and lock the locking clip properly in the slot of master cylinder body.	
Step 7: Fit the Rubber Booster with Push Rod on the second Piston.	

Step 8: Connect Master Cylinder Assembly to the Break Booster on the stud and tighten it properly using suitable bolt.	
Step 9: Properly fit valves inside both outlet ports	
Step 10: Fit Front and rear brake metallic pipe to the respective valve marked on outlet port	
Step 11: Check the type of the brake oil required on cap of reservoir tank	
Srep12: Fill brake oil either Dot 3/Dot 4 as mentioned on the reservoir cap, up-to the Max mark	

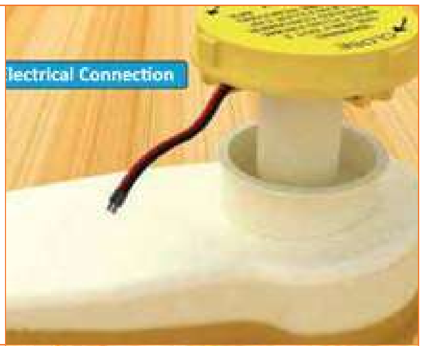
Step 13: Ensure reservoir cap with float assembly is fitted properly with electrical connection	
Step 14: Tighten the cap on reservoir tank	

Table 5.2.2: Brake system assembly procedure

5.2.11 Restoring Drum-Brake Shoes& Disc-Brake Pads

Check the drum brake as prescribed by vehicle manufacturer. Look for worn brake linings.

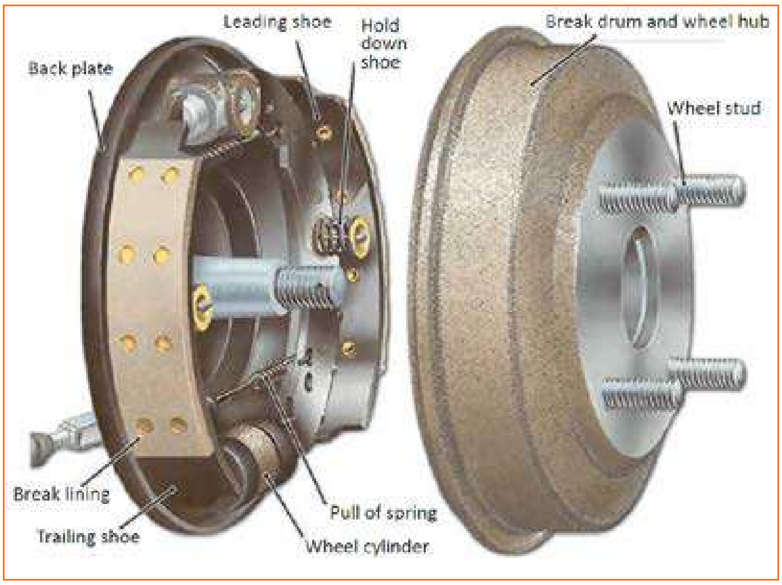


Fig 5.2.30: Integral drum brake

A rear brake with an integral hub and brake drum is shown here.

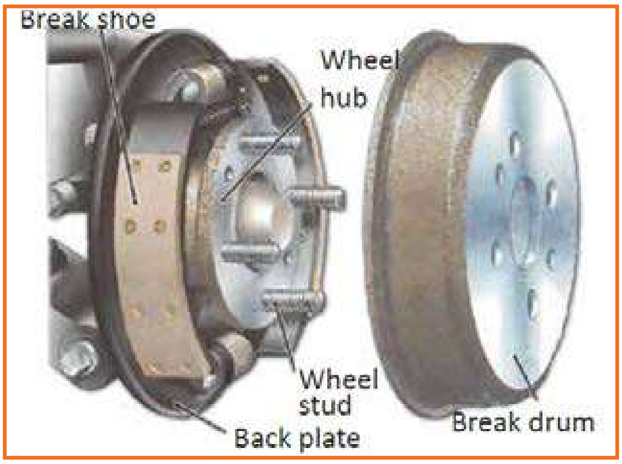


Fig 5.2.31: Separate drum brake

Modern cars have inspection hole plugged in the back plate. For rest of the cars drum has to be removed for inspection.

The figure here shows front brake including drum separated from hub. The hub stays consistent during change of linings.

- For safety reasons replace shoes along with bonded lining. If lining found worn out.
- Always replace both brake shoes even if one is worn out even if oil or brake fluid found on lining both should be replace. Otherwise, braking will remain unbalanced.
- Buy and use only genuine brake shoes.
- For looking through inspection hole in back plate for example, raise car & on axle stands, rather than not just on raising it jacks.
- Before working on rear brakes the handbrake should be off. Make sure to check the wheels on the ground firmly on both sides to avoid the rolling.
- When dismantling brakes, mark using a paper and paper to help them reassemble again.
- Critical details include round brake shoes fitment, holes for springs etc. as them look similar and give confusion.
- While manually adjusting brakes, loosen them, before removing drums. However, for self-adjusting brakes, loosening is not required and may not be possible.
- The brake drum might be an integral part of wheel hub, or it may be separate.

Check wear on brake-shoe linings:

- Lining may checked with using tyre tread depth gauge. Linings must be replaced, if worn out to 1.5mm above rivet heads.
- A rule may be used for checking thickness of bonded lining.
- Lining worn to less than 3mm thickness should be replaced.

Removing an integral drum:


Fig 5.2.32: Central cap with a screwdriver

- Using a screwdriver carefully remove central cap to make sure evenly round the edge otherwise it becomes crooked & sticky.
- If screw driver levering fails, try chisel and hammer to knock lightly around cap edge to remove it.
- If there is no lip in cap lever, then drill a hole in it, insert a self-tapping screw and pull it with a claw hammer. Ensure to plug the hole, before cap is refitted.
- New split pin has to be used while reassembly.
- Carefully check the nut to ensure left hand threaded. Tighten to a precise torque, as recommended by vehicle manufacturer.
- For removing very tight nuts, helper may apply the brakes.
- After removing the nut, pull the drum off by hand, if possible. It comes off complete with bearings. Spread a cloth on the ground to catch any bearings that may fall off.


Fig 5.2.33: Pull the drum off by hand

Removing a separate drum:


Fig 5.2.34: Stubborn set-screws

- Remove the bolts / screws while protecting drum. Knock stubborn screws using centre punch. Impact drive may also be used.
- After loosening the stubborn set screw, finish unscrewing with a screwdriver.
- Mark one wheel stud & hole with paint marker, to refit them in the same position, while reassembling the drum.
- Soft faced hammer required to tap round the edge, if the drum sticks. Be careful as it may damage drum lip or back plate while hitting.
- The drum may have one or two screws or hexagon headed bolts. Remove them.
- The drum may also have spring clip on one wheel stud.
- Brake drum balancing should be done. Refitting drum back to its position will avoid upsetting the balancing.
- Drum may straight be pulled off, if possible. If it sticks the try knocking it around edge of drum, do not tap lip with hammer.
- Do not lift the lip from the back plate to avoid damaging it.
- If tapping does not remove the drum, Penetrating oil can be used. After applying oil wait for a while. Ensure not to get any oil on the drum.
- Another way rapping it using rags and applying boiling water over it, to expand the drum.


Fig 5.2.35: Marking on wheels stud


Fig 5.2.36: Tapping on edge

Removing drum brake parts

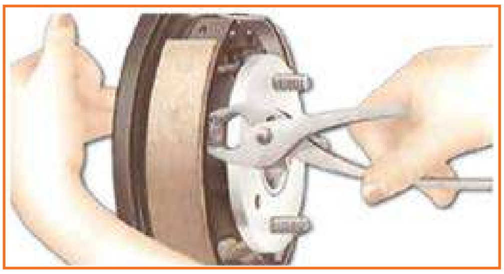


Fig 5.2.37: Remove coil hold-hand spring

- Remove a coil hold down spring, by holding the pin from the rear and pushing & turning the cap with pliers, until pin end lines up with cap slot.
- To take off brake shoe, the hold-down springs and sometimes the pull off springs will have to be removed.
- Twin leading shoes removal process is slightly different from Leading and trailing shoes.
- Make detailed notes and sketches, or take photo graphs of all parts before remove them to help you during the refitment.
- General rule is to do the refitting in reverse order of dismantling.
- Springs holding shoes may be small coil springs.
- Do the fitting of pins on each shoe, which pass through back plate & shoe.
- Do the fitting of coil spring fits under dished slotted cap. The pin end is compacted & fits in the cap and lies at 90 degrees to it.
- For removing, grip cap with pliers & push it down, while holding pin from rear of back plate.

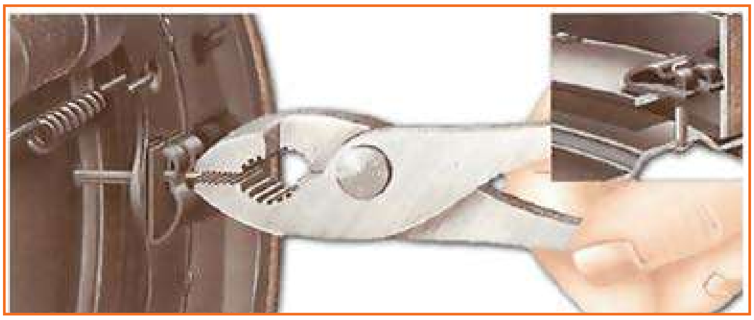


Fig 5.2.38: Spring clip removal

- For removal of spring clip, using pliers push it down, clip forked end protect T shaped pin which is used to hold brake shoe to back plate.
- Turn the cap so that it can aligned with the slot. Remove the cap. For spring clip removal, using plier and press it downwards.

Fig 5.2.39: Pull-off spring

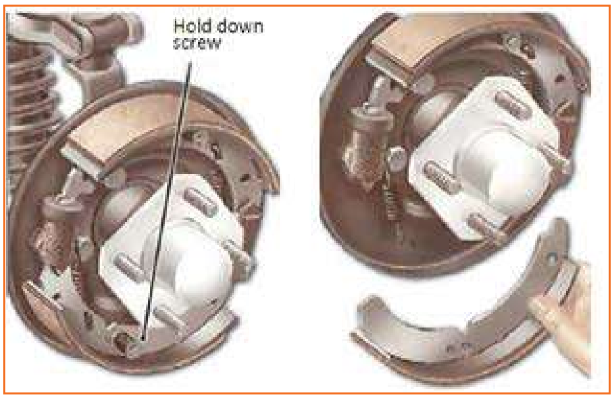


Fig 5.2.40: (A)Hold down spring (B) Removal brake shoe

5.2.12 Replacement of Disc-Brake Pads

Steps for changing brake pads

Step1: Remove the wheel	
Step 2: Remove the slider bolt	
Step 3: Pivot the caliper up	
Step 4: Slide out the old brake pads	
Step 5: Replace the retaining clips	
Step 6: Slide in the new brake pads	

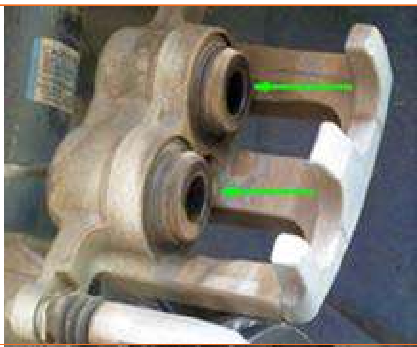
Step 7: Retract the pistons		
Step 8: Monitor the brake fluid level		
Step 9: Reposition the calliper **Step 10:** Reinstall the slider bolt **Step 11:** Repeat for the other side **Step 12:** Test-drive under safe conditions		

Table 5.2.3: Disc brake replacement procedure

5.2.13 Drum Brake Wheel Cylinder Replacement

Brake fluid is normally replaced with new one during leaking or wheel cylinder sticking.

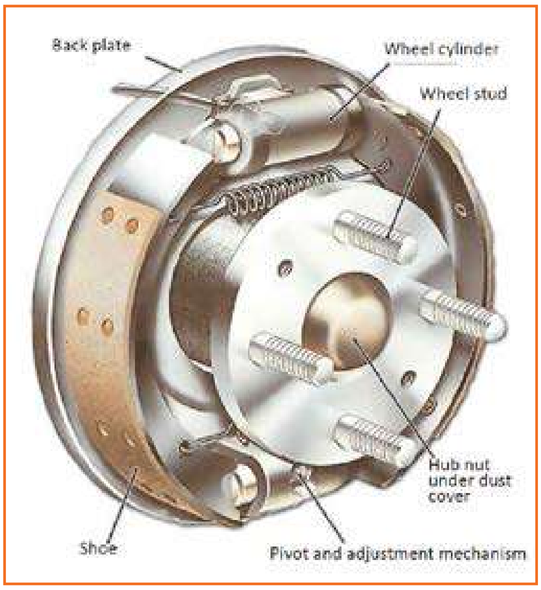


Fig 5.2.41: Leading and trailing shoe brake

The figure shows leading and trailing shoe brake. Both the shoe brake have separate cylinders.

If brake fluid has been top up, or it does not need replacement, avoid the or minimize the loss during cylinder replacement.

These precautions will also make the system easier to bleed, after reassembly.

Detaching the cylinder:

- Remove reservoir cap and loose the union before freeing wheel cylinder.
- Remove master cylinder reservoir cap.
- Remove flexible brake hose clamp, while taking care against damaging the hose.
- Remove brake drum & shoes.
- Loosen brake pipe union at rear of wheel cylinder and unbolt or unclip wheel cylinder, before removing brake pipe.

This method may differ depending on assembly type. Fixing with bolts or nuts may be stiff.

Better apply penetrating oil to them a few hours beforehand. Ensure it should not touch drum.

Fig 5.2.42: Reservoir cap

Fig 5.2.43: Hose clamp

Fig 5.2.44: Brake pipe union

Removing the brake pipe:

1. Union nut should be gripped using spanner. Twist cylinder to make free union completely.
2. During removal of brake pipe, union nut has to be loosened, before wheel cylinder removal.
3. When the cylinder is free pull an inch or two of brake pipe through the back plate.
4. Before pulling brake pipe first remove bleed nipple
5. Using spanner hold union nut disengage union by twisting cylinder thus in this process brake pipe is not twisted.
6. Use penetrating oil If unions are rusty or rigid ensuring that it should not go to drum.
7. When unscrewing the union nut do not twist the pipe or hose.
8. Brake-pipe union nuts are soft, therefore, use correct size spanner and ensure nut is fully held in the jaws.

9. A difficult nut may be loosened with a self-locking wrench.
10. Disconnected brake pipe end should be sealed properly.
11. Do not touch the brake pedal.
12. If a nut is not opening never apply force using spanner.

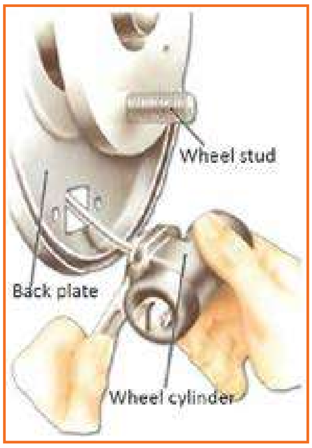


Fig 5.2.45: Brake pipe union


Fig 5.2.46: Releasing the bleed nipple

5.2.14 Adjusting the Brakes

A typical automobile front wheel use disc brakes whereas rear wheels use drum brakes.

Square peg should be turned clockwise to drive a wedge between two pistons, forcing the shoes apart.

Normally handbrake is operating on rear shoes using some short of mechanical linkage.

For adjusting the brakes wheels are raised and if required it may need to removed also for adjusting brake.

Place the jack close to wheel and raise the car.

Also provide support for axle stand.

Disc brakes brake pads adjust automatically for wear, either 2 wheels are having disc brake or all 4 are having.

Automatic adjusters work on the handbrake / footbrake. Every time brake is applied, a ratchet wheel is turned by liver which do the brake shoes adjustment.

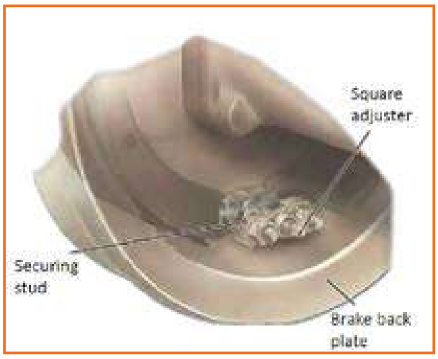


Fig 5.2.47: Wedge adjuster

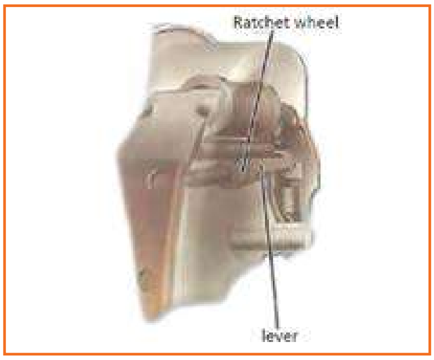


Fig 5.2.48: Automatic adjuster

Cars having drum brakes at rear, there is shoes are getting adjusted automatically because linings wear down, keeping the contact surface of the shoes close to drum & reducing brake pedal travel. If there is no provision for automatic adjustment of drum system, you have to manually move shoes closer to inner surface of drum as lining material wears down.

Fig 5.2.49: Cam adjuster

Manually adjusted drum brakes normally have a single adjuster. On front wheels, there may be two. Check brake back plate, behind wheel and drum. For vehicle having 2 brake pipes, or bridge pipe, this will contain 2 hydraulic wheel cylinders and might be 2 adjusters also.

Adjuster peg through back plate of brake revolve snail cam alongside peg on brake shoe. Star wheel adjuster is used to turn on a threaded rod which pushes brake shoes apart. Adjuster end is mainly is a rod that coming from back plate. Some adjuster have hexagonal end also. It is difficult to adjust the end using spanner. Always use correct brake spanner to protect adjuster from damaging.

Adjuster can also be accessed through hole in back plate or front of brake drum. In such case remove front wheels. The adjusters being exposed to weather and dirt, are prone to seizure. Better use oil lubrication before working with them.

Due to uneven braking car will swing or start to roll, especiallyon slippery surfaces even during moderate braking.

Fig 5.2.50: Star wheel adjuster

Adjusting a star wheel:

To get star wheel access back plate plug should be removed. To turn star wheel use good length screwdriver.

Loosen wheel nuts to take wheel off to reach adjuster hole. Raise car at nearest jacking point with axle stand support.

Teeth should be moved to make brake shoes jam against drum till no further movement is possible. Then move star wheel in reverse direction to make free rotation of the wheel.

Fig 5.2.51: Star wheel

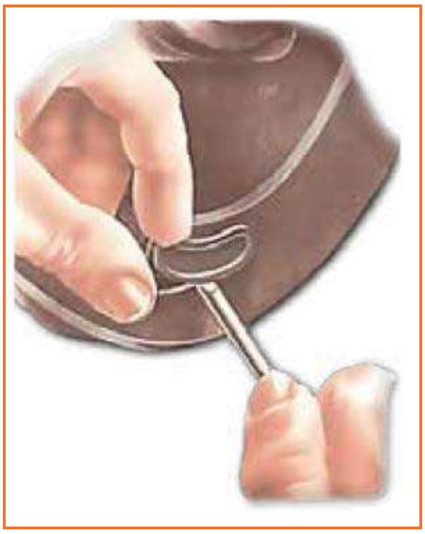


Fig 5.2.52: Star wheel plug

Backing off an automatic adjuster:

To remove the shoes from drum remove hexagonal bolts on back plate. Remove brake drum to work on brake shoes & automatic adjustment mechanism.

Automatic adjusters maintain correct adjustment of brakes. During removal of break drum back off the adjustment a little, to make the job easier.

After reassembly process it is a mandatory requirement to use both foot and handbrake for proper restoring brake adjustment.

Adjusting a snail cam:

Turn each adjuster clockwise, bringing the shoes near to drum.

Press brake paddle multiple times to centralise brake shoes inside drum. Raise car at nearest jacking point with axle stand support.

Put little oil to lubricate adjuster. Clockwise turn adjuster to move shoes closer to drum. This is normal direction. Not applicable to all vehicle.

Turn until resistance is felt now turn the wheel to ensure it is locked. Turn adjuster back slowly until wheel spin freely.

Due to transmission gearing driven wheels may have some pull. Spin wheel, before making adjustment, so as to know amount of drag.

Repeat the adjustment exercise on the other wheel / wheels of the car, as necessary to ensure braking balance.

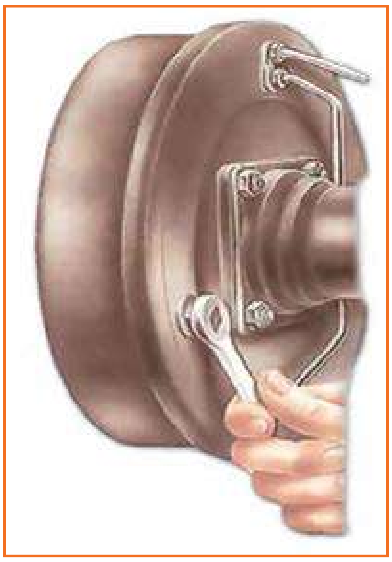


Fig 5.2.53: Adjusting snail cam

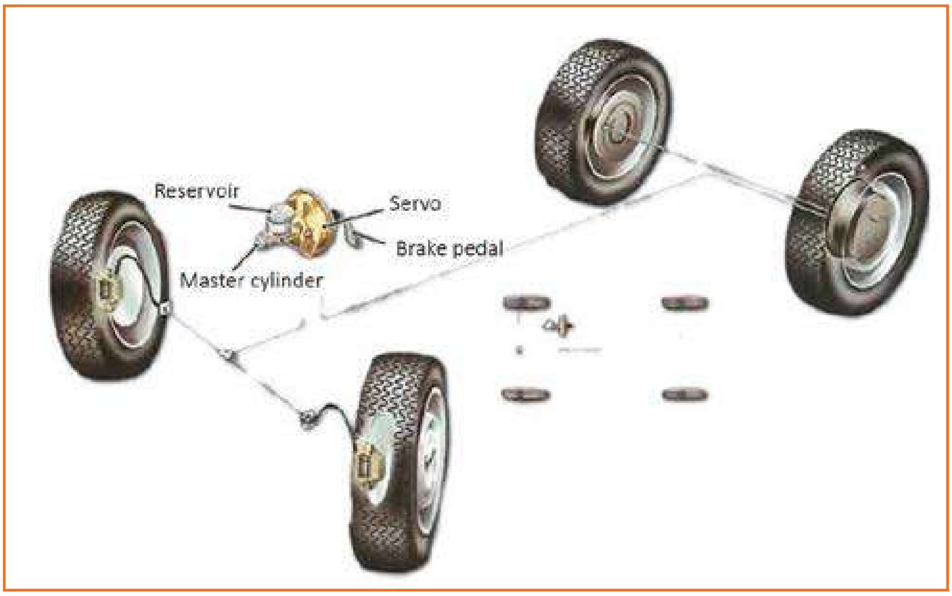


Fig 5.2.54: Bleeding a dual brake system

5.2.15 Bleeding the Brakes

In dual brake system both front and rear brakes have individual hydraulic circuits. Depending on manufacturer it may vary also. During no weight on wheels, bleeding operation cannot be performed in some car.

- The brake fluid is hygroscopic in nature andabsorbs moisture from atmosphere caused lower boiling point.
- Regular heavy braking friction cause heating fluid in wheel cylinders. Thus water content turns to vapour.
- Then, brake pedal feels ‘spongy,’ when you press it. In severe cases, brakes may completely fail.
- Air ingress in hydraulic system also makes the pedals spongy due to air compression.

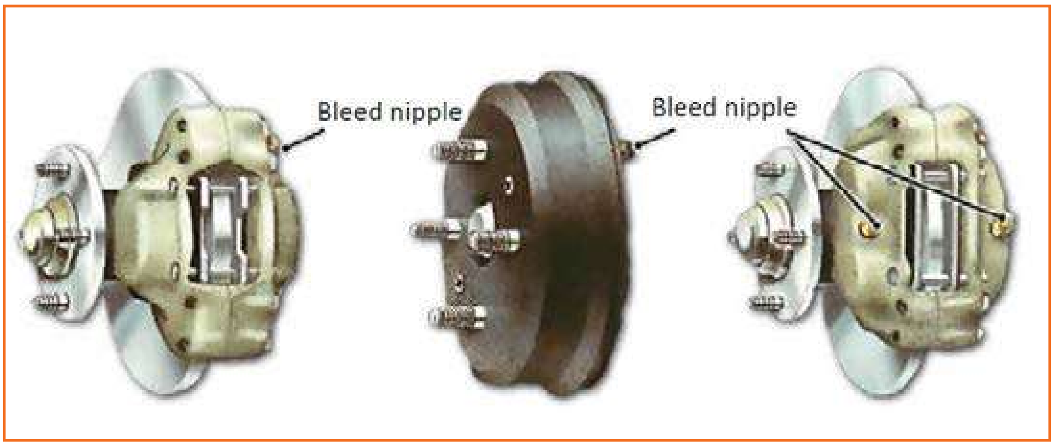


Fig 5.2.55: Location bleed nipples

- Check the system for possible leakage If pedal is spongy before replacement schedule of fluid. Air may be getting entrapped through leaking seals / faulty brake pipes.
- After finding a leak, replace faulty components first then after refill the brake fluid and do the bleeding process.
- Open bleed nipples for removing brake fluid from the system. These are small valves(bleeding nipples), on each caliperor wheel cylinder. Pump brake pedal repeatedly.
- At the same time master cylinder reservoir should be filled with new brake fluid on regular interval to maintain its level.
- If the reservoir gets empty, air gets into system. Whole process is to be repeated, until all the air is expelled.
- Keep topping up closer to the marking. If the bleed pipe does not have non-return valve, take help from the helper.
- Avoid brake fluid contact on body paint. If contacted accidently take it off immediately using clean rag. Also, wash your hands thoroughly, if it has gotten on your fingers.
- In dual circuit brake systems, usually start bleeding at front wheel brake because it is close to master cylinder on driver's side.
- Do the bleeding of other front wheel & then rear wheels. Lastly, the furthest one from master cylinder. In cars with servo supported brakes start with servo unit using bleed nipple.
- All wheels are getting brake fluids using common hydraulic pipe thus in case of leaks all breaks are getting affected.

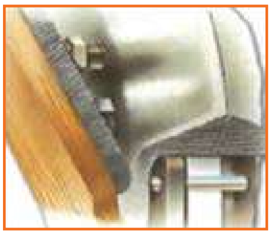


Fig 5.2.56: check the bleeding process 1

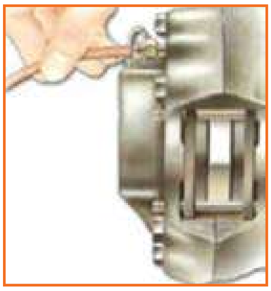


Fig 5.2.57: check the bleeding process 2

Fig 5.2.58: check the bleeding process 3

Removing air from a brake system:

- Remove off dirt & corrosion products around nipple with wire brush. Clean nipple using rag.
- Before bleed tube removal ensure that after bleeding nipple is tighten properly.
- Use appropriate size spanner for nipple. Attach bleed tube. Half turn the nipple. Brake fluid will start flowing into jar. Ensure that tube end is inside jar fluid.
- Bleeding method for most of the braking system is similar.
- To remove road wheel, place car on axle stand other wheels should be chocked.
- Remove dust cap, if is provided. Put ring spanner of exactly right size over the nipple. Length of tubing should be around 2ft. Fit it airtight on the nipple.
- Keep clean glass container below the nipple. Keep tube free end into it. Dispense brake fluid in jar till end of tube is inside it.
- During bleed nipple opening be careful as applying force while opening may lead to crack as the nipple is manufactured using soft metal.

- A corroded nipple may easily break off and in such case new brake caliper or wheel cylinder may be required.
- If nipple is very tight to turn with realistic force, use penetrating oil on threads.
- Open bleed nipple around half turn and keep the spanner on nipple only. Brake fluid will start oozing out from nipple and will be collected in jar. If fluid does not flow there is a possibility of blocked nipple in such case clear it.
- Once fluid start flowing, let helper pump brake pedal repeatedly. After some time master cylinder reservoir will become empty. Keep checking and topping it up, as required. If you see small bubbles, it indicates air in the system. Keep on pumping till bubbles stops.
- Let the helper to pump two three more time and then keep it fully depressed. Tighten nipple to close it using spanner. Now remove the tubing & the spanner. Replace the road wheel & move to the next nipple.
- You may not need any helper, if tube has non-return valve. Otherwise the procedure remains the same.
- The same procedures are used for bleeding the system to replace fluid, similar to expelling air.
- Normally, 6 strokes of brake pedal is required for each open nipple. Replace it with new. Ensure to retighten each nipple, before moving on to the next one.
- The pumping sequence may differ with different types of master cylinder.
- After bleeding all brake pedal should not be spongy. If it is spongy indicates air in the system. In such cases bleeding process should be repeated..
- Test the break in no traffic situation. With slow driving & test the brakes by pressing the brake pedal, as you would do normally.
- The car should drag quickly & move in a straight line and no spongy pedal. Apply the brake in normal speed & apply the brakes firmly. The vehicle should stop quickly.
- Try a few more times, if the sponginess persists it indicates air is still in the system. Repeat the bleeding process, till you are satisfied with the brakes operating correctly.
- If bleed nipples do not have dust caps, buy some and fit them after bleeding.

Opening blocked nipples:

If bleeding does not begin when you open a nipple, it may be blocked. Take off the tubing & unscrew bleed nipple.

Carefully clear the nipple by poking with stiff, thin wire.

Replace nipple tightly, refit flexible tubing to it. Remove hose clamp. After removing blocked nipple, try to clear it. Dirt dislodged may enter into slave cylinder. Loosen bleed nipple by half a turn, fluid should start to flow.

Fig 5.2.59: Brake hose clamp

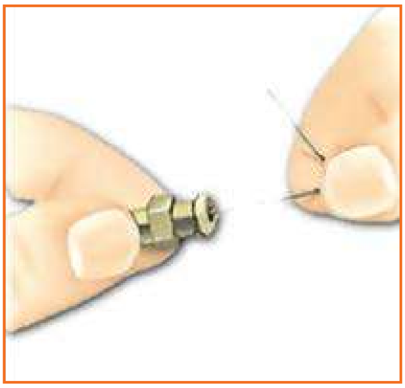


Fig 5.2.60: Carefully poke the nipple clear with a thin wire

Pumping correctly for different master cylinders:

Types of master cylinder are:

1. Aluminium valve (CV) master cylinder (single circuit type).
2. Cast iron compression barrel (CB) master cylinder (dual circuit type)

Each type calls for a different pump action for bleeding. This applies to single / dual system units.

For CV type, pedal should be pushed as far as it is possible, then give it 3 quick strokes in short span near the bottom & release it fully.

Repeat at once, and continue the sequence no air coming out from the bleed nipple.

For CB type, pedal should be pushed as far as it is possible, then let it come up slowly. Wait for few seconds and repeat it again all air is removed from the system.

Change the pumping action, try a different bleed sequence, bubbles are not getting cleared from fluid.

Fig 5.2.61: Master cylinder CV type

Fig 5.2.62: Master cylinder CB type

5.2.16 Master Cylinder Replacement

Leaking master cylinder has to be replaced. It can be located on the bulkhead which separate engine & car interior. Vacuum servo may also be fitted with master cylinder.

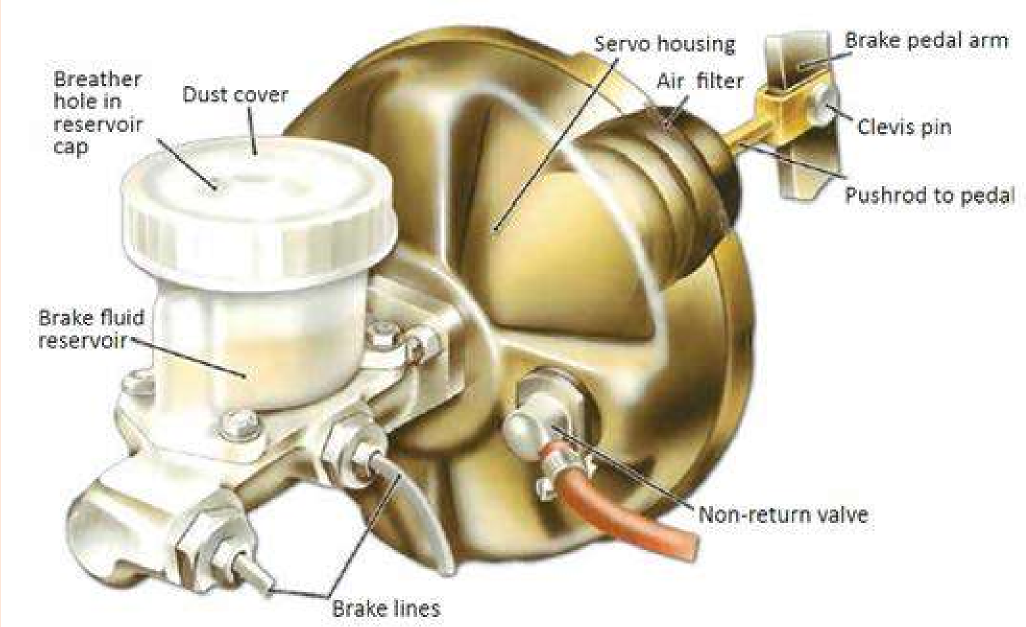


Fig 5.2.63: Dual circuit cylinder and servo

Tandem master cylinder serving dual circuit braking system & fitted with vacuum servo unit. Master cylinder is generally connected to brake pedal by pushrod.

Fig 5.2.64: One circuit cylinder

- Leaking or faulty unit has to be replaced. It may be faulty, if t became hard to push brake pedal is hard to push down & there is no more fault in breaking system.
- Check condition of air filter. Air filter should be changed periodically as per vehicle manufacturer recommendation.
- Before disconnecting any device or parts make sketch of the fitments.
- If you empty brake fluid from master cylinder never reuse fluid.

Removal of master cylinder:

- Better drain brake fluid from reservoir.
- For draining cylinder, open wheel bleed nipple. For split system, open rear wheel nipple also. If getting confused open all bleed nipples one by one starting from front first and then rear.
- Pump brake pedal and collect the fluid in jar. Fluid contact with body paint should be avoided.
- Minor dripping may occur thus place enough under cylinder and brake lines.

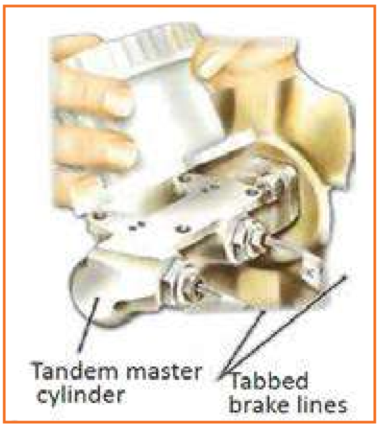


Fig 5.2.65: Removing master cylinder

- Remove reservoir from master cylinder, if it can be unplugged.

Disconnecting a pushrod:

For disconnecting pushrod, Remove split pin using pliers. Push out clevis pin sideways.

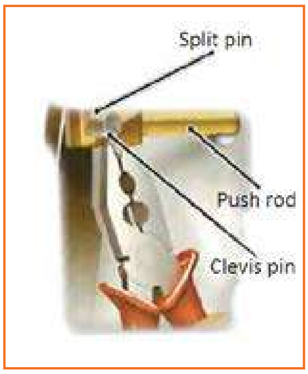


Fig 5.2.66: Disconnecting push rod

In most cars, pushrod is linked to brake pedal arm using Levis pin, instead of split pin.

Sometime removal of parcel shelf / trim panel is required for reaching it.

Remove pin using pliers. Push out clevis pin sideways.

While doing reassembly use new pin, ensure linkages of rod to the correct hole.

Pushrod:

Few cars allow pushrod to be pulled out from master cylinder. During reassembly, length can be adjusted using locknut. No need to detach from brake pedal. Refer the type in the workshop manual.

Fig 5.2.67: Disconnecting VW push rod

While doing reassembly, adjust length of the push rod. Slacken locknut & turn rod so that there is about 1/25 in. (1 mm) of free play between ball end of the rod & it's seating in the cylinder piston.

Removing the master cylinder:

1. Before dismantling mark break pipe with tags for ease of refitting.
2. Unscrew bolts holding the master cylinder.
3. Ensure washers and Inspect seal between it & servo unit.
4. Dismantle the brake pipes from master cylinder and collect the fluid in a jar.
5. Disconnect electrical leads, like those to fluid level warning light / stop light switch.
6. Disconnect any other parts that are in the way, like the choke or accelerator cables.
7. Sometimes holding bracket is also used to hold master cylinder.
8. Unfasten bolts holding cylinder & take it off by not losing any washers.
9. After fitting new master cylinder, tighten up pipe unions first by hand, then with spanner. They get easily cross threaded.
10. When reassembly is over, refill the empty reservoir, bleed breaking system and top up reservoir.

Fig 5.2.68: Master cylinder removal step 1,2 and 3

Replacing a servo unit:

1. Remove servo unit from master cylinder. Check seals condition and replace if it is required.
2. Disconnect it by loosening the hose clip.
3. Disconnect it from brake pedal then unfasten it from mounting bracket. Remove the servo unit. Check condition of gasket between servo & it's mounting. Replace, if worn out.

While renewing servo unit alone, it is possible to dismount the master cylinder without disconnecting brake pipes. They are long one allowing removal to one side. In that case, no need to drain master cylinder. If not, then disconnect push rod & remove master cylinder as explained.

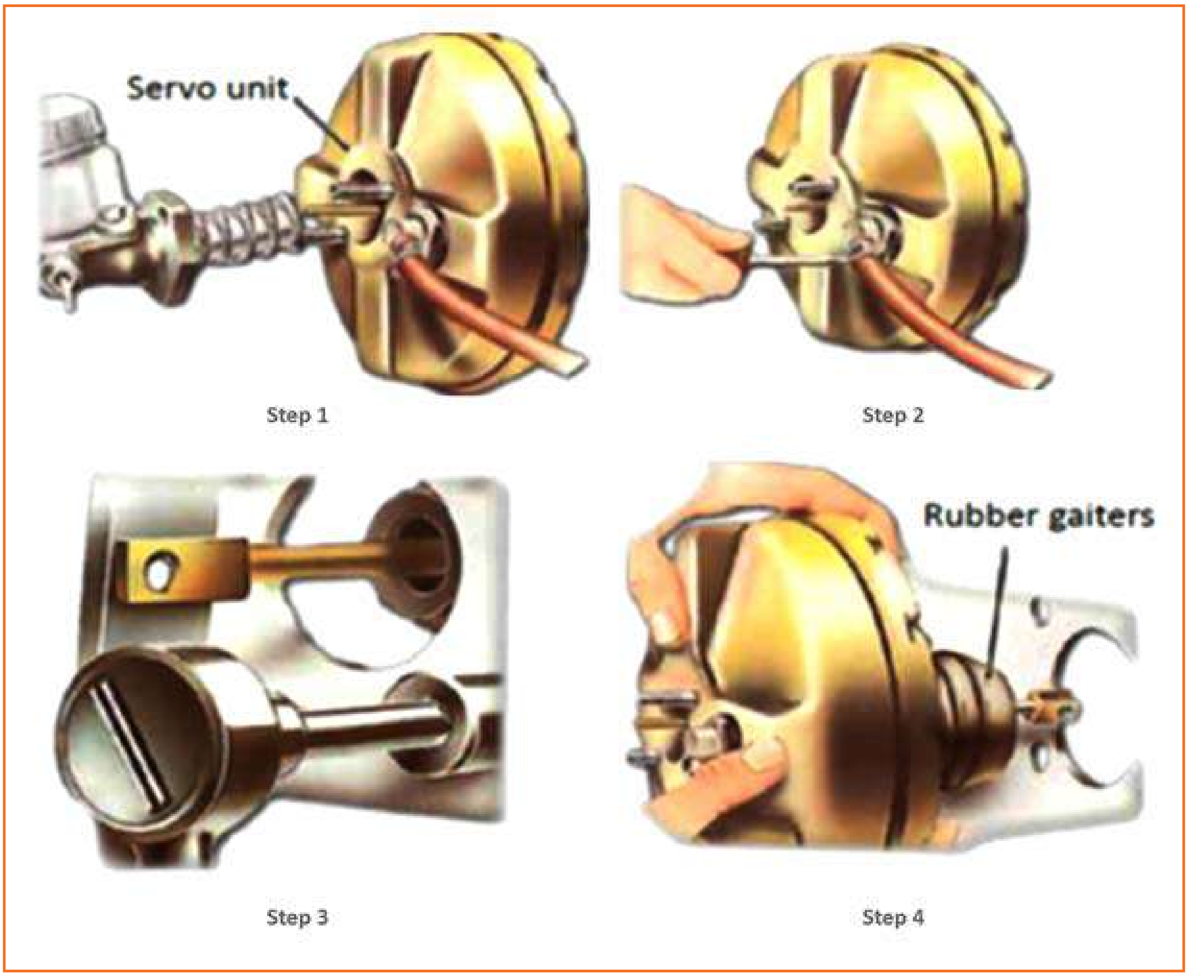


Fig 5.2.69: Replacing servo unit steps fron1 to 4

4. Check condition of seal between servo & master cylinder. Replace, if necessary.
5. Make sketch of the way servo pushrod is connected to brake pedal, and vacuum connection to servo. Disconnect both of them.
6. Unfasten it from its bracket on the bulkhead and remove it. Check gasket. If worn out, replace it.
7. While refitting a new unit, inspect vacuum hose condition and replace, if necessary. Ensure the tightening of all clips.
8. Bleed the system after reassembly.
9. Dismantle it from the master cylinder. Check the condition of seals between the servo and

cylinder. Fit new seals, if necessary.

10. Disconnect vacuum hose by loosening the hose clip.
11. Unfasten it from it's mounting bracket. Remove the servo unit. Check condition of gasket and replace, if worn out.

Renewing a servo air filter:

It is possible to reach air filter from inside the car or at rear side of unit. Sometime servo needs to be removed for filter replacement.

- Slide rubber gaiter along pushrod to expose filter. Take out the filter.
- Using a sharp knife, cut filter at 45 degrees, so that it can be fitted on pushrod.
- Insert filter over pushrod and place it in housing. Push both ends of the filter simultaneously and replace rubber gaiter over filter.
- Some core uses plastic ring in place of felt ring. It is not renewable. Wash it in mild water & detergent mixture. if found blocked, replace it.

5.2.17 Adjusting the Handbrake

After tightening brake shoes hand brake lever is getting pulled quiet a long, the cable is possibly got elongated due to stretching and needs adjustment.

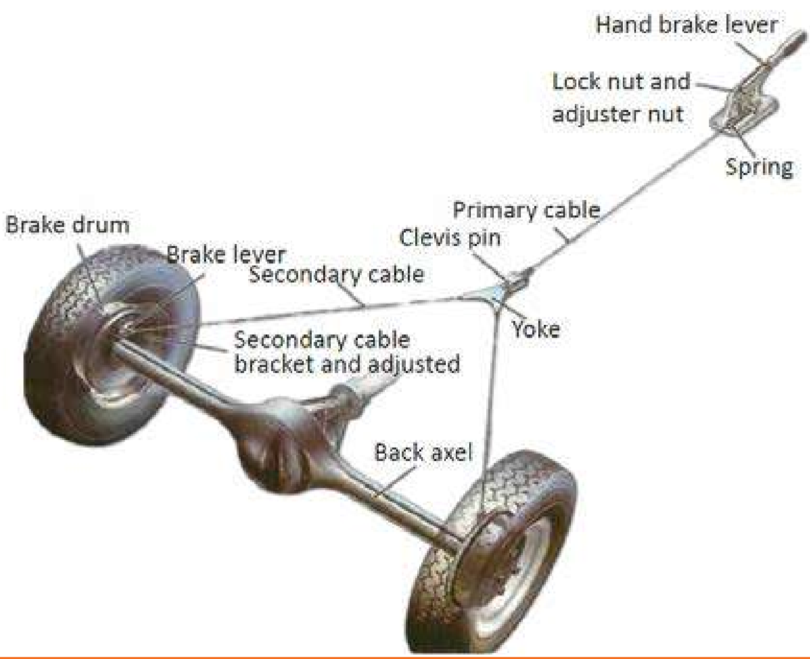


Fig 5.2.70: The handbrake

The handbrake is mainly used for parking, although it provides some braking effect during failure of hydraulic system. It separately acts on same brake drums / discs, as hydraulic system and needs separate adjustment. In some systems there is a primary & a secondary cable. When handbrake is applied, secondary cable operates through yoke attached by clevis pin to primary cable.

Different types of adjusters are used for shortening / lengthening cable.

- Some are at base of handbrake lever, inside car.
- Some are underneath car andmight be either dirty or rusty.
- While working under car, always ensure proper supporting mechanism such as axle stand.
- Wheels on ground should be properly chocked.

A single adjustment compensates for wear on separate pads and cable stretch.

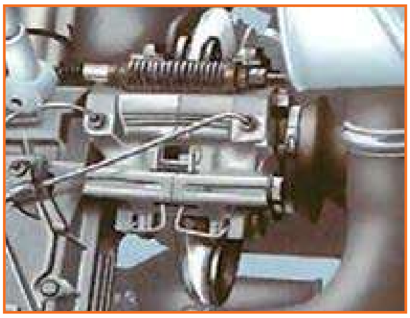


Fig 5.2.71: Disk Brake

Use penetrating oil on to all nuts and screw threads before starting the work. This will help in opening joints.

Lubricate pivots and linkages with engine oil as they may get damaged due to road dust or corrosion. Ensure free movement of cable or rods in their sleeves covering them.

In typical handbrake bowden cable, runs to one brake drum & operates other by sloping rod.

Fig 5.2.72: Bowden cable

Safety rules for repairing tubeless tyres:

- Never attempt sidewalls repairing or tyres with punctures larger than a 1/2 inch.
- Reduce air pressure to at least 15-psi, when removing an object from the tyre.
- Broken strands in a steel belted tyre can indicate more serious damage than initially suspected.
- Replace the tyre. Follow procedures given in tyre repair kit.

Exercise

Long Answer Questions

1. Describe the maintenance process of four wheeler.

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2. Describe the selection criteria of engine oil for a four wheeler.

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3. Describe the servicing requirements of four wheeler vehicle.

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4. List the steps for maintenance of four wheeler engine.

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5. List the steps for servicing and repairing of brakes.

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Summary

This module covers how to conduct routine servicing and maintenance (including electrical and mechanical aggregates) of 4 wheeler vehicles. In this module, participant knows about identify defects and repair or rectify them as per organisational procedures and guidelines.

Scan the QR code or click on the link to watch related videos

www.youtube.com/watch?v=NITwzS_P_-E

Checking and adding coolant

www.youtube.com/watch?v=3V2wJAB-WwE

Checking engine oil level

Notes

ANNEXURE - QR Codes

Chapter No.	Unit No.	Topic Name	Page No.	QR code(s)	URL
Chapter 1: Introduction to the Role of a Four Wheeler Service Technician	Unit 1.1 - Introduction to Automobile	History of Automobile	7		https://www.youtube.com/watch?v=5GAIvqzf-SKM
Chapter 1: Introduction to the Role of a Four Wheeler Service Technician	Unit 1.2 - Job Role of Four Wheeler Service Technician	Job role of four wheeler service technician	11		https://www.youtube.com/watch?v=x3fgC2a-2S3o
Chapter 2: Work Effectively and Efficiently	Unit 2.1 - Safe Working Practices	Workshop safety	22		https://www.youtube.com/watch?v=oV-jYG73RFSg
Chapter 2: Work Effectively and Efficiently	Unit 2.2 - Emergencies, Rescue and First Aid Procedures	Workplace emergency procedures	35		https://www.youtube.com/watch?v=DaYwcH-1GMEg
Chapter 2: Work Effectively and Efficiently	Unit 2.3 - Workplace Quality Standards	First-aid practices	35		https://www.youtube.com/watch?v=BumbKH-qXJo0
Chapter 2: Work Effectively and Efficiently	Unit 2.4 - Health and Hygiene During an Epidemic and Pandemic	Workplace quality standards	49		https://www.youtube.com/watch?v=XSAzVS-3fvXA

Chapter No.	Unit No.	Topic Name	Page No.	QR code(s)	URL
Chapter 3: Optimize Resource Utilization	Unit 3.2 - Waste Management	Waste Management	73		https://www.youtube.com/watch?v=K6ppC-C3lboU
Chapter 4: Assist in Diagnosing Repair Requirements	Unit 4.1 - About Four Wheeler Vehicle	Anatomy (Aggregates) of Four wheeler	80		https://www.youtube.com/watch?v=Shr0u-85MUQw
Chapter 4: Assist in Diagnosing Repair Requirements	Unit 4.2 - Tools and Measuring Instruments Required	Measuring Tools	96		https://www.youtube.com/watch?v=rd-dQmcNk1w4
Chapter 4: Assist in Diagnosing Repair Requirements	Unit 4.2 - Tools and Measuring Instruments Required	Special Service Tools	96		https://www.youtube.com/watch?v=kladaxe-kWNI
Chapter 4: Assist in Diagnosing Repair Requirements	Unit 4.3 - Diagnosis of Four Wheeler Vehicle	Job Card	258		https://www.youtube.com/watch?v=5ziWx-5tjLvs
Chapter 4: Assist in Diagnosing Repair Requirements	Unit 4.3 - Diagnosis of Four Wheeler Vehicle	Engine	258		https://www.youtube.com/watch?v=x70VqM-rXrbs

Chapter No.	Unit No.	Topic Name	Page No.	QR code(s)	URL
Chapter 4: Assist in Diag-nosing Repair Requirements	Unit 4.3 - Diag-nosis of Four Wheeler Vehicle	Types of Four Wheeler Engine	258		https://www.youtube.com/watch?v=eYBdjc-3dOgM
Chapter 4: Assist in Diag-nosing Repair Requirements	Unit 4.3 - Diag-nosis of Four Wheeler Vehicle	Working of MPFI System	258		https://www.youtube.com/watch?v=ZM-s1e7GvOvY
Chapter 4: Assist in Diag-nosing Repair Requirements	Unit 4.3 - Diag-nosis of Four Wheeler Vehicle	Fuel System	258		https://www.youtube.com/watch?v=jWW0B-sIQ2mQ
Chapter 4: Assist in Diag-nosing Repair Requirements	Unit 4.3 - Diag-nosis of Four Wheeler Vehicle	Cooling System	258		https://www.youtube.com/watch?v=vSJB-5vEdTtk
Chapter 5: Per-form routine service and repairs	Unit 5.2 - Service and Repairing of Four Wheeler Vehicle	Checking and adding coolant	312		https://www.youtube.com/watch?v=NIT-wzS_P_-E
Chapter 5: Per-form routine service and repairs	Unit 5.2 - Service and Repairing of Four Wheeler Vehicle	Checking engine oil level	312		https://www.youtube.com/watch?v=3V2w-JAB-WwE

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