# CHAPTER-1

## Auto Workshop Layout And Equipments

### General Safety Precautions & Procedures

(i) Keep the tools and equipment specified places only and do not allow them to be scattered here and there. For instance, it is very common for one to slip by accidently treading over a screw jack handle on creeper. Similarly slipping some sharp tool in your pockets and later forgetting might injure you.

(ii) Always wear proper clothes while working in the garage. For instance, never wear a necktie, a shirt with loose sleeves, a loose wrist watch chain etc. These are likely to get caught in the machines.

(iii) Never work under the car when it is supported by jack only. Always use proper stands before going under.

(iv) While working with moving parts like fan, flywheel or machines like grinder, take utmost cute to keep your hands and cloths away.

(v) Be cautious while working with parts containing springs under compression (e.g. clutch) . Because carelessness many result in the spring flying away and causing serious injury.

(vi) Compressed air should not be used for cleaning clothes as this can cause the dirt particles to become embedded in your skin causing infection. Again never play with compressed air. Pointing compressed air against any person might injure him.

(vii) Always use proper tools for the job since use of a wrong tool or even the wrong use of the correct tools may cause injury to you besides damaging the job.

(viii) Never run the engine in a closed space without proper ventilation. Exhaust from the engine contains carbon monoxide which is poisonous and can kill.

(ix) Smoking in the garage should be allowed, since petrol is a highly inflammable substance.

## Function of General shop Equipments and Tools:

- Many of the tools & items of equipment are necessary to enable the motor vehicle workshop to cope with the wide variety of servicing and repair work. The following is a list of tools and equipments in the auto shop.

**Hand tools**

Many kind types and sizes of tools are used in automobile work.

**(1) Double Ended spanner set**

These are most commonly used type of spanner in garage. The opening should be the right size to fit the nut or bolt. If the spanner opening is too large, it could round off the corners of the hex. These make the use of the proper spanner more difficult. These spanners are available in different sizes ranging from 6 to 32 mm.

**(2) Ring Spanner**

In ring spanners the end openings completely enclose the nut or the bolt head so that they do not slip and cause damage. Further, the end holes in the ring spanner are twelve sided, because of which they can be used in restricted spaces, since the nut or the bolt head can be worked upon even when the swing of spanner is restricted to 15.

**(3) Tubular Spanner**

These are also used for the same purpose as ring spanner. It will be like a long tube having hexagonal ends at each end of different size. They may vary in size from 8mm to 32mm. It can be used where double end and ring spanner cannot be used.

**(4) Socket Spanner**

These type of spanners are useful in restricted spaces where common type of spanners cannot be used. They consist of sockets of different sizes which can be used with various types of handles. The handles have projections at one end around which the sockets fit. One type of handle has a universal joint at the projection end which makes it possible to work with the handle at an inclination with the socket. A ratchet handle is also available which obviates necessity of lifting of the socket from the nut or the bolt head.

**(5) Adjustable Wrench**

This wrench has jaws that can be adjusted to fit nuts and bolt heads of various sizes. These types of wrenches have advantage that these can be suitable for a large number of nut and bolt head sizes.


**(6) Torque Wrench**

Important nuts and bolts in automobile work have to be tightened with a specified amount of torque, because excessive torque may result in their breakage while less torque they will remain loose. This is made possible by a torque wrench it is a specialized form of socket spanners.

**(7) Screw Drivers**

The screw driver is used to drive, or turn screws. The most common type has a single flat blade for driving screws with slotted heads. There are also the Phillips head and reed, and prince screw drivers.

**(8) Hammer**

A medium of weight ball pen hammer is the one commonly used in automobile work. It should be gripped on the end of the handle. When you swing the hammer, the face should strike the object squarely, and not an angle.

**(9) Pliers**

Pliers are a special type adjustable wrench. The two legs (handle) move on a pivot so that items of various sizes can be gripped. There are two types. Gripping pliers and Cutting pliers.

**(10) Pullers**

Pullers come in variety of types and sizes and are used to remove wheels, gears and bearings from the shafts from housings. Each pulling operation differs from the other, and are must be exercised to prevent damage to the parts during pulling.

**(11) Spark Plug Spanner**

It is used for removing or tightening spark plugs.

**(12) Feeler Gauge**

For measurements such as valve clearance, spark plug gap, contact breaker gap etc., we use feeler gauge which are simply blades of different thickness.

**(13) Valve spring compressor**

Valve spring compressor or lifters are used to compress the valve spring to facilitate the removal of the valve retain lock or keeper from the valve stem.

**(14) Piston ring compressor**

Piston ring compressors are places around the piston covering the rings. As the compressor is tightened, it compresses the piston rings into their grooves on the piston. Then the piston and rod assembly is installed into the cylinder.

**(15) Piston ring Expander**

It is generally use to expand and remove the piston rings from their grooves without breaking.

**(16) Dial Indicator**

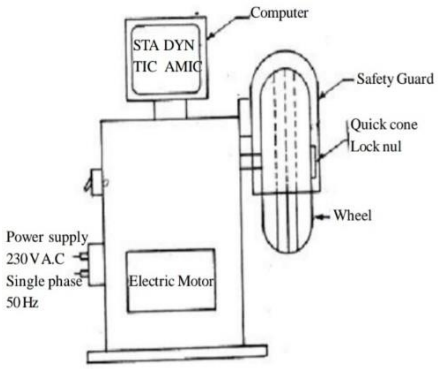
It is a gauge that uses a dial face and a needle to register measurements. It can be used to measure the endplay in shafts or gears. Also it can be used to measure taper in engine cylinder.


**(17) Hydrometer**

The float type hydrometer has a float with a stem that sticks up above the electrolyte level in the tube. The float stem is marked to indicate the specific gravity of the electrolyte. The height of the stem above the electrolyte indicates the battery state of the charge. It varies from a high 1280 in a fully charged (good condition) battery to a low 1.125 in a completely discharged (bad condition) battery.

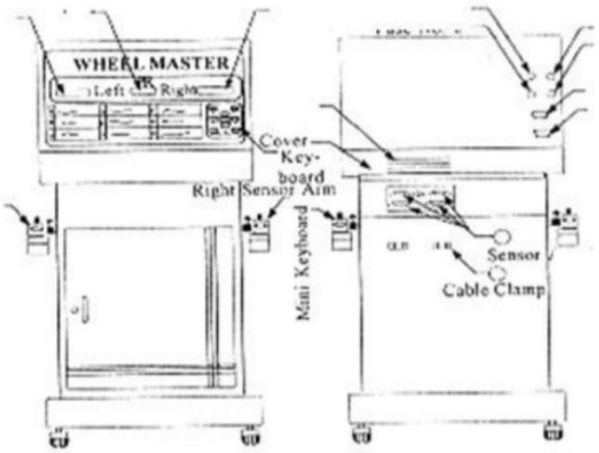
## (1) Wheel Balancer

Wheel balancing /Tire balancing is the process of equalizing the weight of the combined tire and wheel assembly. So that it spins smoothly at high speed. Balancing involves putting the wheel on tire assembly on a balancer which centers the wheels and spins it to determine where the weight should go. Two types of wheel balancing are there (I) Static and (ii) Dynamic.




## (2) Wheel Aligner

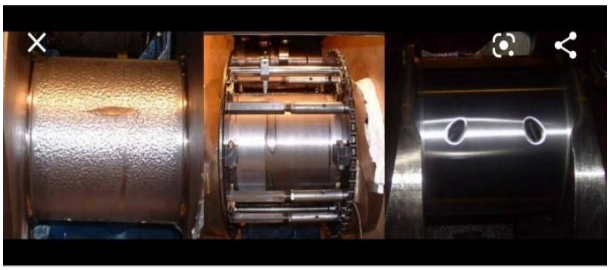
It is a part of standard automobile maintenance. They are consist of adjusting the angle of wheels to the car manufacture specifications. Purpose of this adjustment is to reduce tire wear and to ensure that vehicle travel is straight and true (without put to one side). Primary angles are Camber, Caster, and Toe in and out. Secondary angles are Steering axis inclination, Frame angle etc.




**(3) Crankshaft aligner and straighter**

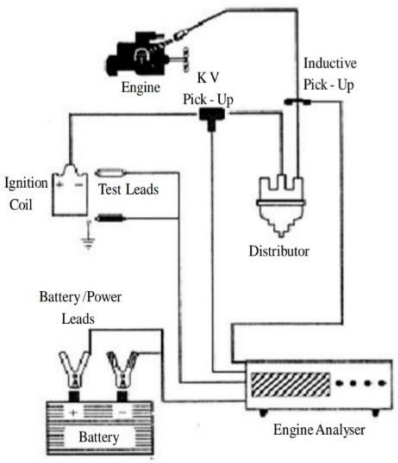
When an engine Crank shaft has suffered from an overheated crank pin or main journal, then it may be that the crankshaft buckled under the influence of thermal stresses, that were included by the bearing failure. A trueness check of the crankshaft will reveal if the crankshaft suffers from buckling. So then it is often possible to straighten the crankshaft without removing it from the crank case.

Crankshaft alignment is the process of aligning shafts with each other to within a tolerated margin. It is an absolute requirement for crank shaft before crankshaft is put in service**.**



**(4) Engine Analyzer**

It is a complex multifunction instrument, sometimes called a scope that can helps diagnose engine and engine related problems or, assist in tuning following on overhaul. An engine analyzer can be used with gasoline and diesel powder vehicle.




**(5) Arbor Press**

It is a small hand operated press. It is typically used to perform smaller jobs such as staking, riveting, installing, configuring and removing bearings and then press fit work. Punches, inserters on other tools/dies may be added to end of the ram depending on the desired task.


**(6) Drill Press**

It is also called drilling machine, device for producing holes in hard substances. The drill is held in a rotating spindle and is fed into the work piece, which is usually clamped in a vice resting on a table.

**(7) Battery Charger**

When a battery is discharged and is not capable of delivery any current it may be recharged. This is done by supplying it with a flow of current from external source such as a generator which forces the current through the battery in a reversed direction. Thus the plates can restore into their original composition and battery become recharged. It is then ready for use.


**(8) Tire Changer**

A tire changer is a machine used to tire technician dismount and mount with automobile wheels. The tire change has all the component necessary to remove and replace the tire from the wheel. Different tire changers allow technical to replace tires on automobiles, motor-cycles and heavy duty trucks. New tire and wheel technology has improved certain tire changers to be able to change low profile tire and run the tire.

**(9) Car Washer**

Regular chassis washing of both cars and commercial vehicles to remove grease, oil, mud and other corrosive deposit is most essential. This type of cleaning is a true representative of preventive maintenance this is easily done by a spray of water with a solvent with high pressure.

**(10) FIP calibration machine**

In measurement technology and metrology calibration is a comparison between known measurement (standard measurement) and the measurement using your instrument. Typically the accuracy of the standard should be 10 times the accuracy of the measuring device being tested. For the calibration of the scale a calibrated slip gauge is used.

**(11) Head light aligner**

A head lamp tester on aligner is a means to check both the orientation and intensity of a vehicle head lamp to ensure that it meets a minimum standard for the country use of vehicle. A headlight tester comprises is fully adjustable single optical collimated light lense assembly which is rail mounted and design to prevent any distortion of optical lense supporting structure during general use, such as aligning the test to the vehicle or maneuvering the assembly along the rails.

**(12) Valve Grinder**

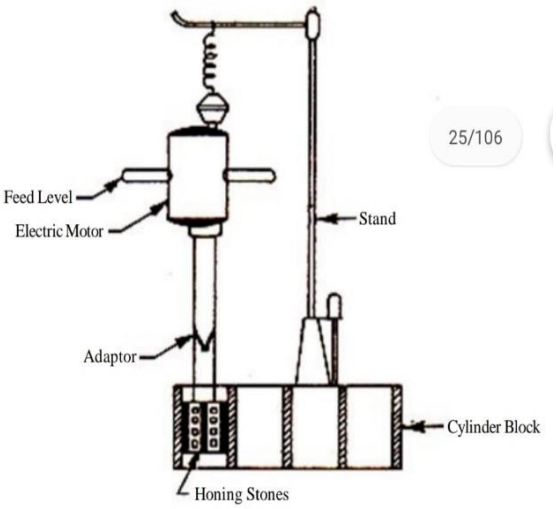
Grinding valve seats with abrasive stones has been round about as long as the internal combustion engine. This sheet material is designed to prolong to the ability of the valve seat to seat against the pounding of the valve head during engine operation. When fitting pointed valves use an old valve to guide the valve seat since clean engine oil on the valve stain end cutter head. The valve head to the sucker on the end of the grinding tool. Smear of thin film of grinding paste round the chambered edge of the valve head and insert the valve fully into it's guide.

**(13) Honing machine**

Honing is an abrasive machining process that produces a precision surface on a metal work piece by scrubbing on abrasive stone against it along a controlled path. Honing is primary used to improve the geometric from of a surface but many also improve the surface texture. In honing operation a rotating tool caring abrasive removes metal from the interior surface of a bore or cylinder. The main purpose is to finish the surface to a particular diameter & geometric cylindrity. Honing is a super finishing operation which is performed by a tool called 'hone'. In automobile engines the hones are used for deglazing and resurfacing of cylinder walls. The hone basically contains abrasive of ultra fine grid sizes depending upon the embidance of these abrasive. The hones may be two types.

(i) Cloth hone

(ii) Stone hone

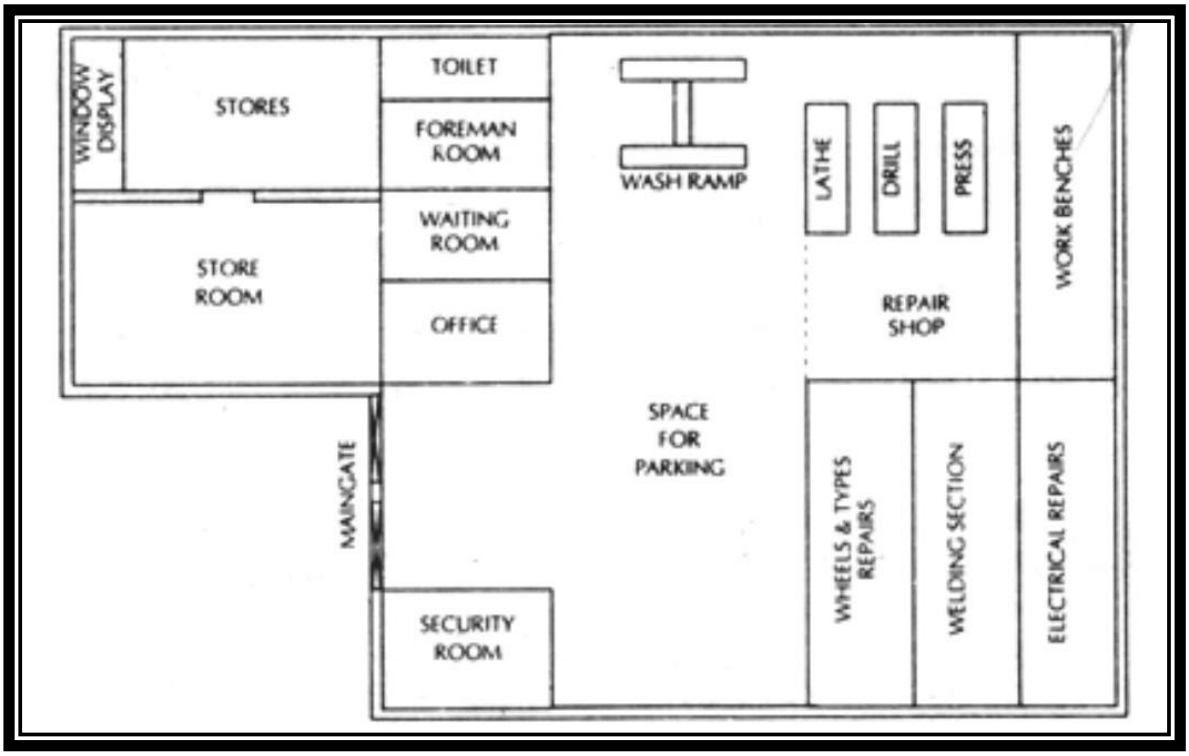



**(14) Cylinder boring machine**

In machining boring is the process of enlarging a hole that has already been drilled in cast by means of a single point cutting tool (or, of boring head containing several such tools), such as in boring an engine cylinder or a gun barrels. Boring is used to achieve greater accuracy of the diameter of a hole and can be used to cut tapered hole. Boring can be used as the internal diameter counterpart to turning which cuts the external diameter. There are various types of boring. The boring may be

supported on both ends (which only works if the existing hole is a throw holes) or it may be supported at one end (which work for both throw hole and blind holes). Line boring implies the former type of boring. Back boring is the process of reaching throw end existing hole and then boring on the backside of the work piece (relative to the machine head stock).

## Layout of Garages:



**Garage:**

Garage are provided for repairing purpose. Depending upon the external repairing work carried out the garages are classified into 3 types. They are

(a) Small Garage
(b) Medium Garage
(c) Large Garage

(a) Small Garage

Small garages are deal with replacement and adjustment of the measure components for a particular range of vehicle and stock a large range of tool parts and accessories.

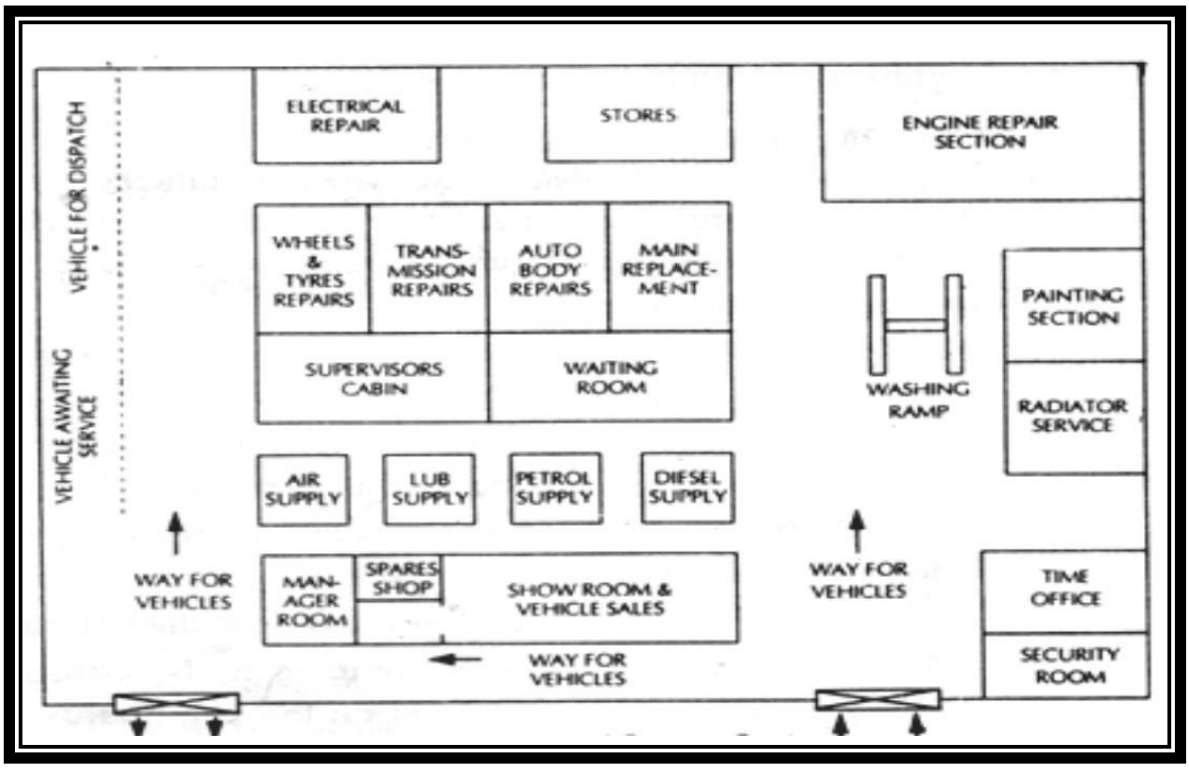
(b) Medium Garage

Medium garage provides all types of written service and repair works including break testing. They also have parking facilities and suitable reception access for customers.

(c) Large Garage

Large garage has well trained and qualified staff to carry out inspection, servicing, repair without advance booking. Body works and repairs are of high standard. Adequate and comfortable waiting tracking facilities are available in this garage. In advance countries now automobile garage and service station or center are called diagnostic center have been established with the latest automobile testing equipment. In through analysis are made of each system of automobile and then it provides to the customer.

## Layout of Modern workshop:




**Specialist repair shop/Modern workshop:**

It is an engineering workshop where works not attended in service station will be attended. The specialist repair shop needs experts in their particular line. They usually provide good service in attending to repairs at reasonable charges as well as take of the responsibility from the shoulders of the service station men. Similarly the electrical repair, radiator repair, painting and welding jobs as well as body work can be also send to specialist repair shop.

### (1) Crankshaft grinding

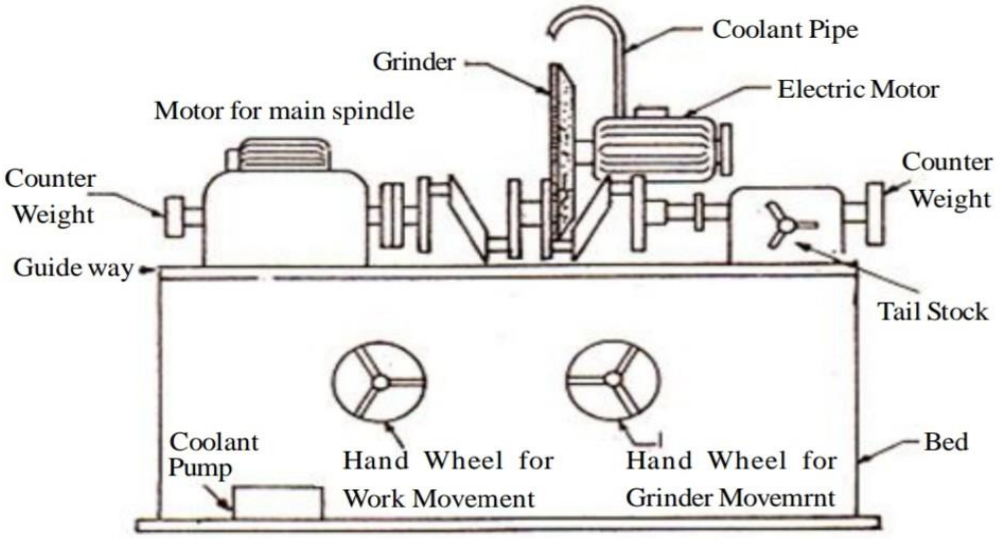
Grinding a crankshaft is a process of removing material from the journals in an effort to refurnish and reuse an expensive, yet vital component of an engine. It is usually done during the process of rebuilding an engine when needed but also has some performance aspect which come along with these process. The main parts are working with when grinding are the journals, both main and rod. During the rebuild

process it will be determined of the journal surfaces are within sufficient tolerance to be used as there. There are several reason why they need to do machining.

(i) If the surface of the journal has wear which makes it no longer smooth.
(ii) If the journal is out of round.
(iii)If the journals are not square (same diameter at both ends of the pin).

There are some side benefits to doing the grinding are:

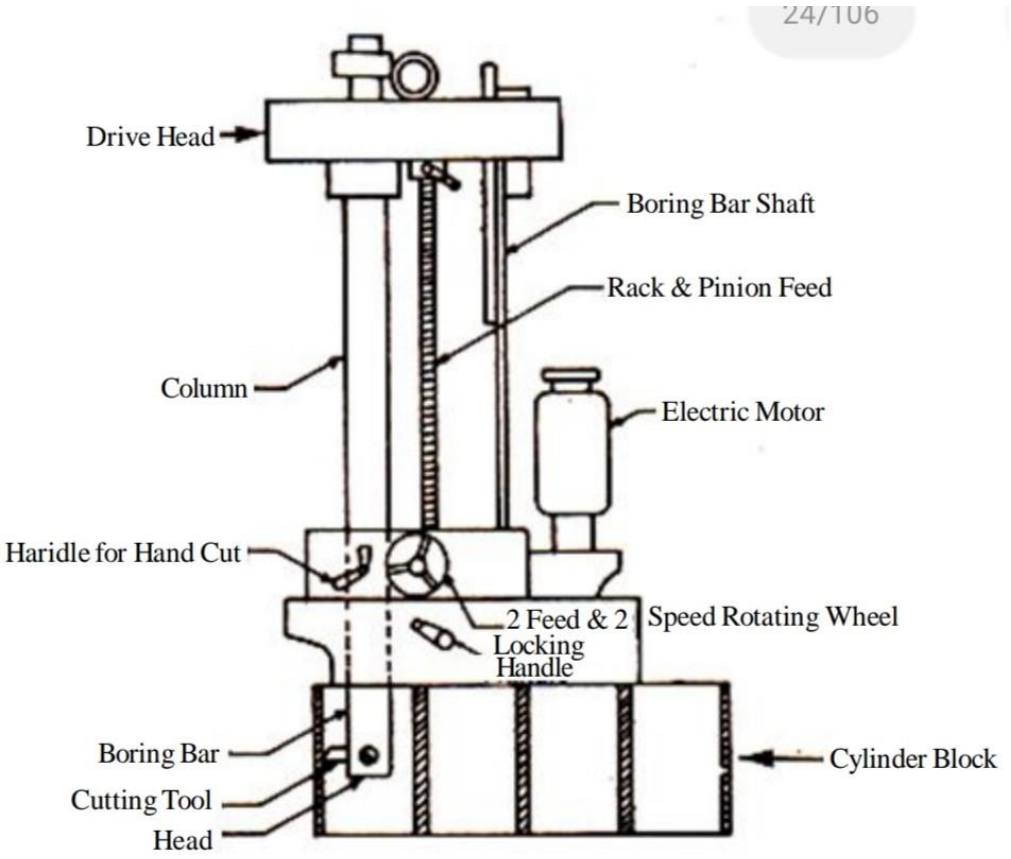
(i) It does tighten the over whole weight of crankshaft but overall it does that much to create a huge different.
(ii) Grinding journals reduce their overall size by reducing the size we have less surface area which results in reduces friction losses impose by the journal faces.
(iii)Grinding process also makes the corner of the journal so they have a greater radius. This actually make the crankshaft stronger by reducing the stress rise at the corners.




**(2) Engine Re-boring**

The engine cylinder walls and the piston rod lose their trueness after 1000 hour of operation. The wear on their surfaces will also the compressed air/fuel mixture to leak out and their by reducing the compression ratio. Sometimes they lose their

circular shape therefore the engine is remove from the vehicle and a boring machine is used to increase the diameter of the cylinder by hundreds of an inch and a new piston which should in the new diameter replaces the old one. Due to the slight increase in swept volume (air/fuel mixture) drawn into the cylinder so there is slight increase in torque and power produce.




**(3) FIP Repairs**

Fuel injection pump refers to a device used to pump or send fuel into the engine cylinder.

Some basic problems in fuel pump are

(i) Air in fuel lines which can be overcome by bleeding of the fuel system.
(ii) Injector clogging which can be overcome by overhauling the injector pump.
(iii) A clogged filter can be solved by replacing it's filter or by cleaning the filter.

There are some special method of testing done in specialist shop to overcome some problems of fuel injection pump.

(i) Leakage test

With the on off valve closed and both the pump isolator and gauge protector valves open the tester is operated to build up pressure up to approximately 70N/cm$^2$ below the recommended pop off pressure. Depending upon the manufacture specification either a leakage at the nozzle is observed or a drop in pressure gauge reading is observed by clog the pump isolator valve.

(ii) Pop off pressure test

With the on/off valve closed and both the pump isolator and gauge protector valves open, the tester is operated until the nozzle pops. Now the maximum indicator reading is observed for pop off pressure and the result is compared with manufacturer specification.

(iii) Spray pattern test

This test perform in the same manner as the pop off test and may be made simultaneously. The resulting spray pattern is compared with manufacturer recommendation.

(iv) Chatter Test

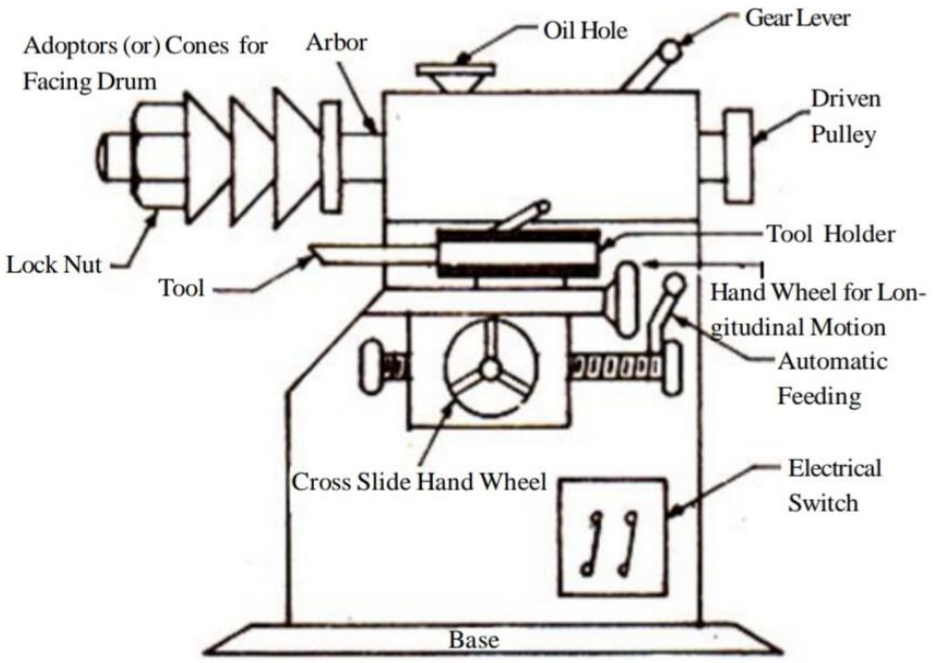
The set up and the procedure ever same as the pop off pressure test. The chatter of nozzle valve stem is observed and then referred to the manufacturer recommendation for a result.

**(4) Crankshaft Journal boring**

It is use to enlarge the crankshaft journal for smooth flow of oil.

**(5) Brake drum boring**

The inner surface of the brake drum get rubbed and worn due to continuous rubbing of brake linings. Remove the unevenness from their surfaces and to make them cylindrical concentric, we use brake drum boring process by using the brake drum lathe.



# CHAPTER-2

# MAINTENANCE MANAGEMENT AND RECORD KEEPING

- Maintenance means keeping all the system and feature's functioning as much as possible to the manufactures original design intension.
- Maintenance helps the vehicle to start, run and stop as the manufacturer intended. So that maximum amount of performance, reliability and service life are achieved.

**Need of Vehicle Maintenance**

- To keep the vehicle in good running condition.
- To keep the operation cost less.
- To provide safety on vehicle operation.
- To give feedback to manufacturers to improve development.
- To adhere to the legal requirement of vehicle operation.

**Importance of Vehicle Maintenance**

- To extend the life of the vehicle.
- To boost the performance of the vehicle.
- To improve fuel economy.
- To improve safety.
- To have higher reset value.
- To maintain the vehicle in good condition.
- To reduce the wear and tear of components.
- To reduce the risk of serious problem.
- To improve the driving quality of the vehicle.

## 2.2 Types of Maintenance

There are four types of vehicle maintenance namely

1. Preventive maintenance
2. Breakdown maintenance
3. Periodic maintenance (or) schedule maintenance
4. Operation maintenance

1. **Preventive maintenance:** Prevention without breakdown or without giving trouble on road some attention or maintenance taken to the vehicle is called as preventive maintenance. It intends to reduce or totally eliminate breakdowns and accidents due to mechanical failures and reduces repair cost. Any good preventive maintenance program leads to following advantages.

   - Reduce the breakdown of vehicle
   - Increased safety due to reduced breakdown
   - Less expenses on repair
   - Good control on inventory of spare parts
   - Lesser number of equipments are required

2. **Breakdown maintenance:** Break down maintenance is the attention which is to be provided when a motor vehicle becomes immobilized due to faults created during running. These faults are started difficulties, puncture, electrical faults, carburetors and fuel supply faults, overheating, fan beltings, breakage and accidents etc.

3. **Periodic maintenance:** Periodic maintenance or operative maintenance is the attention provided to motor vehicle after in operation for a specified time or covered distance. These maintenance may be done daily, weekly, quarterly, yearly or after covering every 500 km, 1000 km, 2000 km, 4000 km, 8000 km of running. In garages this work is done on the basis of pre-set schedules so as to avoid road failures and to minimize break down during use.

4. **Operation maintenance:** Daily maintenance by the operator for proper running of the vehicle is known as operation maintenance. It is needed to keep the vehicle in proper working condition. Tire inflation, battery, brakes, clutch, smoke color, staring system, ignition system and lights are checked in this maintenance daily.

**Types of Periodic Maintenance**

a) Daily Maintenance
b) Weekly Maintenance
c) Monthly Maintenance
d) Quarterly Maintenance
e) Half yearly maintenance or frequency certificate work.
f) Yearly maintenance or fitness work

**Daily Maintenance**

- Clean the vehicle.
- Check engine oil level top up it necessary.
- Check radiator water level and water top up.
- Inspect tire for normal pressure.
- Check for fuel in tank.
- Check of whether light and electrical accessories.
- Checkup brake for normal functioning.
- Start engine and checkup performance.

**Weekly Maintenance**

- Check electrolyte level in battery and add distilled water if necessary.
- Clean battery terminals and apply vestine to avoid corrosion.
- Check tire pressure and inflate if necessary to correct pressure.
- Check tires per abnormal wear if abnormal wear is noticed correct wheel alignment.
- Check brake fluid level and top up if necessary.
- Wash vehicle with water mixed with detergent with soap water.

- Check oil leak if any from engine transmission and differential and arrange to rectify.
- Clean stark plugs and refit if the vehicle is petrol driven.
- Tighten joint bolts and axle bolts.
- Tighten spring and shackle bolts and nuts if necessary.
- Adjust fan belt play if necessary.
- Checkup water pump grease cup and repair.
- Check whether dynamo is functioning well adjust regulator if necessary.
- Check oil in steering gear box and top up if necessary.

**Monthly Maintenance**

- Service vehicle at appropriate date.
- Checkup and adjust for play of brake.
- Checkup and adjust for play of clutch.
- Checkup engine oil at appropriate mileage.
- Checkup tune up vehicle (Petrol driven)
- Tighten engine gear box and body mounting bolt.
- Remove all the wheels check brake drum brake linings etc.
- Examine all wheel bearings remove old grease and repack with fresh grease.

**Quarterly**

- Higher body bolts and checking if necessary (rubber packing)
- Blow and adjust break.
- Carry out engine timing of period prevent vehicle.
- Check out pedal side play and reset it.
- Check up and renew mounting blades.
- During service over and clean scale pin if necessary (leaf spring)
- Check out steering leakage and play and reset if necessary.
- In case of diesel engine overhaul injector
- All the items mention in the monthly maintenance schedule should be carried out during quarterly maintenance also.

**Half yearly Maintenance/fitness Certificate**

- Remove gearbox and check the components
- Check differential
- Overhaul all four wheels, breaks and the universal joints.
- Overhaul engine and do the de-carbonization
- In diesel overhaul injection and pumps
- Overhaul water pump
- Overhaul dynamo and self starter.
- Overhaul exhaust and air compressor.
- Check oil wiring and switches.
- Carryout body repairs, do denting if necessary.
- Repair valves if trucks or vans.

## Vehicle insurance

- Motor insurance gives protection to the vehicle owner against damages to his/her vehicle.
- Pays for third party liability to determine as per law against owner of the vehicle.

## Service Procedure:

For servicing a vehicle, it should be mounted on a lift or hoist or on the ramp. A four post lift which enables a car to be lifted and also allows a car to be lifted with its wheels free, is the best for all working conditions as it enables the inspection and repair of wheel hubs and the brakes and drives to be worked on quite easily. In the case of hoist, all four wheels are stripped off to enable servicing to be done at the time of fitting them back. The position of the wheels is interchanged diagonally.

The service procedure may be carried out in the following steps:

**Step 1:** The under-frame of the vehicle is cleaned with water and dried with air. A mixture of mobile oil and kerosene is then sprayed on the under-frame under pressure. The under-frame is then rubbed with cloth soaked in the above mixture of oils and later washed with water again and dried with compressed air.

**Step 2:** To clean engine of dirt, grease, etc. spray method with compressed air is used. A kerosene spray under pressure is sprayed on the engine, wheels, spindles, springs, steering knuckles etc. After sometime, it is sponged off with soap suds (linseed oil soap) followed by rising with cold water and then sponged off dry.

**Step 3:** For cleaning engine the exhaust system, the exhaust manifold pipe and muffler are taken apart and soaked in kerosene oil overnight. Alternately, a long wire packed with kerosene soaked waste, may be drawn through it for cleaning the pipe and manifold.

**Step 4:** Grease all points with a grease gun. Open the front wheel axle cups and grease.

**Step 5:** Check the mobile oil of the engine differential gear box oil, steering column oil and hydraulic brake oil.

**Step 6:** For proper maintenance of 12 V battery carry out the following:

(a) Wash and dry the top of the battery.
(b) Wash the corrosion product from the hold-down frame.
(c) Dry it thoroughly and apply black acid resistant paint, if necessary.

Use cell testers for checking individual cells and also check for gravity.

## Overhauling Procedure

The over hauling of any assembly consist of the following steps.

(i) Evaluation
(ii) Pre checks

To decide to locate the defect at initial stages.

(iii) Dismantling

It is to be done is perfect order as per instructions given by the manufacturer numbering proper keeping of the components.

(iv) Inspection

The inspection condition of each component is also check at the time of dismantling.

(v) Cleaning

By each component is theory clean by using cleaning against and dying.

(vi) Replacements

The defective components are removed in place of these component correct component are replaced.

(vii) Assembly

The assembly of the component is done in accordance with the guide line provided by the manufacturer.

❖ The correct positioning is also check at each stage.

## Log Book of a Vehicle

The log book of a vehicle gives the details of the vehicle, which will be useful not only for the owner of the vehicle but also to the Mechanic who might take the job of the vehicle Maintenance.

## Details of Log Book

- Distance covered
- Fuel consumption
- Average fuel consumption
- Best worst mileage
- Total maintenance cost
- Running cost
- Faults in the vehicle
- Likes dislikes
- Date of the previous maintenance report.

## Check List

A check list is a type of informational job at use to reduce to failure by compensating for potential unit for laymen memory and attention.

It helps to protect consistency.

## Repair Order

- Repair order is used for legal tax and general record keeping purposes.
- Technician copy gives the listing of the repairs needed and he is used for making rotation of repairs completed and items needing attention.
- Costumer copy includes the cost estimate.
- Copy for the shop records.

## Importance of Repair Order

- It fully identifies the costumer and the vehicle.
- It gives the technician an idea of the reason of the car is in the shop for repair.
- It tells the shop hourly needed.
- It gives the costumer and estimate cost of the repair.
- It gives the time the vehicle will be ready for costumer.
- The signature of the costumer gives approval for the repair and agree to pay for the shop service when the job is completed.
- It is a legal document.

# CHAPTER -3

## ENGINE MAINTENANCE

### Troubles, Causes and Remedies In Engine:

| Complaint | Possible causes | Remedy |
|---|---|---|
| **Poor starting** | **Starter will not run:** | |
| | 1. Main fuse is blown off. | Replace. |
| | 2. Contact is not closing in main switch or this switch is open circuited. | Repair or replace |
| | 3. Run-down battery. | Recharge |
| | 4. Defective starting relay. | Repair or replace |
| | 5. Loose terminal connection on the battery. | Clean and retighten |
| | 6. Defective brushes in starter. | Replace |
| | 7. Loose battery cord connections. | Retighten |
| | 8. Open in field or armature circuit of starter. | Repair or replace |
| | **No Sparking:** | |
| | 1. Defective spark plug. | Adjust the gap or replace. |
| | 2. Short circuit (grounded) fault in high tension cords. | Repair or replace defective cords. Replace. |
| | 3. Cracked rotor or cap in distributor. | Replace. |
| | 4. Burnt breaker contact points. | Adjust as prescribed |
| | 5. Breaker contact gap out of adjustment. | Replace. |
| | 6. Defective condenser. | Replace. |
| | 7. Contact is not closing positively in main switch or this switch is open circuited. | Set right or replace |
| | 8. Loose or blown fuse. | Adjust as prescribed |
| | 9. Ignition timing out of adjustment. | Replace. |
| | 10. Defective ignition coil. | |
| | **Faulty intake and exhaust systems:** | |
| | 1. Carburetor needs readjustment | Adjust as prescribed. |
| | 2. Fuel pump is not discharging adequately. | Replace. |
| | 3. Clogged fuel filter. | Clean or replace |
| | 4. Defective choke mechanism. | Repair or replace |
| | 5. Loose intake manifold. | Retighten |
| | 6. Carburetor is dirty and clogged. | Disassemble and clean |

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| | 7. Float level out of adjustment.<br>8. Clogged fuel hose.<br>9. Not enough fuel in the tank.<br>10. Clogged exhaust ports. | Adjust as prescribed<br>Clean or replace<br>Refill<br>Clean |
| | **Abnormal internal condition in engine:**<br>**1.** Ruptured cylinder head gasket.<br>**2.** Valve clearance out of adjustment<br>**3.** Weakened or broken valve spring.<br>**4.** Loose manifold, permitting air to be drawn in.<br>**5.** Worn pistons, rings or cylinders<br>**6.** Broken valve timing belt.<br>**7.** Poor valve seating.<br>**8.** Wrong kind of engine oil.<br>**9.** Burnt valves. | <br>Replace.<br>Adjust as prescribed<br>Replace.<br>Retighten and as necessary, replace the gasket.<br>Replace worn rings and pistons and as necessary re bore.<br>Replace.<br>Repair or replace<br>Replace.<br>Replace. |
| **Not enough power.** | **Inadequate compression:**<br>1. Valve clearance out of adjustment.<br>2. Valves not seating tight.<br>3. Valve stems tending to seize.<br>4. Broken or weakened valve spring.<br>5. Piston rings seized in grooves or broken.<br>6. Worn pistons, rings or cylinders.<br>7. Leaky cylinder head gasket.<br>**Improperly timed ignition:**<br>1. Ignition timing out of adjustment.<br>2. Defective spark plug.<br>3. Breaker point gap out of adjustment.<br>4. Leaky high tension cords for some cylinders.<br>5. Distributor governor is not working correctly. | <br>Adjust as prescribed<br>Repair<br>Replace.<br>Replace.<br>Replace.<br>Replace worn parts and as necessary, re bore<br>Replace.<br><br>Adjust as prescribed<br>Adjust the gap or replace<br>Adjust or replace<br>Replace<br>Replace |
| | **Fuel system out of order:**<br>1. Clogged carburetor | <br>Disassemble and clean |

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| | 2. Defective fuel pump<br>3. Clogged fuel filter<br>4. Choke wire working erratically.<br>5. Float level out of adjustment.<br>6. Clogged fuel pipe.<br>7. Clogged fuel tank outlet.<br>8. Loose joint in fuel system. | Repair or replace<br>Replace<br>Adjust<br>Adjust<br>Clean or replace<br>Clean<br>Retighten |
| | **Abnormal condition in air intake system:**<br>1. Air cleaner dirty and clogged.<br>2. Poor returning motion of choke valve. | <br>Clean or replace<br>Repair, adjust or replace |
| | **Clogged exhaust system:**<br>1 Muffler is clogged with carbon. | <br>Clean |
| | **Overheating tendency of engine:**<br>1. (Refer to the section entitled "over heating") | |
| | **Others:**<br>1. Dragging brakes<br>2. Slipping clutch | <br>Adjust as prescribed<br>Adjust or replace |
| **Sudden drop of speed in high speed cruise** | **Abnormal condition in electrical systems:**<br>1. Breaker contact point gap too large.\<br>2. Spark plug gap too large.<br>3. Cracked rotor cap in distributor, resulting in leakage.<br>4. Defective condenser.\<br>5. Deteriorated ignition coil or crack resulting in leakage.<br>6. Leaky high tension cords.<br>7. Ignition timing out of adjustment. | <br>Adjust as prescribed<br>Adjust as prescribed<br>Replace<br>Replace<br>Replace<br>Replace<br>Adjust as prescribed |
| | **Abnormal condition in fuel system:**<br>1. Float level set too low.<br>2. Clogged condition of main, jet circuit in carburetor. | <br>Adjust as prescribed<br>Clean. |

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| | 3. Inadequately discharging fuel pump. | Replace |
| | **Abnormal condition in engine:**<br>1. Loss of compression pressure due to leaky cylinder head gasket.<br>2. Compression pressure too low because of worn pistons, rings, cylinders or burnt valves. | <br>Replace.<br><br>Replace and as necessary, re bore |
| **Engine not responding quickly to pedal control in picking up speed.** | **Abnormal condition in electrical system:**<br>1. Ignition timing out of adjustment.<br>2. Defective spark plug or plug gap out of adjustment.<br>3. Leaky high tension cords for some cylinders.<br>4. Breaker contact points out of adjustment or defective.<br>5. Defective condenser. | <br>Adjust as prescribed<br>Replace or adjust as prescribed.<br>Replace<br><br>Adjust replace<br><br>Replace. |
| | **Abnormal condition in fuel system:**<br>1. Float level too low or too high<br>2. Clogged jets in carburetor.<br>3. Air cleaner is dirty and clogged | <br>Adjust as prescribed<br>Clean<br>Clean or replace |
| | **Abnormal condition in engine:**<br>1. Exhaust ports dirty with carbon.<br>2. Muffler clogged with carbon.<br>3. Compression pressure too low<br><br>4. Poorly seating valves.<br>5. Valve clearance out of adjustment<br>6. Pistons tending to seize.<br><br>7. Bearing tending to seize. | <br>Clean<br>Clean<br>Replace worn running Parts or re bore<br>Repair<br>Adjust as prescribed<br>Replace and as necessary, re bore<br>Replace |
| **Erratic idling** | **Abnormal condition in Ignition system:**<br>1. Ignition timing out of adjustment. | <br>Adjust as prescribed |

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| | 2. Defective spark plug or plug gap too large<br>3. Cracked cap in distributor, there being leakage inside.<br>4. Leaky high tension cords.<br>5. Cracked rotor in distributor, there being leakage inside. | Replace or adjust.<br>Replace<br>Replace<br>Replace |
| | **Abnormal condition in fuel system:**<br>1. Carburetor idling adjustment is disturbed.<br>2. Clogged pilot jet in carburetor.<br>3. Float level out of adjustment.<br>4. Air cleaner is dirty and clogged.<br>5. Air is being sucked in due to loose joints or broken parts.<br>6. Broken carburetor packings. | <br>Adjust as prescribed<br>Clean<br>Adjust as prescribed<br>Clean or replace.<br>Retighten or replace<br>Replace. |
| | **Abnormal condition in engine:**<br>1. Exhaust ports clogged with carbon.\<br>2. Valve clearance out of adjustment.<br>3. Poorly seating valves.<br>4. Blown cylinder head gasket. | <br>Clean<br>Adjust as prescribed<br>Repair<br>Replace. |
| **Abnormal detonation** | **Abnormal condition in ignition system:**<br>1. Spark plugs are tending to overheat.<br>2. Ignition timing out of adjustment.<br>3. Defective breaker contact point.<br>4. Loose connection in high tension or low tension circuit. | <br>Change plug heat value.<br>Adjust as prescribed<br>Replace<br>Retighten |
| | **Abnormal condition in fuel system:**<br>1. Air-fuel mixture too lean.<br>2. Carburetor is dirty inside.<br>3. Float level out of adjustment.<br>4. Water inside carburetor.\ | <br>Clean and adjust<br>Clean<br>Adjust as prescribed<br>Clean |

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| | 5. Air is leaking in through inlet manifold joint. | Retighten |
| | **Abnormal condition in engine:**<br>1. Excessive carbon deposit on piston crowns or cylinder head.<br>2. Blown cylinder head gasket, resulting in low compression pressure.<br>3. Valve clearance out of adjustment<br>4. Valves tending to size.<br>5. Weakened valve springs. | <br>Clean<br>Replace<br>Adjust as prescribed<br>Replace<br>Replace. |

## Troubles, Causes and Remedies In Fuel System:

## I. Gasoline Fuel System

| Sl. No. | Troubles | Causes | Remedies |
|---|---|---|---|
| 1. | High fuel consumption | Air cleaner may be chocked<br>Fuel may be leaking<br>Wrong idle adjustment | Clean<br>Inspect the plug and the leak<br>Adjust |
| 2. | Difficult starting | Carburetor jet may be clogged<br>Fuel filter clogged<br>Fuel pump pressure not constant | Service carburetor<br>Clean the filter<br>Check the pressure and rectify the defect |
| 3. | Poor acceleration | Fuel line clogged<br>Fuel filter clogged | Check the fuel line<br>Clean the filter |
| 4. | Lack of power | Incorrect carburetor setting<br>Faulty inlet manifold | Adjust<br>Replace |

## II. Diesel Fuel System

| Sl. No. | Troubles | Causes | Remedies |
|---|---|---|---|
| 1. | Engine cranks normally but will not start | Incorrect or dirty fuel<br>No fuel to nozzle or injection pump<br>Plugged fuel return | Flush system use Correct fuel<br>Check for fuel to nozzles |
| 2. | Rough idle with abnormal noise and smoke | Injection pump timing off<br>Nozzle trouble | Check return, clean retime<br>Check in sequence |
| 3. | Idle correct, but misfires as throttle opens | Plugged fuel filter<br>Injection-pump timing off\Incorrect or dirty fuel | Replace filter<br>Retime<br>Flush system use correct fuel |
| 4. | Combustion noise with excessive black smoke | Timing off<br>Injection-pump trouble<br>Nozzle sticking open<br>Internal engine problems | Reset<br>Replace the pump<br>Clean or replace |

## Troubles, Causes and Remedies In Cooling System:

| **Sl. No.** | **Troubles** | **Causes** | **Remedies** |
|---|---|---|---|
| 1. | Loss of liquids coolant due to leaks. | (1) External leak<br>(2) Internal leak caused by a faulty gasket, loose cylinder head, cracked or wrapped head or, cracked engine block, which may allow some coolant to drain into the engine oil. | It can be noted by inspection and block the leak.<br>Proper fit gasket must be placed and the cylinder head and engine block required to be repaired. |

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| 2. | Over heating | • Insufficient quantity of water in the cooling system,coolant loss.<br>• It also caused by the clogged radiator and water passages, in operative thermostat, too low engine oil level, clogged exhaust system etc. | Check the water, coolant level and top up if required. Clean the passages and remove blockages if any present. |
| 03. | Over cooling (if it is running below the normal operating range) | (1) A thermostat that opens too soon or, remains open at all times.<br>(2) The coolant by pass valve remaining open. | Remove the thermostat, test for its faults and then replace it. |
| 4. | Incorrect temperature Gauge reading. | (1) Temperature gauge fitted on the instrument panel may be faulty. | It should be either replaced or correct. |
| 5 | Noise | (1) Dry bearing a loose pulley on the pump shaft an impeller loose on the shaft. | Some pumps require the addition of a special water-pump lubricant to the coolant by which the operation become noise less. |
| 6 | Frozen coolant | (1) When the vehicle is parked where the temperature is below freezing point. | Check the cooling system for possible change by the frozen coolant before operation vehicle. |

## Cooling System:

- Check the radiator for any damage and blocks.
- Check the hoses that connect radiator and engine.
- Check for any leakage.
- Check the fan belt.
- Use clean water in the radiation.

## Troubles, Causes and Remedies In Lubrication System:

| Sl. No. | Troubles | Causes | Remedies |
|---|---|---|---|
| 1. | High oil consumption (oil added frequently) | (1) External oil leakage out of the engine.<br>(2) Internal leakage of oil into the combustion chamber(blue smoke in exhaust) | Replace the gaskets or, seals.<br>Replace the badly worned piston rings and cylinders. |
| 2 | Low oil pressure (Gauge reads low, indicator light glows or, abnormal engine noises) | (1) Low oil level.<br>(2) Worn connecting rod or, main bearings (Pump can not provide enough oil volume)<br>(3) Weak or, broken pressure relief valve spring (valve opening too easily)<br>(4) Thin or diluted oil (low viscosity oil, fuel in the oil)<br>(5) Cracked or loose pump pick up tube (air being pulled into the oil pump)<br>(6) Worn oil pump (excess clearance between rotor or | Top up oil<br>Replace connecting rod or main bearings<br>Replace relief valve<br>Use proper specified oil<br>Change the tube<br>Change oil pump |

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| | | gears and hosing.<br>(7) Clogged oil pick up screen (reduce amount of oil entering pump) | Clean the pump |
| 3 | High oil pressure | (1) Pressure relief valve struck open (not opening at specified pressure.<br>(2) High relief valve spring tension (strong spring or spring has been improperly shimmers)<br>(3) High oil viscosity (excessively thick oil or, use of oil additive that increases viscosity) | Clean the pressure relief valve<br>Change the spring<br>Use proper specified oil |

## Lubrication System:

- Check the level of lubrication oil in the crankcase.
- Check the lubrication oil filter, if clogged replace it with new one.
- If the oil is bad, remove that oil and introduce new oil of the correct grade.

## Troubles, Causes and Remedies In MPFI Engine:

| Sl. No. | Troubles | Causes | Remedies |
|---|---|---|---|
| 1. | Misfiring Engine | • A clogged or, dirty fuel injector.<br>• An injector that won't open. | Clean the fuel injector.<br>Replace it be injector. |
| 2 | Uneven power in engine | • A dirty fuel injector | Clean the fuel injector. |

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| 3 | Diminished fuel economy | • Leakage present in fuel injection. | Block the leakage or, replace the fuel injector. |
| 4 | Inconsistent Engine idling | • Dirty fuel injector | Clean the fuel injector. |

## Checking and Servicing of Following Engine Components:

## I. Cylinder head:

### Checking cylinder heads for cracks

Cracks in the cylinder-heads are hard to find by visual inspection. They often occur in or around the combustion chamber and the valve port areas. Often, cracks can only be located by special crack-detection methods. There are two methods used in automotive workshops-one uses magnetism and the other user's dye.

### Magnetic method

The magnetic method of crack detection is suitable for all of ferrous metals that is used on cast iron cylinder heads. The detector magnetizes the area being tested and, if a crack exists, one side of the crack will become a north magnetic pole and other side a south magnetic pole. Metal powder or metallic fluid is applied to the area. The fine particles of the metal will be attracted to the poles and will form a line that follows the crack, making it visible as a fine grey line.

### Dye penetrant method

The dye penetrant method is suitable for most materials, including nonferrous metals, that is can be used for both Aluminum alloy and cast iron Cylinder-heads. It can be used around the valve ports where magnetic attraction is difficult.

The suspected area of the part is cleaned with a special solvent to remove all the dirt, Grease and this also cleans any cracks. A red dye penetrant is then sprayed over the surface and this penetrates any cracks.

After allowing the dye penetrant, the surplus dye is removed and a developer is sprayed over the area any cracks will then be seen as fine red lines.

**Installing Cylinder-Heads**

Installing a Cylinder-head is, generally, the reverse procedure to removal. Following are related points:

1. Before installing Cylinder-head, the surfaces of both the Cylinder-head and cylinder-block must be clean. The bolts and threads into cylinder-block must also be clean.
2. A new Cylinder-head gasket must be used. The gaskets are ready and sealer is not usually used. Aligning studs can be installed in two diagonally opposite holes to keep the gasket in place.
3. Cylinder-one bolts must be tightened in the correct sequence and the correct torque. Incorrect tightening can cause head and block distortion, gasket leakage or bolt failure.

## II. Cylinder Block:

The cylinder block is typically made up of several cylinders, according to the type and size of the engine. The outer section is solid metal and seals off everything inside of it. It is the engine's central frame that houses the main parts that help vehicles operating on internal combustion continue to run. In older vehicles, it was made from a cast iron metal construction. Automobile manufacturers mainly install cylinder blocks made from aluminum alloy.

Cracks are the most common issues found within engine blocks. These can be caused by heat, frozen coolant, and stress levels that exceed the block's strength level. When coolant freezes, it can cause cracks to the outer surface near the core plugs of the block. Often, cracks in the cylinder bores, lifter valley, and near the main-bearing webs are the result of too much stress.

Whether the engine ran without coolant or if a water pump has failed, the expansion and flexing can result in a crack or series of cracks. Other problems include stripped threaded holes, blockages, and blown cylinder head gasket. A hose might even have holes in it, leaking water under the engine. Many problems can be seen by the naked eye.

However, it’s critical to have a professional check it out with specialized equipment to rule the possibilities out. Flexible automotive bore scopes can be used for nondestructive, visual inspections of the cylinder block and other hard to see places without having to dismantle the entire vehicle.

Automotive technicians frequently use automotive borescopes to check the molding and interior sections, which reduces the likelihood of a defective engine. These medical grade optics tools contain an articulating camera situated on the tip of a slender probe.

## III. Cylinder Liners:

When doing the liner inspection, following points should be checked:

- Cracks on the surface and near scavenge port openings.
- Sharp edgy surface of scavenge ports.
- Ridge formation at TDC position.
- Mechanical friction wear marks and abrasive wear on the liner surface.
- Dark areas of liner surface - Acidic and cold corrosion.
- Scuffing and scoring marks of liner surface.
- Clover leafing-corrosive wear between the lubricator ports if he cylinder oil cannot neutralize the acid products of combustion.
- Cracks and damage at lubrication openings.
- Glazing of liner surface (mirror finish)
- Flow of oil from lubrication ports.
- Linear calibration to check the linear ovality and wear.

Cylinder liner has to be gauged at regular intervals as specified in the maintenance manual. The records of gauging are kept for each cylinder and wear rate is calculated.

The liner has to be cleaned and inspected before the gauging. Generally while taking the measurements, the temperature of the liner and micrometer should be same.

If the temperature exceeds then that of the liner or vice versa, then the readings have to be corrected by multiplying the value with the correction factor and deducting the value obtained from the readings taken. The reading obtained at the end will be the correct reading.

## IV. PISTON AND RINGS:

After removing the piston and rod assembly from the engine, separate the piston and rod. Then remove the rings from the piston by a special ring tool. Remove the carbon from the piston surfaces and clean the ring grooves with a clean out tool. Also, clean the oil ring slots or holes. Inspect carefully the piston for worn, scuffed or scored skirts; and for cracks at the ring lands, skirts, ring bosses and heads. Check the piston pin bushings for wear. Also, check fit of piston rings in grooves.

Check the diameter of the piston by taking measurements perpendicular to the piston pin bore at the sizing point and parallel to the piston pin bore. Compare the sizing point reading with the measurement of the cylinder diameter. If the cylinder wall is excessively worn, it will require refinishing, which means that an oversize piston will be required. As a rule, engine manufacturers supply oversize pistons of the same weight as the standard pistons.

Piston rings are to be checked for tension, scratches and wear. Sometimes, all that is required is to free up the rings in the ring grooves by cleaning out carbon. New rings are to be installed depending upon the condition of the cylinder walls. If the walls have some taper but not enough for re boring, special *severe* or *drastic rings* should be used. These rings have greater tension and more flexible. This enables them to expand and contract as they move up and down in the cylinder.

The pistons of some engines have an extra piston groove cut at the lower end. When walls wear tapered, an extra oil control ring can be fitted into this groove to improve oil control.

Piston rings must be fitted to the cylinder and the ring grooves in the piston. The ring should be first pushed down into the cylinder with a piston; and the ring gap should be checked with a feeler gauge. If the ring gap is correct, the outside surface of the ring should be inserted into the proper ring groove in the piston and the ring rolled around in the groove to make sure that the ring has a free fit around the entire piston circumference. After the rings are installed in the grooves, fit should again be tested. This test is made by inserting a feeler gauge between the rings and the side of the groove.

To install the piston in the cylinder, compress as the rings in their grooves so that they will enter the cylinder. It is done by a piston ring compressor. The compressor clamps around the rings, compressing them into the groove so that the piston can be pushed into the cylinder. Care should be taken to install the piston facing in the right direction. Many pistons have a notch or other marking that must face to the front of the engine.

## V. Crankshaft:

The crankshaft is one of the most highly stressed engine components. The stress increases four times as the engine speed doubles. The crankshaft is rejected if there is any sign of a crack, because a cracked crankshaft may break if continues in service. Crankshaft cracks in high production passenger car engines can be detected with a close visual inspection. High-rpm racing crankshafts should be checked with Magna flux to detect any minute crack that may lead to failure.

**A crankshaft-bearing journal**

Bearing journal scoring, one of the most common crankshaft defects appears as scratches around the journal circumference, generally near the center of the journal. Dirt and grit carried in the oil enter between the journal and bearing. If these particles are large enough to get through the oil clearance, they partially embed in the bearing and scratch the journal. Dirt can also be left on the journal during assembly. The most important factor for the maximum journal life is the continuous supply of clean lubricating oil.

Crankshaft journals can have nicks or pits in them. Nicks are formed by carelessness when the journal is bumped with another part while exposed or while being assembled. Pits can be caused by corrosion.

A bent crankshaft can be detected by a dial gauge by supporting the end main bearing journals in V-blocks. A dial gauge installed on the middle-bearing journal shows run-out as the crankshaft is turned. In the absence of V-blocks, the crankshaft can be supported by the two upper half end bearings in the block and the other bearing shells are removed. A dial gauge is used in the same manner to indicate the shaft bend or run-out.

Journals wear out-of-round and become tapered. Out-of-round and taper are measured using micrometer by taking measurements at a number of different locations on each journal. Rough journals and slight bends can be rectified by grinding the journals on true centers. Forged shafts with excess bend should be straightened before grinding.

## VI. Connecting rod:

**Connecting Rod Side Clearance Measurement**

The side clearance of the connecting rod is measured with a feeler gauge. If the side clearance exceeds the manufacturer's specifications, the journal width should be measured to find out the cause of the excessive clearance. The Plastigage method of measurement can be used and the procedure is the similar to the measurement of connecting rod bearing clearance.

Connecting rod reconditioning involves the following two steps:

(i) Reduce the rod bore size to slightly below its standard size.

(ii) Remove just enough material from the rod bore to bring it back to the original standard size.

Connecting rod reconditioning restores the bore to its original shape with the specified accuracy of roughness, straightness, surface finish, ad bore size.

Precision grinding of the rod and cap at the parting lines reduces the rod bore slightly. The micrometer dial control on the rod-and –cap grinder is used to accurately control

metal removal. Equal amounts of metal are removed from both sides of the parting surfaces. The amount of metal removed from the cap and the rod is usually about 0.0508 mm. The grinding operation does not increase the center-to-center distance between the rod pin hold and the bore, and also it does not cause interference between the top of the piston and the valves.

Once the grinding operation is over, the cap should be assembled on the rod and the bolts are torqued to the specified values holding the rod is an assembly fixture. The rod bore is honed back to its original size on a precision honing machine, which automatically centers the rod bore. The honing machine only removes metal from the smaller diameter of the bore, so that very little or no metal is removed in the parting line area.

**Connecting Rod Alignment**

Connecting rod alignment is checked by a rod aligner. Rod alignment may be checked with the piston assembled to the connecting rod. When the connecting rod installed on the aligner, the aligner V-block edges should make complete contact with the aligner precision ground surface as the piston is moved back and forth. If the rod is bent or twisted, the V-block edges do not make complete contact with the prevision ground surface. A slightly bent or twisted rod can be straightened with the bending bar supplied with the aligner.

## VII. Valves:

Valve service includes the following functions:

1. Adjusting valve-tappet clearances (called adjusting valve lash).
2. Grinding valves and valve seats.
3. Installing new set inserts.
4. Cleaning or replacing guides.
5. Timing the valve.
6. Servicing the camshaft bearing.
7. Checking valve springs.
8. Turning the engine.

The valve-tappet clearance is measured by a feeler gauge. A two-step “go, no-go” feeler gauge of the specified thickness can be used. If the ‘go’ step fits the clearance, the adjustment is correct. If it is not correct, turn the adjusting screw in or out as necessary to correct it. On some engines, the measurement is made with the engine cold and not running. The engine is turned over until the valve lifter is on the low point of the cam; and the clearance is then checked. On others, the engine is warmed up on idling.

Valves and valve seats are ground to correct size and shape so that the valve may seat properly on the seat. For effective valve seating and sealing, the valve face must be concentric with the valve stem; and the valve guide must be concentric with the valve face. Also, the valve face angle must match the valve seat angle.

The valve seat insert is replaced if it is badly worn, or has been ground down previously so that there is no sufficient metal for another grind.

Check the valve guides for wear. Clean, replace or ream for large guides as necessary. A wire brush or adjustable blade cleaner can be used to clean the guide. If the guide is worn, it should be replaced.

The timing gears or sprocket and chain are marked to establish the proper positions and correct valve timing. Some engines have another marking system for checking valve timing. This marking is on the flywheel or vibration damper, near the ignition timing markings.

Valve springs are tested for proper tension and for squareness. Spring tension is tested by special fixture. The pressure required to compress the spring to the proper length is measured in this test.

For testing the squareness of the spring, stand the spring, closed coil end down, next to a surface plate. It should be rotated to see if the top coil moves away from the square more than 2 mm. If the spring is more than 2 mm out of square, of if it does not have the proper tension at the specified length, it should be replaced.

**Servicing Valves**

After removing the valve from the engine, clean the carbon deposits from it with a wire brush or buffing wheel. Valve stem should be cleaned with a fine abrasive cloth. To do this, clamp the valve in the soft jaws of a vise, wrap the abrasive cloth around the stem and pull it back and forth. This can also bed one on a lathe. Rotate the valve in a lathe, hold the abrasive cloth wrapped partly around the stem. While cleaning the valve examine it. If it is badly fitted, cracked, burned, worn or bent, replace it. After the valve is cleaned, inspect the specific parts of the valve, as shown in.

## Tuning Of Engine:

**Definition of tune up:** Tune-up is the process of making checks and minor adjustments to improve the operation of the engine.

Tune up is also preventive maintenance. Troubles can be caught early and prevented by checking out the engine before it actually fails.

**Tune-up procedure**

The tune-up procedure restores drivability, power, performance and economy that have been lost through wear, corrosion and deterioration of engine parts. These changes take place gradually in many parts during normal car operation. A typical tuning procedure is given below.

- Air intake and exhaust system

(i) Clean out pre cleaner
(ii) Remove and clean air cleaner
(iii) Swab out inlet pipe in air cleaner body
(iv) Inspect exhaust system and muffler
(v) Check crankcase ventilating system for restrictions.

- Basic engine

(i) Recheck air intake for restrictions.
(ii) Check radiator for air bubbles or oil indicating compression or oil leaks.
(iii) Cylinder head gasket leakage.
(iv) Retighten cylinder head cap screws.

(v) Adjust valve clearance.

(vi) Check compression pressure in each cylinder.

**Tuning procedure:** A typical tuning or tune up procedure is given below, which includes visual and mechanical checks and also checks with instruments. Some of the checks are not related to the engine but should be done for the safety purpose.

1. Loose spark plugs, start engine to blowout carbon and dirt, shut off engine and remove plugs.
2. Test engine compression.
3. If the compression ratio is not up to specifications, perform engine services that will eliminate the trouble. If the compression is all right, re-install the spark plugs.
4. Remove distributor cap, clean it, and visually check it for carbon tracks, chips and corroded terminals. Replace it if it is not in good condition.
5. Clean and inspect rotor and replace it if it is not in good condition.
6. Inspect the high tension leads, and if they have cracked, or frayed insulation or wires or damaged, replace them.
7. Check distributor centrifugal advance.
8. Test the vacuum advance.
9. Check distributor contact points and clean them. Read just the point opening.
10. Re-install distributor cap and replace wiring.
11. Check battery state of change, water and hold down clamps.
12. Check battery cables for damage, corrosion and loose connections and make necessary corrections.
13. If the battery has been overcharged or undercharged, check the alternator and regulator.

14. Check drive belts and tighten or replace them as required.
15. Check the condition of the manifold heat control valve, making sure that it is free to operate.
16. Check the intake manifold bolts for tightness to proper specifications. Even a slight leak will reduce engine performance.
17. Check fuel lines for tight connections and kinks, beads or leaks.
18. Check the cooling system for leaks, weak or collapsed hoses, correct coolant level and anti-freeze protection.
19. Check and adjust the accelerator linkage, if necessary.
20. Check crankcase ventilation system.
21. Check intake manifold and air injection system.
22. Remove carburetor, air cleaner, and check choke valve to make sure “Choke is working normally”. Clean or replace air filter element, if necessary.
23. Check and adjust contact point dwell and ignition timing.
24. Adjust idle speed and mixture to specifications.
25. Check the doorjamb sticker to see if lubrication is required.
26. Check the working of lights and horn. Check headlight adjustment.
27. Check steering system for looseness and ease of action.
28. Check suspension system and shock absorbers for looseness, excessive play and wear.
29. Check front wheels and ball joints for excessive wear or loose bearings.
30. Other tests that can be done included cylinder balance test to find a weak cylinder, cranking motor operation, conditions of ignition coil and condenser, tightness of mounting bolts, oil level in the engine, air pressure in tires, condition of tires and efficiency of the brakes.

## Fuel Feed System:

1. Check fuel lines for leaks or restrictions.
2. Clean fuel pump sediments bowl
3. Test fuel pump pressure
4. Clean and check carburetor
5. Service diesel fuel filters
6. Check diesel injection pump
7. Check and clean injector
8. Bleed diesel fuel system
9. Check diesel injection pump timing.

## Carburetor:

Carburetor is the most important item in the fuel feed system of spark ignition engines. It is connected between the fuel filter and the induction manifold. It supplies the air-fuel mixture of varying proportions to suit engine operating conditions. The fuel enters the float chamber of the carburetor. The air enters the air horn of the carburetor. Mixing of the fuel and air take place when both pass through the venture in the mixing chamber of the carburetor. This air-fuel mixture then goes to the intake manifold.

### Maintenance of Carburetor

The carburetor should be cleaned time to time in order to avoid blocking of the jests and passages. For this purpose, it is preferable to use compressed air. Never use wire for cleaning the jets. Also check periodically for tightness of flange securing nuts, starter fixing screws, main jet, starter jet and pilot jet. Make sure that there is no side play in the throttle spindle.

### Service Points:

Make sure that:

1. Gasket between the fixing flanges is not damaged.
2. Spraying nozzle is not pulled out, it is press fitted.
3. Float toggle is not in an inverted position.
4. Pilot air bleed is not blocked.
5. The float is not damaged.
6. Volume control screw taper is not damaged.
7. The petrol level is not changed.
8. Jets and passages are not leaking, sticking or worn.
9. Needle valve is not leaking, sticking or worn.
10. Float chamber vent is not blocked.
11. Acceleration pump diaphragm is not porous or assembled incorrectly.
12. The loose glass ball positioned under the pump injector is not sticking or lost.
13. Injector tube is not pulled out of the injector assembly.
14. Injector is blocked.
15. Pilot jet seating fully.
16. All jets and needle valve are screwed tightly.
17. All gaskets and washers are placed properly. They are not leaking.
18. Filter is cleaned properly every 800 km.
19. Acceleration pump is adjusted and cleaned.
20. Gaskets are changed while opening the carburetor.

## Nozzle Cleaning:

Remove the injector from the cylinder and clean the carbon deposits, if any, by washing them thoroughly in petrol. Remove the nozzle and dip it in the clean fuel of and the nozzle needle too. After cleaning the needle, insert into the nozzle body.

Note: Nozzle needle and body are lapped together and must not be exchanged.

**Initial Test**:

1. **Visual test (Only on used nozzle):** After cleaning, used nozzle should be visually inspected.

Look on nozzle needle for damaged or rough needle seat, for worn or damaged or carboned seat and for out of round of needle hole.

2. **Slide test:** After visual test all nozzle should be given slides test.

Fist dip the nozzle needle in clean fuel oil and insert into the nozzle body. Holding the body almost vertically, pull up the needle by one third of its engaged length. When released, the needle should slide down by its own weight.

## Testing with Nozzle tester:

The following is tested on the nozzle tester:

(a) Opening pressure.
(b) Leakage.
(c) Chattering characteristics and spray pattern.

**Use clean test oil for testing.** It is very important that the oil is clean. The nozzles are adjusted by their respective nozzle holders.

When clamping the nozzle into nozzle holder take care that the sealing surface is clean and undamaged. Place nozzle on sealing surface of nozzle holder, tighten cap nut first by hand and then with a well-fitting wrench to torque 6-8 kg-m.

Connects nozzle holder with its respective delivery pipe to the outfit. To test for nozzle jamming, press the hand lever of the nozzle tester down vigorously a few

times (approximately 6-8 downward movements per second) with pressure gauge bypass. With nozzle moving properly, with nozzle should chatter with shrill whistling buzz.

**Opening pressure:** The opening pressure is specified under description and operation for individual engine and should be adjusted correspondingly. With the pressure gauge open to pressure slowly depress hand lever until the nozzle ejects with slight chattering. Take reading on the pressure gauge, if this pressure differs from the specified opening pressure, it is necessary to change total shim thickness.

**Caution**: When the pressure gauge is open to pressure, increase and decrease pressure slowly otherwise the gauge may be damaged.

Leakage test: Operate hand lever of the nozzle tester until pointer on the pressure gauge indicates 20 kg/cm$^2$ (285 p.s.i.) below the specified opening pressure.

The nozzle considered leak-proof if no drop of fuel emerges out at the end of the nozzle within 10 seconds.

**Chatter test and spray pattern.** For these tests, it is absolutely necessary that the pressure gauge be by passed.

**Testing speed range:** 1stroke is in approx.. 0.2 to 2 sec (5 to ½ downward movements per sec.)

**Chatter test:** These types of nozzles chatter in the entire range of attainable lever velocity (lowest test velocity: One downward movement per second). Single non-chattering in intermediate range is of no significance.

**Spray pattern:** At low test velocity, atomization is course. In the non-chattering ranges, non-atomized streams are formed.

## Phase angle test:

The object of this test to check interval between successive injections, so that for a six-cylinder pump the intervals will be 60 and for a four-cylinder pump 90.

1. The rack is set to a position stated by manufactures, using a pump rack setting device, the delivery valve and spring are removed from number one element and the test pipe connected to this element.

2. If necessary the tappet adjusting screw, tappet pads, or phasing shims should be altered to provide a small clearance usually 0.6-1 mm between the top face of the plunger and the base of the delivery valve seat. This is clearance may be measured with a dial gauge or by a special tool.

3. The pump camshaft is rotated by hand until number one element is at the bottom of its stoke, a valve on the test bench is opened to allow fuel to flow out of the test pipe, this is long spill.

4. Continued rotation of the camshaft will eventually cause the flow from the rest pipe to cease, indicating the point at which both inlet and spill ports are closed and delivery is about to commence i.e. end of long spill.

5. The position of the camshaft when this occurs can be read from a pointer and 360 scale on the test machine.

6. This process should be repeated several times to verify the reading. Care must be taken not to confuse end of long spill and end of short spill. Which occurs when the plunger is moving down from T.D. position?

7. Number one valve and spring should be replaced and the above procedure repeated in the firing sequence of the engine.

8. It is necessary the tapped adjusting screw, tapped pads, or phasing shims should be corrected until the timing of injection to each cylinder is within the prescribed tolerance typical value being ±½ of camshaft rotation. If adjustment has to be made, recheck the clearance of the plungers at the top of their respective strokes.

It is essential, therefore, during adjustment of the pump, to ensure that the subsequent pumping elements commence to inject at exactly the correct interval in the camshaft degree after No.1 element. Assuming that the injection sequence of a 6-cyliner pump is 1, 5, 3, 6, 2, 4, and then No.5 element must commence injection $60^{o}$ after No.

(the pump work at half engine speed) and No. 3 at the same interval after No. 5 and so on. The interval on all types of pump is $360^{o}$ camshaft angle divided by the number of elements in the pump. This adjustment for correct timing interval is known as “phasing” or adjusting the phase angle of the pump.

## Calibration:

Calibration of the pump should be carried after the phase angle test. This consists of adjusting each element to deliver an equal quantity of fuel to the cylinders. The quantity delivered per stroke depends upon the manufacturer’s requirement. As the elements of the fuel pump deliver the fuel at various speeds and for different control-rod position. Fuel injection pump calibrated is as under.

1. Mount and couple the injection pump with the pump calibrating machine.
2. Set the control rod to the mid position or stay at 5 mm rack position.
3. Make all the connections of fuel pipes at inlet and outlet of pump elements, ensuring them leak-proof.
4. Operate the machine and run the pump at 600 rpm and bleed the system by opening the air vent cock.
5. The trip plate is arranged in its position; allow the fuel to enter the glass tubes at 600 rpm and for 200 stocks. Then take the readings of fuel delivered into the glass tubes.
6. Compare these readings with the manufacturer’s chart values for the 5 mm rack position.
7. If there are variation in these readings then adjust the pump elements to bring the reading as close as possible to the given chart. This adjustment can be done by slacking the clamping screw and moving the control sleeve in desired direction and then again tightening the clamping screw. This adjustment should be corrected up to ±2.5% if fuel delivery.

8. Repeat the experiment at other speeds within the maximum range and check the collection of fuel at each speed. If there is any variation, the pump has to be serviced to put in normal working condition.

## Injector Testing:

- Coil Test-Specific current supplied measures voltage drop.
- Injector Balance- Inj. Energized for a precise time frame, record fuel pressure drop.
- Noid lights.
- Simple test light that plugs into injector connector.
- Light flashes with each electrical pulse.

## Injector Cleaning:

- Periodic cleaning removes varnish & other deposits.
- Pressurized canister dispenses cleaning solution.
- Must disconnect fuel pump!

## Sensors Used In Multipoint Fuel System:

Typical sensors for multi-point FUEL system include:

**a. An exhaust gas or oxygen sensor (Lambda sensor)**

Oxygen sensor measure the oxygen level in engine as a means of checking combustion efficiency. Oxygen sensor voltage output vary with change in the content of the exhaust. Increase in oxygen makes the sensor output voltage to decrease and a decrease oxygen content causes increased sensor output. Sensor then sends data to the computer. The computer then alters the opening and closing of injector to maintain a correct air-fuel ratio for maximum efficiency.

**b. Intake Manifold pressure sensor**

This sensor measures the pressure inside the engine intake manifold. High pressure indicates a high load that requires a rich mixture and low manifold pressure indicates small load requiring a leaner mixture. The manifold pressure sensor changes resistance with change in engine load and thus computer alter the fuel mixture.

**c. A throttle position sensor**

In throttle position sensor a variable resistor is connected to the throttle plate shaft. When the throttle wings is opened for more power or closes for less power, the sensor changes the resistance and sends the signals the computer. Computer then makes the mixture richer or leaner as required.

**d. An engine coolant temperature sensor.**

Engine coolant temperature sensor monitors the operating temperature of the engine. This sensor is kept so that it is exposed to the engine coolant. When the engine is cold, the sensor might provide a high current flow. The computer would enrich the air-fuel mixture for cold operation. When the engine warms, the sensor would supply information so that the computer could make the leaner mixture.

**e. An airflow sensor**

Airflow sensor is used to measure the amount of air entering the engine. This helps the computer to determine the amount of fuel required in combustion. Air flow through the sensor causes an air flap to swing tone side. The air flap is connected to a variable resistor; the amount of air flow into the engine is converted into an electrical signal for the computer. Computer then make the mixture richer or leaner as required.

**f. An inlet air temperature sensor.**

Inlet air temperature sensor measure the temperature of the air that enters the engine. Cold air being denser than warm air requires a little more fuel as compared to warm air. Air temperature sensor helps the computer compensate for the changes in outside air temperature and maintain an almost perfect air-fuel ratio.

**g. A crankshaft position sensor and distributor rpm sensor**

Crankshaft position sensor or distribution rpm sensor is used to detect the engine speed and cylinder identification. The sensor consists of magnet and coil. It is mounted on oil pan with specified air gap between the sensor core end and crankshaft timing belt pulley tooth. This sensor allows the computer to change injector opening with changes in engine rpm. Higher engine speeds generally require more fuel. Lower engine speeds require less fuel. This data is used by the computer to alter the fuel mixture.

**h. Vehicle speed sensor**

The vehicle speed sensor, located on the transmission gearbox or speedometer, generates a signal in proportion to the vehicle speed. Receiving this signal, the speedometer uses it for operation of its indicator and also converts it into to the ON/OFF signal by doubling the cycle. This signal is sent to ECM where it is used as one of the signals to control various devices.

## Lubrication System Service:

### Engine Lubricating Troubles

It may be due to

- Failure of oil pump
- Clogged oil lines and oil passages
- Contaminated oil

### Maintenance of Lubricating System

- Maintaining Proper oil level
- Choose proper grade of oil.
- By keeping the breather clean in the sump.

## Oil Filter:

Oil filter is used in the engine lubricating system of most of the motor vehicles to filter out the dirt or grit particles from the oil.

The oil filter systems are of the two types:

1. By-pass system
2. Full flow system

In by-pass system, the whole of theoil does not pass through the filter at the same time, but some of the oil without being filtered goes to the bearings. Remaining oil passes through the filter and then goes to bearings. When the engine is run continuously for a long period, the whole oil is, however, filtered.

In full flow system, the whole oil passes first through the filter and then goes to the bearings. If the filter is clogged due to any reason, the system fails completely and bearings would be starved.

The different types of oil filters used in automotive engines are as follows:

1. Cartridge type
2. Edge type
3. Centrifugal type

## Oil Pump:

Oil pump is generally located inside the crankcase below the oil level. The function of the oil pump is to supply oil under pressure to the various engine parts to be lubricated. The different types of the oil pumps used for engine lubrication are as follows:

1. Gear pump
2. Rotor pump
3. Plunger pump
4. Vane pump

## High Oil Consumption:

The oil consumption may be high due to the following reasons:

1. Loose bearing.
2. Tapered or out-of-round cylinders.

3. Excessive clearance in the intake valve guides.
4. Worm piston rings.
5. Broken or improperly installed oil pan, valve cover, timing gear over gaskets.
6. Worn oil seats at front or rear main bearings.
7. Loose connections in oil filter lines.
8. Worn rear camshaft oil seal.
9. Excessive oil pressure.
10. Clogged oil breather.
11. Clogged oil return from the distributor.
12. Stuck positive crankcase ventilation regulator valve.
13. Cylinder distortion due to improper tightening of the cylinder head nuts.
14. Leaky fuel pump vacuum booster diaphragm which sucks oil from the crankcase.
15. Excessive clearance in the intake valve guides.
16. High speed and high temperature, which reduce oil viscosity. More oil flows and more oil leaks and more oil burns.

## External oil leakage:

It is detected as darkened oil wet area on or around the engine. Oil may also be found in small puddles under the vehicle. Leaking gaskets or seals are usually the source of external engine oil leakage.

Internal oil leakage-shows up as blue smoke exiting the exhaust system of the vehicle. For example, if the engine piston rings and cylinders are badly worn, oil can enter the combustion chambers and will be burned during combustion.

Note: Do not confuse black smoke (excess fuel in the cylinder) and white smoke (water leakage into the engine cylinder) with blue smoke caused by engine oil.

## Low Oil Pressure:

For proper lubrication of the engine parts, the oil pump should supply the oil at the required pressure. If the oil pressure is too low, as indicated by the oil pressure gauge, the vehicle should be stopped and fault should be found out, otherwise the lack of lubricating oil due to the too low pressure will cause any serious damage. The oil pressure may be low due to any one of the following reasons:

1. Less oil in the oil pan.
2. Loose connection in the oil lines.
3. Faulty pressure gauge giving incorrect reading.
4. Excessive clearance in the bearing causing rapid oil leakage from the bearing ends.
5. Too weak relief valve spring.

# CHAPTER-4

# CHASSIS AND BODY MAINTENANCE

## Clutch Maintenance:

The clutch must be properly maintained and correctly operated to obtain its normal life and satisfactory performance. There are two conditions which shorten clutch life:

1. Continuous operation of the clutch release bearings.
2. Clutch slippage.

**Cleaning and inspection**

(i) Now clean the dismantled parts of the clutch with kerosene.

(ii) Inspect the clutch facing for wear. In case it is worn-out up to the rivets heads, replace with new one.

(iii) Inspect the cushioning and torsion springs on the clutch plate. In case they are found to be cracked or weak, complete plate has to be replaced.

(iv) Check the pressure springs for stiffness. If variation in case of a particular spring from the original value is more than the allowable, the same should be replaced.

(v) Clean and grease the thrown out bearing. Now hold the inner race and try to rotate the outer race keeping it under pressure. It the rotation is not uniform the bearing needs replacement.

(vi) Check he pressure plate; it should have a smooth plane surface. In case it is distorted by more than 0.3 mm, or is badly scored, replace it.

## Adjustment Of Clutch:

Although the clutch is fitted and set very accurately on the initial assembly of the vehicle, however, it requires some adjustments after a considerable time of use due to the wear of the fraction surfaces. Usually the following four adjustments are made on most

of the clutches, three of which can be made without removing the clutch from the care and the forth after the clutch assembly has been removed:

1. **Floor board clearance adjustment:** This adjustment is required to prevent the pedal arm from resting against the floor board when the clutch is engaged. This adjustment is made with the help of a screw located near the lower end of the clutch pedal.

2. **Clutch pedal travel adjustment:** This adjustment is required to ensure complete clutch disengagement when the clutch is thrown out. This adjustment is made by raising or lowering the pedal assembly upper stop in the suspended clutch pedal.

3. **Free adjustment play:** This adjustment is required to keep a specified amount of free play in the pedal after the clutch has been engaged. This adjustment is generally made by changing the length of one rod located somewhere in the clutch linkage. It should be made only after the correct floor board clearance or clutch pedal travel has been made.

4. **Clutch release lever adjustment:** This adjustment is made only after removing the clutch from the vehicle. Also, this adjustment should be made every time the clutch is removed from the vehicle. For making this adjustment to factory specification, a clutch rebuilding machine equipped with a dial gauge or a gauge plate is used.

## Troubles, Causes and Remedies Of Clutch:

| | | |
|---|---|---|
| 1. Clutch slips while engaged | ➢ Broken or weak pressure springs<br>➢ Broken engine moment<br>➢ Warped clutch disc<br>➢ Grease or oil on disk facing | Replace<br>Replace<br>Replace<br>Replace facing or disk |
| 2. Clutch chatters when engaged | ➢ Warped clutch disc<br>➢ Broken engine mount<br>➢ Binding in clutch release linkage | Replace<br>Replace<br>Adjust and lubricate |

| | | |
|---|---|---|
| 3. Clutch noises | ➢ Misalignment of engine and transmission<br>➢ Friction disc bub loose on the clutch shaft<br>➢ Release lever not properly adjusted | ➢ Realign<br>➢ Replace worn parts<br>➢ Readjust (or ) Replace the assembly |
| 4. Clutch pedal pulsations | ➢ Engine and transmission not aligned<br>➢ Flywheel not seated on the crankshaft flange | ➢ Realign<br>➢ Seat properly |
| 5. Friction disc facing wear | ➢ Driver rides clutch<br>➢ Excessive and incorrect use of clutch<br>➢ Crack in fly wheel | ➢ Keep foot off clutch except when necessary<br>➢ Reduce use<br>➢ Replace |
| 6. Clutch pedal stiff | ➢ Clutch linkage lacks lubricant<br>➢ Misaligned linkage plate<br>➢ Bent clutch pedal | ➢ Lubricate<br>➢ Realign<br>➢ Replace |

## Gearbox Maintenance:

Gearboxes are an essential part of so many pieces of machinery. If you want to keep your gearbox functioning at its optimal performance, then regular maintenance should be done. The beat way to maintain your gearbox is to check it regularly to determine potential failures and fix them before they happen. This will keep you from those surprise breakdowns at the most inconvenient times.

To keep your gearbox functioning at it best and for a longer time, here are some key maintenance tips to consider.

- Drain gearbox fluid
- Inspect the fluid for evidence of sludge
- Fill the gearbox to the recommended level with new fluid of the correct type and viscosity.
- Inspect fit of plug and drain plug

- Check for leaks and wear on seals
- Check shift lever bushes
- Check clutch operation
- Test to check working of serviced gearbox.

## Troubles, Causes and Remedies Of Gearbox:

| Complaint | Possible causes | Check (or) Correction |
|---|---|---|
| 1. Hard shifting into gear | ➢ Gear shift linkage out of adjustment<br>➢ Gear shift lacks lubricants<br>➢ Excessive clutch free-pedal play | ➢ Adjust<br>➢ Lubricant<br>➢ Adjust |
| 2. Transmission sticks in gear | ➢ Gear shift linkage out of adjustment<br>➢ Gear shift lacks lubrication<br>➢ Synchronizing unit stuck | ➢ Adjust<br>➢ Lubricate<br>➢ Replace damaged parts |
| 3. No power through transmission | ➢ Clutch slipping<br>➢ Gear broken<br>➢ Misalignment of transmission with engine | ➢ Adjust<br>➢ Replace<br>➢ Realign |
| 4. Transmission noisy in neutral | ➢ Gears worn or teeth broken<br>➢ Bearings worn away<br>➢ Transmission misalignment with engine | ➢ Replace gears<br>➢ Replace and lubricate<br>➢ Realign |
| 5. Transmission noisy in gear | ➢ Insufficient lubrication<br>➢ Gears loose on main shaft<br>➢ Synchronisers worn | ➢ Properly lubricate with correct lube<br>➢ Replace worn parts<br>➢ Replace worn parts |
| 6. Gear clash while | ➢ Synchronisers defective | ➢ Repair or replace |

| | | |
|---|---|---|
| shifting | ➢ Incorrect lubricant<br>➢ Idle speed excessive<br>➢ Incorrect free-pedal play | ➢ Replace with correct lubricant<br>➢ Readjust<br>➢ Adjust |
| 7. Transmission noisy in reverse | ➢ Reverse idler gear damaged<br>➢ Shift mechanism damaged | ➢ Replace<br>➢ Repair, Replace, readjust defective parts |
| 8. Oil leaks | ➢ Foaming due to incorrect lubrication<br>➢ Oil level too high<br>➢ Oil seals damaged<br>➢ Drain plug loose | ➢ Replace with correct lubricant<br>➢ Use proper amount, not more<br>➢ Replace<br>➢ Tighten the plug |

## Measuring Ring Gear Runout:

1. Mount a dial indicator on the carrier assembly.
2. With the stem of the dial indicator on the ring gear, note the highest and lowest readings.
3. The difference between the two readings is the ring gear run out.

## Checking Ring and Pinion Backlash:

- Mount the dial indicator base firmly on the axle housing
- Place the dial indicator against the face of a ring gear tooth
- Move the ring gear back and forth and read needle movement
- Take readings at several points around the gear.

## Gear Tooth Pattern Nomenclature:

- “Drive” –The convex side of the tooth
- “Goat”-The concave side of the tooth.

- “Heel”- The outside diameter of the ring gear
- “Toe”- The inside diameter of the ring gear
- “High”- The area near the top of the tooth.
- “Low”- The area near the bottom of the tooth

## Pinion Bearing Preload:

- Check the pinion bearing preload using an inch-pound torque wrench
- Tightening the pinion nut crushes the collapsible spacer to set the preload.
- Tighten the nut in small increments, checking preload after each phase
- Take care not to over tighten the nut

When noise and vibration occur regardless of road speed, the cause could be damaged or worn universal or slip yokes, loose flange nuts, bent or distorted flanges or yokes which cause high propeller shaft runout, and high bearing friction. The slip yoke or universal joint bearing may be seized, the propeller shaft could be bent or damaged, or road tar may be sticking to the shaft. It is also possible that the balance weight could have broken off the propeller shaft tube. Any of the above could cause an unbalanced condition.

## Propeller Shaft Trouble Diagnosis:

1. **Turning Issue:** The most obvious symptom of a bad driveshaft is when you have trouble turning your vehicle. Your wheels won’t receive the proper amount of torque due to a U-joint issue at the end of the driveshaft, so making turns will be very difficult due to the additional resistance.
   Once you confirm it’s the driveshaft at fault, you need to get it replaced quickly or risk an accident due to not being able to control the vehicle.

2. **Squeaking Noise:** If there is a squeaking sound present that will just not to away, then you may have problems with the driveshaft.
   This could be due to worn out internal components such as bushings or bearings within the shaft or U-joint or possibly an imbalance in the shaft. Usually the noise increases as you to faster

3. **U-Joint Rotation Issues:** Your driveshaft has a U-joint which rotates at a steady pace. If the rotation fails or speeds up too quickly, then it will cause issues with your driveshaft.
   Perhaps you have a bad U-joint or your bearings have rust on the cap seals. This may require you to replace your entire driveshaft if the damage is too significant.

4. **Clunking Sound:** A failing driveshaft could cause clunking sounds to be heard as you step on the gas pedal or drive in reverse. These may be in addition to the squeaking sounds that you normally hear all the time.
   At this point, you should feel more than motivated to want to replace your shaft before some real damage occurs.

5. **Vibrations:** When you have a worn ut driveshaft, it may cause vibrations to come from underneath the vehicle which can be felt through the steering wheel or floor board. These vibrations coupled with another symptom should be a clear sign that your shaft needs to be replaced.
   In most of these cases, the shaft may have bushings which are worn out.

   Remember that the shaft is held in place by the bushings. If the bushings are loose, damaged, or worn out, then your shaft will vibrate because of it. Then it could lean to your shaft getting damaged.

6. **Shuddering while Accelerating:** If you experience shuddering or shaking when attempting to accelerate from a stop or low speed, you may have a worn U-joint or center bearing inside the driveshaft. This will usually be accompanied by strange noises as well.

## Differential Trouble Diagnosis:

The first sign of differential trouble is usually noise.

1. **Humming:**

- A humming noise is often due to incorrect internal adjustment of drive pinion or the ring gear.
- Incorrect adjustment causes rapid tooth wear or even failure of differential.

- This humming noise will take on a growling noise as wear progresses.

**2. Noise Or Acceleration:**

- Noise from differential is louder when the care is accelerating since there is heavy contact on the ends of the gear teeth.
- Noise is louder when the car is coasting since there is heavy toe contact and both these conditions must be corrected.

**3. Noise On Curves:**

- If the noise is heard only when the car is going around a curve, the trouble is inside the differential case.
- Pinion gears tight on the pinion shaft, damaged gears or pinions, too much backlash between gears could be cause for this problem.
- When the care turns along a curve, the parts inside the differential case more relative to each other.

**4. Limited-Slip Differential:**

- The limited slip differential requires a special type of lubricant. The wrong lubricant can cause clutch surfaces to grab. This may produce chattering noise during a turn.
- The remedy is to drain the old lubricant and fill specified lubricant designed for limited-slip differential. In such cases wheel spin can also occur. Even though differential is in good condition.

## Troubles, Causes and Remedies Of Rear Axle:

| | **Fault** | **Cause** | **Remedies** |
|---|---|---|---|
| 1. | Axle noisy on acceleration | (i) Heavy heat contact on ring gear<br>(ii) Improper adjustment of pinion and ring gear<br>(iii) Rough pinion bearings | (i) Correct it<br>(ii) Re-adjust<br>(iii) Replace<br>(iv) Adjust |

| | | | |
|---|---|---|---|
| | | (iv)Loose pinion bearings | |
| 2. | Axle noisy on coast | (i) Excessive backlash in ring gear and pinion<br>(ii) End play in the pinion shaft<br>(iii)Heavy to contact on ring gear<br>(iv)Rough bearings | (i) Adjust<br>(ii)Re-adjust<br>(iii) Re-adjust<br>(iv) Replace |
| 3 | Axle noisy on both coast and acceleration | (i) Worn differential gears<br>(ii) Worn pinion and ring gears<br>(iii) Defective bearings<br>(iv) Excessive backlash between ring gear and pinion<br>(v) Pinion set too deep in ring gear<br>(vi) Pinion and ring gear too tight | (i) Replace<br>(ii) Replace<br>(iii)Replace<br>(iv) Adjust<br>(v) Adjust<br>(vi) Adjust |
| 4. | Back lash | (i) Axle shaft splines worn<br>(ii) Axle shaft nut loose<br>(iii)Worn universal joints<br>(iv) Worn differential bearings<br>(v) Worn differential side gear thrust washers | (i) Replace axis shaft<br>(ii) Tighten as necessary<br>(iii)Replace<br>(iv)Replace<br>(v) Replace |

## Inspection And Repair Of Following Brake Parts:

### Master Cylinder:

The master cylinder is the heart of the hydraulic brake system. It consists of two main chambers-the fluid reservoir which contains the fluid to supply to the brake system; and the compression chamber in which the piston operates.

**Overhauling of Master Cylinder**

Servicing of master cylinder is proceeding as follows:

1. Remove the push rod.
2. Remove the brake line from the master cylinder. Cover the open end of the line with tape.
3. Remove the nuts and bolts holding the master cylinder in place and slide the unit out.
4. Remove rubber boot and circlip.
5. Thoroughly clean the outside of the master cylinder, then remove the cover and drain all the brake fluid.
6. Pull out piston, spring and valve, remove primary and secondary cup from the piston.
7. After disassemble the master cylinder, clean all parts in alcohol and dry it with compressed air.
8. Inspect the piston for scoring and corrosion. If either condition is excessive, replace with a new piston.
9. If the cylinder bore is rough, it should be honed out or replace it.
10. Clean out the cylinder with alcohol and with wire passed through the parts.
11. Clean all the parts with fresh brake oil and assemble the master cylinder.
12. Insert primary and secondary on piston.
13. Install a valve assembly, return spring and piston.
14. Fill up little brake oil in reservoir and pump up the piston with the help of screw driver to ensure its free travel throughout its travel.
15. Assemble rest of the parts and mount the master cylinder on the chassis, fix up linkages, pipes and fill up brake oil in reservoir.

**Wheel Cylinder (Or Slave Cylinder):**

Wheel cylinder is the second important component of the hydraulic brake system. A typical double piston wheel cylinder consists of two pistons which can move in opposite directions by the fluid pressure. It is rigidly mounted on the brake shield.

**Brake Drums:**

Brake drums are thin cylindrical members whose outside ends are closed and the inside open to admit the brake shoes. All brake drums were made in the form of steel pressings. However, this type of drum not only become scored but also gave rise to brake squeaks due to vibrations of the metal.

**Disc Brake:**

The motor vehicles are now being fitted with disc brakes instead of the conventional type drum brakes which are generally used on some American cars. A disc brake consists of a rotating disc and two friction pads which are actuated by four hydraulic wheel pistons contained in two halves of an assembly called a caliper.

The chief advantage of the disc brakes is their resistance to fading, since the disc remains cool under repeated severe brake applications. Also, pad wear adjustment is automatic, renewal of the pad is quick and easy. The condition of the pad wear can be checked without dismantling the brake system.

**Brake Linings:**

The brake linings are either of solid woven type or molded type. The asbestos base non-metallic linings have an average co-efficient of friction of 0.4 up to about 260$^{o}$C. Their maximum temperature resistance is about 350$^{o}$C. Zinc wire lining have better resistance to wear.

## Adjustment Of Hydraulic Brakes:

**Brake Clearance:**

At the time of operation of brakes, wear and tear of the lining takes place. Hence, the clearance provided between the lining and the drum in the initial stage increases, thus

necessitating adjustment. The adjustment is made at the toe and heel of the shoe. It is because of this reason that when there is enough clearance at the toe and heel, there will be sufficient clearance at other points. In the case of two shoe brakes, the clearance provided between the lining and the drum lies between 0.250 mm and 0.375 mm. Even some of the manufacturers specify as low clearance as 0.150 mm. The small clearance has the advantage of giving larger ratio of pedal movement to brake-shoe radial movement, although it does increase the chance of making the brakes self-locking.

**Brake Pedal Travel:**

The travel of the brake pedal during the process of braking can be divided into three parts. The first part is represented by the distance of 3 to 6 mm which is required to take up the clearance between the piston of master cylinder and the piston rod when in released position. The second part is represented by the distance of 16 to 19 mm which is required to cover up the pass port of the master cylinder. The third and final part is required to move the brake shoe from the released position to the applied position. This is of the order of 25 mm. The total pedal travel this way works out between 44 and 50mm. If the brake clearance is 0.250 mm, the ratio between pedal travel and brake shoe radial travel will be100:1. Generally, the pedal is kept away from the floor board by a distance of 15 cm which is the total pedal travel available. The difference between 15 cm and 44 mm to 50 mm is called the pedal reserve. This reserve is kept to take care of lining wear and also temperature rise during operation.

**Parking And Emergency Brake:**

In most passenger cars, the mechanical brakes operated by hand or foot are used for parking and emergency brakes. These brakes either act on the rear wheels or are attached to the transmission or to propeller shaft. The brake lever is mounted under the instrument panel to the left of the driver. When the brake is applied, the lever is locked in place by a ratchet. For releasing the brakes, different methods are used. Some hand brakes are released by squeezing the level and control finger together, others are released by tuning the lever and pushing it down. The foot pedal types are released by special release levers.

In *rear wheel type parking brake,* a cable or pull rod usually connects the parking or emergency lever to an idler lever which is mounted on a cross member of the frame. The

idler lever pulled forward against the action of the pull back spring. The two cables engaging the rear wheel brakes are also pulled when the brake is applied.

Transmission or propeller shaft parking brakes are of three types:

1. External contracting type.
2. Internal expanding type.
3. Disc type.

All these types of brakes operate to lock the transmission main shaft or the propeller shaft when the mechanical brake is applied. As the rear wheels are connected to the propeller shaft through the axle shaft, differential and universal joint, the rear wheels are prevented from coming when the propeller shaft is locked.

**Adjustments Of Brakes:**

There should be at least 12.7 mm, or as recommended by the company, free pedal travel before the braking action takes place.

Brake adjustment procedure is as follows:

1. Raise the vehicle until the wheels are off the floor.
2. With a wrench loosen the lock nut for the forward brake shoe and hold it.
3. With another wrench turn the eccentric towards the front of the vehicle until the brake shoe strike the drum.
4. While turning the wheel with one hand, release eccentric until the wheel turns freely.
5. Hold the eccentric in position and fasten the lock nut.
6. Repeat this operation to adjust the reverse shoe, but only turn the eccentric towards the back of the vehicle.
7. Do this on all four brakes. Check the fluid level in the master cylinder.

## Bleeding Of Hydraulic Brakes:

- The process of removing the brake fluid from the hydraulic pipe line and cylinder is known as bleeding.
- It is necessary whenever any part of the system is disconnected (or) fluid n the supply tank exceeds the limit.
- Whenever seats are worn out it is possible for air to enter into the wheel cylinder without any sign of leakage causing spongy pedal and it is the usual indication of air in the system.
- Never, under any circumstances use the fluid which has been bled from the system to top up the supply tank because it may be aerated, have too much moisture content (or) be contaminated.

**Bleeding Procedure:**

Before starting to bleed, follow the essential steps:

- Before commencing bleeding at each bleed screw, remove the dust cover and clean thoroughly. If the master cylinder is fitted with bleeding screw, bleed the master cylinder first.
- Attach the bleed tube to wheel cylinder and then from the master cylinder to the glass jar containing brake fluid.
- Open the bleed screw to $3/4^{th}$ of a turn sufficient to the brake fluid to flow freely. Depress the foot pedal slowly throughout full stroke of the pedal and allow it to return to its position slowly.
- There would be an interval of 3 to 4 seconds before making the next stroke.
- Repeat this action until the air bubbles seizes and then close the bleed screw immediately.

- While the pedal is thus held, securely tighten the bleed screw and remove the tube. Replace the dust cover on the bleed screw. Repeat the same procedure on all the wheel cylinders.
- After the bleeding operation, top up the master cylinder reservoir with appropriate brake fluid to a level of 3/4$^{th}$ the reservoir and replace the filler cap.

## Troubles, Causes and Remedies In Brake System:

| S.No. | Fault | Cause | Remedy |
|---|---|---|---|
| 1. | **Hydraulic brakes:** Long pedal travel or pedal goes up to goes up to floor board | (i) Excessive clearance between linings and drum,<br>(ii) Weak hose<br>(iii) Leaking wheel cylinder.<br>(iv) Leaking master cylinder<br>(v) Leaking stop light switch.<br>(vi) Air in system<br>(vii) Blocked master cylinder filler cap vent hole<br>(viii) Low fluid level in master cylinder | (i) Adjust brakes<br>(ii) Replace hose.<br>(iii) Service with wheel cylinder repair kit<br>(iv) Service with Master cylinder repair kit<br>(v) Replace stoplight switch<br>(vi) Bleed the system<br>(vii) Clean vent hole or replace cap<br>(viii) Fill the reservoir with brake fluid and bleed the system. |
| 2. | Springy, spongy pedal | (i) Air trapped in hydraulic system.<br>(ii) Badly lined shoes, excessive gap between lining and shoe<br>(iii) Shoes distorted<br>(iv) Bell mounted, worn out, weak or cracked drums<br>(v) Master cylinder filler cap vent clogged.<br>(vi) Weak hose<br>(vii) Weak master cylinder mounting (yielding).<br>(viii) Bend master cylinder push rod and clevis<br>(ix) Unbledded linings. | (i) Bleed the system<br>(ii) Reline the shoes properly<br>(iii) Replace the shoes<br>(iv) Replace drums<br>(v) Clean vent hole or replace cap, bleed system<br>(vi) Replace<br>(vii) Check and strengthen master cylinder mounting.<br>(viii) Replace push rod and clevis.<br>(ix) Bad linings |

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|---|---|---|---|
| 3. | Brakes pulling (vehicle pulls to one side) | (i) Uneven adjustment of brakes.<br>(ii) Tires improperly inflated<br>(iii) Tire tread unevenly worn on either side or different type of treads<br>(iv) Grease or fluid soaked lining on the brake opposite to the direction of pulling<br>(v) Linings of different grades on either side of brake.<br>(vi) Unbledded lining<br>(vii) Shoes wrongly fitted<br>(viii) Rivets loose in lining.<br>(ix) Wheel cylinder piston seized<br>(x) Wheel cylinder diameter different on opposite sides.<br>(xi) Clogged or restriction in hydraulic hose or bundy pipe.<br>(xii) Weak or broken shoe return springs.<br>(xiii) Drums oval or eccentric<br>(xiv) Loose back plate mounting bolts loose shoe abutment or adjuster housing.<br>(xv) Improper steering geometry<br>(xvi) Loose or worn tie-rod<br>(xvii) Loose king pin and bushes.<br>(xviii) Loose wheel bearings, loose 'U' clamp nuts' | (i) Adjust all the brakes evenly.<br>(ii) Inflate to recommended pressure.<br>(iii) Replace with same type of treads all round<br>(iv) Replace linings after remedying the cause for grease or fluid leak.<br>(v) Replace with recommended grade of linings all round.<br>(vi) Bad linings.<br>(vii) Install leading and trailing shoes correctly.<br>(viii) Rivet properly<br>(ix) Service or replace wheel cylinder.<br>(x) Replace with correct cylinder.<br>(xi) Clean or replace pipe lines.<br>(xii) Check and replace weak, open coiled or cracked springs.<br>(xiii) True up or replace<br>(xiv) Tighten back plate mounting blots and adjuster housing mountings. If abutment is loose, replace back plate.<br>(xv) Reset according to vehicle manufacturer's specification.<br>(xvi) Tighten or replace.<br>(xvii) Replace pins and bushes.<br>(xviii) Adjust wheel bearings, adjust steering and tighten 'U' clam nuts. |

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| | | (xix) Weak shock absorbers. | (xix) Replace |
| 4. | Fade (Fade is a temporary reduction of brake effectiveness resulting from heat) | (i) Incorrect grade of line<br>(ii) Distorted shoes.<br>(iii) Overloaded vehicle.<br>(iv) Dragging brakes.<br>(v) Thin drums<br>(vi) Old hydraulic fluid | (i) Replace with recommended grade of lining<br>(ii) Replace shoes<br>(iii) Load the vehicle to the manufacturer's recommended GVW<br>(iv) Adjust or correct the cause.<br>(v) Replace drum<br>(vi) Replace with new fluid |
| 5. | Hard pedal, poor braking | (i) Incorrect brake adjustment<br>(ii) Incorrect lining.<br>(iii) Grease or fluid soaked lining.<br>(iv) Unbledded linings (lining not in full contact).<br>(v) Glazed linings.<br>(vi) Brake pedal binding on shaft.<br>(vii) Seized master cylinder or wheel cylinder piston.<br>(viii) Shoes wrongly fitted.<br>(ix) Bell-mouthed barrel shaped or polished drums. | (i) Adjust the brake<br>(ii) Replace with recommended lining.<br>(iii) Remedy the cause for grease or fluid leak and replace lining.<br>(iv) Bad linings.<br>(v) Sandpaper the lining surface.<br>(vi) Lubricate or recondition pedal bushes<br>(vii) Service master cylinder or wheel cylinder.<br>(viii) Install leading and trailing shoes correctly.<br>(ix) Replace or skim drums as necessary. |
| 6. | Brake pedal travel decreasing | (i) Master cylinder recupeting hole blocked.<br>(ii) Swollen cup seal in master cylinder.<br>(iii)Weak shoe retracting springs.<br>(iv)Wheel cylinder piston sticky.<br>(v) Linings welling. | (i) Service master cylinder.<br>(ii) Flush the system. Replace all rubber parts.<br>(iii) Replace springs.<br>(iv) Service wheel cylinder and replace internal parts.<br>(v) Fit recommended replacement linings. |
| 7. | Judder in brake pedals. | (i) Excessive ovality in drums.<br>(ii) Loose brake drum on hub.<br>(iii) Worn or loose bearing.<br>(iv) Rusty drums. | (i) True up drums<br>(ii) Tighten<br>(iii) Replace or adjust.<br>(iv) De-rust drums or |

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| | | | replace |
| 8. | Brakes binding | (i) Pedal does not return fully.<br>(ii) No clearance between push rod and master cylinder piston.<br>(iii) Maladusted brakes or hand brake.<br>(iv) Recuperating and feed port clogged in master cylinder.<br>(v) Seals swollen.<br>(vi) Seized wheel cylinder pistons.<br>(vii) Improper brake fluid.<br>(viii) Shoe return springs weak or broke.<br>(ix) Filler cap vent hole blocked. | (i) Lubricate pedal shaft or recondition pedal shaft and bushes.<br>(ii) Adjust brake pedal free play.<br>(iii) Check and adjust brakes and hand brake linkage.<br>(iv) Remove master cylinder and service.<br>(v) Flush system and replace all rubber parts.<br>(vi) Service or replace wheel cylinder.<br>(vii) Replace with correct brake fluid.<br>(viii) Replace springs.<br>(ix) Clean vent hole or replace cap. |
| 9. | One wheel drags. | (i) Weak or broken shoe retracting springs.<br>(ii) Brake shoe to drum clearance too small on side.<br>(iii) Loose wheel bearings.<br>(iv) Wheel cylinder piston cup seal swollen or piston seized.<br>(v) Excessive ovality in drum.<br>(vi) Obstruction in hydraulic line.<br>(vii) Distorted shoes.<br>(viii) Incorrect grade of lining. | (i) Replace springs.<br>(ii) Adjust brakes.<br>(iii) Adjust wheel bearings<br>(iv) Service wheel cylinder<br>(v) True up drums.<br>(vi) Flush lines<br>(vii) Replace shoes.<br>(viii) Replace with recommend lining |
| 10. | Rear brake drags | (i) Maladustment<br>(ii) Parking brake cable seized. | (i) Adjust brake shoes and parking brake mechanism.<br>(ii) Lubricate and adjust cables. |
| 11. | Brake squeal, | (i) Backplate bent or shoe slightly twisted.<br>(ii) Backplate bent or shoe slightly<br>(iii) Loose rivets or lining not held evenly against shoe rim (gap between lining | (i) Replace parts.<br>(ii) Replace parts.<br>(iii) Reline shoes properly |

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| | | and shoe rim)<br>(iv) Drums not true, weak or distorted.<br>(v) Incorrect grade of lining<br>(vi) Shoe scraping on back plate shoe pads<br>(vii) Weak or broken hold-down springs.<br>(viii) Loose wheel bearing.<br>(ix) Loose backplate, wheel cylinder or drum<br>(x) Over-adjusted steady post<br>(xi) Glazed lining.<br>(xii) Highly polished drum. | (iv) True up or replace drums.<br>(v) Replace lining with recommended linings.<br>(vi) Lubricate shoes pads with high melting point graphite grease.<br>(vii) Replace defective parts.<br>(viii) Adjust bearings.<br>(ix) Tighten.<br>(x) Adjust properly<br>(xi) Surface linings with sandpaper.<br>(xii) Skim drum |
| 12. | Snapping noise in front end | (i) Deep grooves in back plate shoe pads<br>(ii) Lack of lubrication on moving parts.<br>(iii) Loose drums or backplate<br>(iv) Loose or worn front end parts | (i) Replace back plate<br>(ii) Lubricate all moving parts on backplate with high melting point graphite grease.<br>(iii) Tighten<br>(iv) Tighten or replace defective parts |
| 13. | Thumping noise when brakes are applied | (i) Loose backplate, drums or axle 'U' bolts.<br>(ii) Grabbing linings.<br>(iii) Shoe retracting springs unequal or weak<br>(iv) Too much clearance between shoes and anchors (DAFC). Excessive wear on shoes and anchor pins. | (i) Tighten'<br>(ii) Replace with recommended grade of lings<br>(iii) Replace springs.<br>(iv) Replace worn parts. |
| 14. | Grinding noise | (i) Shoe rim fouling with the drum<br>(ii) Weak shoe hold down springs<br>(iii) Bent shoe web.<br>(iv) Foreign material in lining.<br>(v) Worn out or broken lining.<br>(vi) Rough drum surface. | (i) Check shoe retracting springs for correct fitment. Check hand brake.<br>(ii) Replace parts.<br>(iii) Replace shoe.<br>(iv) Remove or replace lining<br>(v) Replace with relining kit, skim or replaced rum if scored.<br>(vi) Skim drums. |

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| | | (vii) Improper adjustment of steady post | (vii) Adjust properly. |

## Troubles, Causes and Remedies Suspension System:

| Complaint | Possible Cause | Check (Or) Correction |
|---|---|---|
| 1. Hard or rough ride | ➢ Excessive tyre pressure<br>➢ Defective shock absorber<br>➢ Excessive friction in suspension spring | ➢ Readjust to correct pressure<br>➢ Repair (or) replace<br>➢ Lubricate, realign parts |
| 2. Sway on turns | ➢ Loose stabilizer bar<br>➢ Sagging springs<br>➢ Castor incorrect | ➢ Tighten it<br>➢ Repair or replace<br>➢ Adjust |
| 3. Spring breakage | ➢ Overloading<br>➢ Defective shock absorber<br>➢ Loose U-bolts | ➢ Avoid overloading<br>➢ Repair or replace<br>➢ Keep bolts tight |
| 4. Sagging springs | ➢ Broken leaf<br>➢ Spring weak<br>➢ Defective shock absorber | ➢ Replace<br>➢ Replace<br>➢ Repair or replace |
| 5. Noises | Could come from any loose worn (or) unlubricated part in the suspension (or)steering system | |

## Suspension system:

### Repair And Maintenance of Leaf Spring:

Leaf springs generally give trouble free service but sometimes due to overloading, rough driving or driving on a bad road they get broken**.**

In case of a broken leaf, it will be necessary to remove the spring assembly from the chassis. On removing the center bolt, the leaf can be separated and the broken leaf

replaced. Do not forget to apply graphite greases in between spring leaves and assemble the same with bolt.

Sometimes due to continuous use, the spring assembly gets sagged or gets straightened under these circumstances, remove the spring assembly, dismantle the leaf spring and hammer each leaf spring throughout its length one by one anvil which will give desired curve. This hammering of each leaf if called cambering of springs.

In case of replacing the broken leaf from a spring assembly which gone flat, it is necessary to camber rest of the springs also as stated above. It should, however be noted that while cambering one spring assembly it is very necessary to comber the opposite side of spring assembly also failing which the vehicle will remain tilted to one side.

**Here is list of defects which may occur in the springs**

1. Vehicle out level due to broken or flattened spring.
2. Low fender due to broken or weak spring.
3. Wrong shackle position due to weak spring.
4. Broken shackle.
5. Cracked leaves.
6. Damaged rubber bumper
7. Sagged spring hits bottom of the frame.
8. Helpers contact to soon.
9. Loose eyes.
10. Wrapped up spring.
11. Worn bushing in master leaf.
12. Defective or worn-out ‘U’ bolts.
13. Loose or worn axle clips.
14. Shared or broken center bolt.
15. Shifted leaves.
16. Broken rebound clip.

## Alignments of Wheels:

It is used to inspect and repair the wheel geometry. It is equipped with pre-alignment inspection check, self diagnostics to enable quick detection of errors, and on screen real time adjustment for high precision and speed.

Every vehicle manufacturer furnishes the wheel alignment specification for the vehicles manufactured by him.

Measurement and adjusting the wheel alignment angles conforming to the above specified value is called the wheel alignment.

**Wheel alignment angles are:**

(i) Wheel angles- camber and toe.
(ii) Steering axis angles-caster and king pin inclination.
(iii) Unwanted angles-wheel run out and set back.

Each wheel alignment angle has a specific purpose and function. If they are not set properly. The effects will be uneven tire wear, loss of steering control, pulling to one side while driving, jerking on travel etc.

It may not be possible to correct all the above angles in a vehicle. Depending upon the design of suspension, some angles are adjustable at workshop level and some are un adjustable.

**(i) Camber:**

The angle between the centerline of the tyre and the vertical line when viewed from the front of the vehicle is known as camber. When the angle is turned outward, so that the wheels are farther apart at the top than at the bottom, the camber is positive. When the angle is inward, so that the wheels are closer together at the top than at the bottom, the camber is negative. Any amount of camber positive or negative, tends to cause uneven or more tire wear on one side that on other side. Camber should not exceed $2^{o}$.

**Procedure**

(i) Turn the wheel to $30^o$ LHS

(ii) Adjust the sprit level such that the bubble occupies the center position.

(iii) Note the reading ofthe$60^oC$ scale.

(iv) Turn the wheel to $30^0$ RHS and the above procedure is repeated and the value is noted.

(v) The difference between the two readings gives the camber angle.

**(ii) Caster:**

The angle between the vertical line and the kingpin centerline in the plane of the wheel (when viewed from the side) is called the Caster angle. When the top of the king pin is backward, the caster angle is positive and when it is forward the caster angle is negative. The caster angle in modern vehicles range from 2 to 8 degrees.

**Procedure**

(i) Park the car on the turning table

(ii) Turn the wheel alignment gauge to $90^o$.

(iii) Fix the wheel alignment gauge on the wheel.

(iv) Turn the wheel to $25^0$ in RHS.

(v) Adjust the bubble to its original position.

(vi) Note the reading on the $50^o$ scale and the noted value will give the caster angle.

**(iii) Kingpin Inclination:**

The angle between the vertical line and center of the kingpin or steering axle, when viewed from the front of the vehicle is known as kingpin inclination or steering axle inclination. The kingpin inclination in combination with caster is used to provide directional stability in modern cars, by tending to return the wheels to the straight-ahead position after any turn. It also reduces steering effort particularly when the vehicle is stationary. It reduces tyre wear also. The kingpin inclination in modern vehicles range from 4 to 8 degrees.

**Procedure**

(i) Park the car on the turntable.

(ii) Fix the wheel alignment gauge on the wheels.

(iii) Turn the wheel to$30^0$ RHS and adjust the spirit level such that the bubble occupies center position.

(iv) Note the value on the $60^0$ scale and the value gives the kingpin inclination.

**(iv)Toe-in and Toe-out:**

The front wheels are usually turned in slightly in front so that the distance between the front ends (A) is slightly less than the difference between the back ends (B), when viewed from the top. The difference between these distances is called toe-in. The amount of toe-in usually 3 to 5 mm. The toe-in is provided to ensure parallel rolling of the front wheels, to stabilize steering and prevent side slipping and excessive tire wear.

Toe-out is the difference in angle between the two front wheels and the car frame during turns. The steering system is designed to run the inside wheel through a larger angle than the outside wheel when making a turn. The condition causes the wheels to toe-out on turns, due to difference in their turning angles. The toe-out is secured by providing the proper relationship between the steering knuckle, tie-rods and pitman arm.

**Procedure:**

(i) The toe-out bar is positioned from the front of the vehicle such that the pointer touches the wheel and the distance between the wheels is found from the scale on the bar keep is as (A).

(ii) Similarly the distance between the front wheels on the rear side is noted. Keep it as (B).

(iii) From the readings we can find out toe-in or toe-out. If A>B, then it is toe-out and if B>A, then it is toe-in.

**Toe-out on turns**

(i) Park the car on the turn table.

(ii) Turn the wheel to extreme left.

(iii) The readings in both the turntable are noted. The difference in the reading will give the toe-out on left turn.

## Wheel Balance:

- The wheel may be checked for balance on or off the car. This is done in either of two ways: static or dynamic.
- In static balancing, the wheel is taken off the car and put on a "bubble" balancer to detect any imbalance. A wheel that is out of balance is heavier in one section. This will cause the bubble in the center of the balancer to move off the center. To balance the wheel, weights are added to the wheel rim until the bubble returns to center.
- In dynamic balancing, the wheel is spun either on (or) off the car. An electronic wheel balancer is used to balance a wheel on a car. Lack of balance shows up as a tendency for the wheel to move off the center (or) out of line as it spins. If the wheel is out of balance, one or more weights are installed on the wheel rim.

## Troubles, Causes and Remedies Steering System:

| Complaints | Possible causes | Check (or) Correction |
|---|---|---|
| 1. Excessive play in steering system | ➢ Looseness in steering gear<br>➢ Looseness in linkage<br>➢ Loose wheel bearing | ➢ Readjust, replace worn parts<br>➢ Readjust, replace worn parts<br>➢ Readjust |
| 2. Hard steering | ➢ Low tire pressure<br>➢ Friction in steering gear<br>➢ Friction in linkage | ➢ Inflate to correct tire pressure<br>➢ Lubricate, readjust, replace worn parts<br>➢ Lubricate, readjust, replace worn parts |
| 3. Car wander | ➢ Low or uneven tire pressure<br>➢ Steering gear binding<br>➢ Linage binding<br>➢ Incorrect wheel alignment | ➢ Inflate to correct tire pressure<br>➢ Readjust, lubricate, replace worn parts<br>➢ Readjust, lubricate, replace worn parts |

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|---|---|---|
| | | ➢ Check alignment and readjsust |
| 4. Car pulls to one side during normal driving | ➢ Uneven tire pressure<br>➢ Uneven castor or camber<br>➢ Wheel not tracking | ➢ Inflate to correct tire pressure<br>➢ Check alignment, adjust<br>➢ Check tracking, replace effective parts |
| 5. Car pulls to one side while braking | ➢ Brakes grab<br>➢ Uneven tire pressure<br>➢ Uneven castor or camber | ➢ Readjust, replace brake lining<br>➢ Inflate to correct tire pressure<br>➢ Check alignment adjust |
| 6. Front wheel shimmy at low pressure | ➢ Uneven tire pressure<br>➢ Loose linkage<br>➢ Loose ball joints<br>➢ Dynamic imbalance | ➢ Inflate to correct tire pressure<br>➢ Readjust, replace worn parts<br>➢ Replace worn parts<br>➢ Balance the wheels |
| 7. Steering shakes | ➢ Uneven tire pressure<br>➢ Loose in linkage<br>➢ Looseness in steering gear<br>➢ Shock absorber defective | ➢ Inflate to correct tire pressure<br>➢ Readjust, replace worn parts<br>➢ Readjust, replace worn parts<br>➢ Repair or replace |
| 8. Tires squeal on turns (skids) | ➢ Excessive speed on curves<br>➢ Uneven tire pressure<br>➢ Front alignment incorrect<br>➢ Worn tires | ➢ Take curves at slow speed<br>➢ Inflate to correct tire pressure<br>➢ Check and adjust<br>➢ Replace tires |

## Care Of Wheels And Tires:

**Brake Dust: The Bane of Drivers:**

Wheels are probably the hardest part of your car to maintain to a high standard, and it's largely due to contamination from deposits like brake dust. Brake dust is a major problem for cars with alloy wheels; it's corrosive, unsightly, and can be extremely difficult to remove.

Brake dust forms when the brake pad is worn away during braking. Each time you brake, particles from the pad fly off and stick to the rim, resulting in a layer of residue that gets worse over time. Brake dust is composed of metal fillings, adhesive residues and carbon

fibers, and because it’s deposited on the rim at a high-temperature, it etches into the wheel’s protective coating- causing staining and if left to sit for too long, corrosion.

The easiest way to keep tabs on brake dust is to get into a regular wheel cleaning routine. To keep your car’s rims free from brake dust, you’ll need to clean them every 1-2 weeks depending on how often you drive. Here’s a step-by-step guide to keeping your wheels free from brake durst and other residue.

**Step-by Step Alloy Wheel Care:**

**Step 1: Remove loose surface contaminants**

With a hose or pressure washer, blast away any loose debris and dust from the rim, taking care not to knock any of the wheel’s balancing weights while you’re at it.

**Step 2: Scrub the rim using a wash mitt or sponge**

If the brake dust isn’t too bad, scrubbing the rim with a wash mitt should remove most of the residue. You can use a normal car shampoo to help to remove the looser dirt.

**Step 3: Spray on a dedicated wheel cleaner.**

Simoniz Ultracare Alloy Cleaner is non-corrosive, so won’t damage your alloys even if they’re scuffed or scratched. Spray it over the alloys, particularly on brake dust build up, and leave it to soak.

**Step 4: Scrub the rim using a soft-tipped wheel clearing brush**

If the brake dust is stubborn, get yourself a soft-bristled wheel clearing brush to give the rime a more intense scrub. Alloy wheel brushes are great for removing the most dried on and imbedded of wheel deposits, and their shape means you can clean hard-to-reach areas.

**Step 5: Rinse and dry the wheel**

Rinse the rim with a hose or pressure washer to remove any leftover residue or particles. Then, dry the rim thoroughly with a microfiber cloth or towel.

**Step 6: Apply a high quality wheel sealant**

Wheel specific sealants offer better protection against high temperature brake dusk than conventional waxes and sealants, helping to prevent the dust etching permanent marks on the alloys. Like normal car was, wheel sealant should be applied liberally and left to dray. First, ensure your wheels are clean and dry. Use it like a paint, applying in short even bursts to get an even coverage. Leave to dry for a few minutes and enjoy cleaner wheels for weeks.

## Tire Maintenance:

The main purpose of tires is that they have air-filled cushions that absorb most of the shocks caused by road irregularities and secondly they grip the road to provide good traction. Good traction enables the care to accelerate, brake, make turns without skidding. The main steps involved in tire maintenance are:

- Always maintain the recommended tire inflation pressure.
- Do not overload the vehicle beyond the capacity prescribed by manufacturer.
- Avoid frequent sudden acceleration followed by sudden braking.
- Do regular checks like wheel alignment, condition of brakes, springs, wheels, etc.
- Regularly inspect the tread condition very closely since it is equally important like other components.
- Retread the tires promptly before they are completely defected.
- Replace the tire before the tire surface becomes smooth.

## Tire Retreading:

Retread, also known as “recap”, or a “remold” is a remanufacturing process for tires that replace the tread on worn tires. Retreading is applied to casings of spent tires that have been inspected and repaired. It preserves about 90% of the material in spent tires and the material cost is about 20% compared to manufacturing a new one.

**Process:**

There are two main processes used for retreading tires called Mold Cure and Pre Cure. Both processes start with the inspection of the tire, followed by non-destructive inspection method such as shearography to locate non-visible damage and embedded debris and nails. Some casings are repaired and some are discarded. Tires can be retreaded multiple times if the casing is in usable condition. Tires used for short delivery vehicles are retreaded more than long haul tires over the life of the tire body. Casings fit for retreading have the old tread buffed away to prepare for retreading.

Material cost for retreaded tire is about 20% that of making a new tire. About 90% of the original tires by weight is retained in retreaded tires. A 1997 study estimates that then current generation of commercial vehicles tires to last up to 600,000 miles if they're retreaded two to three times.

**Pre Cure:** Previously prepared tread strip is applied to tire cashing with cement. This method allows more flexibility in tire sizes and it is the most commonly used method, but results in a seam where the ends of the strip meet.

**Mold Cure:** Raw rubber is applied to the tire casing and it is then placed in a mold where tread is formed. A dedicated mold is required for each tire size and tread design.

**Bead to Bead Molding:** In this subtype, retreading is also applied to the side walls. These tires are given entirely new branding and stamps.

What is vulcanizing a tire?

A standard tire is comprised of several parts, such as the body plies, steel belts and bead bundle. … The heat that this process generates also serves to fuse the tire's various components together. This is what's known as vulcanizing.

## Tire Vulcanizing:

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Tire vulcanization is the process of adding new raw rubber to a damaged area of a tire to create a repair suitable for the rest of the tires road life. Your damaged tire will be prepared and new rubber molded into the damaged area then put into a tire vulcanizing machine to cook the raw rubber at high temperature. After this process a reinforcing patch is fitted to the inside of the tire and its ready to be fitted back to your car. This process of tire repair allows two days for completion.

## Tire Rotation:

Tire rotation is the practice of moving the wheels and tires of an automobile from one position to another, to ensure even tire wear. Even tire wear is desirable to extend the useful life of a set of tires.

The weight on the front and rear axles differs which causes uneven wear. With the majority of cars having the engine in front, the front tires typically bear more weight than the rear tires. Front-wheel drive vehicles have not only the engine but also the transaxle in front, adding to the weight difference. Moreover, additional stress is placed disproportionately on the front tires by braking and steering. Thus, tire rotation needs to occur more frequently for front-wheel drive vehicles.

Turning the vehicle will cause uneven tire wear. The outside, front tire is worn is proportionately.

## Causes Of Tire Wear:

1. Incorrect inflation.
2. Incorrect castor, camber or toe-in.
3. Excessive braking or violent acceleration.

4. Worn steering mechanism.
5. Worn kingpins.
6. Out of balance wheel.
7. Misalignment.
8. Over-loading.
9. Wrong loading.
10. Defective brakes.
11. Toe-out incorrect on turn.
12. Bleeding of air in tire.
13. Careless driving.
14. Unequal tires

## Frame Repairs:

Defects in frames and body generally occur due to severe impacts on rough roads and collision with other objects or vehicles. Depending upon the nature of collision, the defects of the following kinds may occur.

- Misalignment in horizontal and/or vertical plane.
- Twisting of main frame and/or sub-frames.
- Buckled main frame and/or sub-frames.
- Bent side members and/or dumb iron.
- Broken or loose gusset plate and rivets.

Whenever the vehicle is subjected to a major collision, the frame alignment must be checked. A visual check generally reveals major misalignment, but in case this fails to indicate the defect, the frame check is conducted as follows.

**(a) Wheel Base Check:** The front wheels are set in the straight-ahead position and the wheel bases on each side is checked.

**(b) Alignment:** To verify parallelism of the rear wheels with each other, a cord or straight edge is held against the rear wheel. Then the front wheel is turned until it is parallel with the cord. The clearance (if any) between the wheel and cord should be the same on both sides.

**(c) Plumb-line Check:** A plumb line is dropped from the outside of each fixed shackle of the spring to give eight chalk marks on the floor. The points are joined. All diagonals should cross the center line if the frame is correctly aligned. The tolerance for each check depends on the size of frame, but 6 mm is often considered as the maximum. Frame straightening is a specialized repair and is carried out by using jacks and chains. If the frame has not been heat-treated, it is possible to heat the damaged member to ease the straightening operation.

Cracks can be repaired by welding, and when a reinforcement plate is fitted, it is advisable to taper the end to avoid any sudden change in cross-sectional area.

We have always heard loose rivets should be replaced with new ones, never try to "tighten" old ones. Bolts won't work good either, they will move and enlarge the holes. When a rivet is set besides pulling the two pieces together the rivet expends and becomes tight against the sides of the holes allowing little movement, a bolt doesn't do that.

When distortion-induced fatigue cracks do occur in skewed systems, they can be especially difficult to repair. In situations where cross-frames are carried parallel to the skew, the connection to the cross-frame members is angled, presenting a geometric challenge during repair and non-symmetric loading of the detail.

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## Denting:

The process of body repairing and refinishing is called denting. It mainly involves sheet metal works in which the damaged body panels and fenders and straightened or given profiles to make them look like the original item.

The need for denting of a vehicle arises when,

- The fenders, doors or panels are junked.
- Panels are twisted after collision.

- A series of ridges are seen on certain area.
- A damaged wrinkled panel is to be straightened.
- A protruding sheet metal is to be pressed back into position.
- The patches or scratches have come up and the original color has faded.

The denting is also called as dinging process which involves number of processes such as bending, flatting, shearing, filling, painting, color matching etc. These processes are performed with the help of modern tools are equipments most of which are described. Some tools are very common and essential for the denting and are generally referred as denting tools. These are fender-straightening hand tools, center punches, metal shears, pull rods, dolly blocks, dinging hammers etc.

## Body Paint:

It is very difficult to touch up the stoving enamel surface. However, the following technique may be adopted for touch up work to get better results.

1. **Chipping:** Chipping at door edges to be touched up with Hylux or Golac by brush.

2. **Small spots:**

   (i) Sand thoroughly the damaged part of the stoving enamel film with 400 water proof paper and water with rubber block. After this, the effected portion should be sanded with 600 paper.

   (ii) Whatever metal is exposed, N.C. primer surface should be sprayed.

   (iii) After proper flash time (4 hours), the N.C. primer surface should be wet sanded with water and 400 waterproof paper. After this, again 600 paper should be used on this area.

   (iv) Hylux paint of I.C.I or Glolac paint of additions is to be used for touch up work.

   (v) One coat is to be sprayed first on the primer surface film only. After sometime, apply second coat of the paint starting from inner side of the

area. After 5minutes flash time, spray Hylux thinner or Gloalac thinner, as the case may be, on the dry spray area to wet it. Now, dry it by infrared lamp for 30minuts, keep it for 48 hours for air dry.

(vi) Now rub car polish by a soft cloth on the touched up area.

To give you an idea of how to apply body filler, here are a few general instructions that suit most situations (but be sure to read and follow the directions on the product you buy):

1. Clean the body area thoroughly:

Remove all traces of dirt, wax, and rust.

2. Sand the area:

Use#180 or #220 aluminum oxide sandpaper or the type specified or your vehicle's plastic or aluminum parts.

Selection. Because body fillers don't stick to paint, you must sand the area. When sanding, be sure to feather-edge (blend_ the paint edges to prevent the old paint from chipping up through the new paint in the future and to ensure a good bond. Gently work inward from the edges of the dent to avoid enlarging the damaged area.

3. Mix only as much hardener-filler as you're going to use right away.
4. If you're patching a hole, place something beneath the hole to keep the filler in place.

- For a hole in the metal part of the body: Put fiberglass screening or fine aluminum chicken wire beneath the hole (on the underside of the body)
- For a fiberglass or plastic part: Use the appropriate patch kit available at your local auto supply or auto paint store.

Be sure to clean the area under the edges of the hole thoroughly to get rid of any dirt or paint. Then mix a very small proportion of filler and hardener and apply it to the edges of the screen and the edges of the area to be patched in order to hold the screen in place. If the kit contains no applicator, use a putty knife or plastic pot scraper to apply the filler. Let the screen patch dry for several hours before moving on to the next step.

5. Apply the filler

Work slowly and carefully to avoid spreading the filler outside the dent or hole and marriage the surrounding area. After you finish, the filled portion should be slightly higher than the surface of the car around it.

6. As soon as the filler starts to harden (about to the consistency of hard cheese), use a perforated file to bring the level down almost to the level of the paint.
7. Wait at least 20 to 30 minutes until everything is bone dry; then sand the area with medium-grain sandpaper until it conforms perfectly to the surrounding body surface.
8. When everything is smooth and even prime the area and touch up the paint.

You can use primer as a last layer of filler to fill-tiny holes or irregularities. Apply several layers of primer, sanding each layer with a sanding block, until the area appears perfectly smooth. (To check that it's smooth, wet the primer and look at the way light reflects off the surface.)

## Defects In Paint Work:

The defects which are commonly found in paint work are as follow:

1. **Blistering**

   Formation of bubbles like shapes on the painted surface is known as blistering. The primary cause of this defect is water vapor. When water vapor trapped under the paint layer, it creates bubbles under the film of paint.
2. **Blooming**

   Formation of dull patches on the painted surface is known as blooming. The primary cause of this defect is poor quality of paint and improper ventilation.
3. **Fading**

   When there is a gradual loss of color from the pained surface, it is known s fading. The main cause of this defect is the reaction of sunlight on pigments of paint.

4. **Flanking**

   In this type of defect, some portion of the paint film is not sticked properly with the surface; resulting flaking off of the paint layer. This is cause due to poor adhesion between paint and the surface to be painted.

5. **Flashing**

   Presence of glossy patches on the painted surface is known as flashing, The cause of this defect is mainly due to poor workmanship, cheap paint or weather actions.

6. **Grinning**

   If the thickness of the final coat of paint becomes very thin, the background can be seen clearly. This is known as grinning. Poor workmanship is the main cause of this defect.

7. **Running**

   This type of defect is seen when the surface to be painted is very smooth. In case of smooth surface the paint runs back and leaves small areas of surface uncovered.

8. **Sagging**

   This type of defect is more prominent when a thick layer of paint is applied on a vertical or inclined surface.

9. **Saponification**

   Formation of soap patches on the painted surface is termed as saponification. Chemical action of alkalis is the cause of this defect.

10. **Wrinkling**

    This type of defect is more prominent when a thick layer of paint is applied on a horizontal surface.

## Adjustment Of Doors And Locks:

1. When checking door alignment, look carefully at each seam between the door and body. The gap should be even all the way all the way around the door. Pay particular attention to the door seams at the corners farthest from the hinges; the this is the area where errors will be most evident. Additionally, the door should push against the weather strip when latched to seal out wind and water. The

contact should be even all the way around and the stripping should be about half compressed. The position of the door can be adjusted in three dimensions; fore and aft, up and down, in and out. The primary adjusting points are the hinge-to-bolts.

2. Apply tape to the fender and door edges to protect the paint. Two layers of common masking tape works well.

3. Loosen the bolts just enough to allow the hinge to move. With the help of an assistant, position the door up and down as required and snug the bolts.

4. Inspect the door seams carefully and repeat the adjustment until correctly aligned.

5. Inspect the front door seal and determine how much it is being crushed. If there is little or no contact in this area, or if the door is recessed into the body at the front when closed, loosen the hinge-to-door bolts and adjust the door in or out as need. Don't worry about the latch yet.

6. Make sure the door moves smoothly on the hinges without binding. When the door fits the opening correctly, tighten the bolts.

7. To adjust the latch, loosen the large cross point screw holding the striker on the door jam on the body. These bolts will be very tight; an impact screwdriver is the best tool for this job. Make sure you are using the proper size bit.

8. With the bolts just loose enough to allow the striker to move if necessary, hold the outer door handle in the released position and close the door. The striker will move into the correct location to match the door latch. Open the door and tighten the mounting bolts. The striker may be adjusted towards or way from the center of the car, thereby tighten or loosening the door fit. The striker can be moved up and down to compensate for door position, but if the door is correctly mounted at the hinges this should not necessary.

**Note:** Do not attempt to correct height variations (sag) by adjusting the striker.

1. After the striker bolts have been tightened, open and close the door several times. Observe the motion of the door as it engages the striker; it should continue its straight in motion and not deflect up or down as it hits the striker.
2. Check the feel of the latch during opening and closing. It must be smooth and linear, without any trace of grinding or binding during engagement and release. It may be necessary to repeat the striker adjustment several times (and possibly re-adjust the hinges) before the correct door-to-body fit is achieved.

The door alignment within the door opening in the body shell is adjusted my loosening the hinge bolts moving the door as necessary. The door closure is adjusted by moving the latch pin or bracket.

**The door hinges should be adjusted such that:**

1. The door shell is level with lower door jamb.

2. On front doors, the forward edge of the door is even with or slightly recessed, not to exceed 0.040 inches (1 mm), relative to the rear portion of the front fender.

3. On rear doors, the forward edge of the door is even with, or slightly recessed not to exceed 0.040 inches (1 mm), relative to the rear edge of the front door, which can be accomplished by moving the hinges of the rear door or by moving the striker pin or bracket of the front door if the front door closure is properly adjusted.

   The closure of the doors is accomplished by moving the latch pin or bracket on the door pillar. The latch brackets are secured by2 fasteners that are loosened to allow the bracket to be moved. The latch pin is adjusted by turning it counterclockwise to loosen it, moving it to the desired position and then tightening it. Use either a thin wall deep well socket or a boxed and wrench to loosen or tighten it.

Adjust the closure of the doors by loosening and moving the latch pin or bracket on the door pillar such that:

1. On front doors, with the door closed the rear edge of the door is slightly above the leading edge of the rear door not to exceed 0.040 inch (1 mm).

Note if the door has a tendency to rattle over bumps, check and adjust the height of the latch pin or bracket as necessary.

2. On rear doors with the door closed the rear edge of the door is slightly above the adjusting body panel, not to exceed 0.040 inch (1 mm) Note, if the door has a tendency to rattle over bumps, check and adjust the height of the latch pin or bracket as necessary.

On Audi A4 models the upper door window frame can be adjust with the help of an assistant as follows:

1. Remove all the door panel.

2. Loosen the 2 rear and the upper front fasteners that secure the window frame to the vehicle just enough the window frame can be moved but tight enough to hold its position. Loosen the front lower fastener such that it is just touching the door shell.

**Note:** The front lower faster has a graduated wedge installed between the window frame and the door shell.

1. Have the assistant sit in the vehicle and firmly press upward on the upper window frame toward the roof and the A-pillar, while, from the outside the fit of the window carrier is observed, marking sure it is properly seated, then have the assistant slide the graduated wedge as necessary to retain the position.

2. Open the door and tighten the window carried-to-door shell mounting bolts to 22 ft. lbs. (30 Nm.)

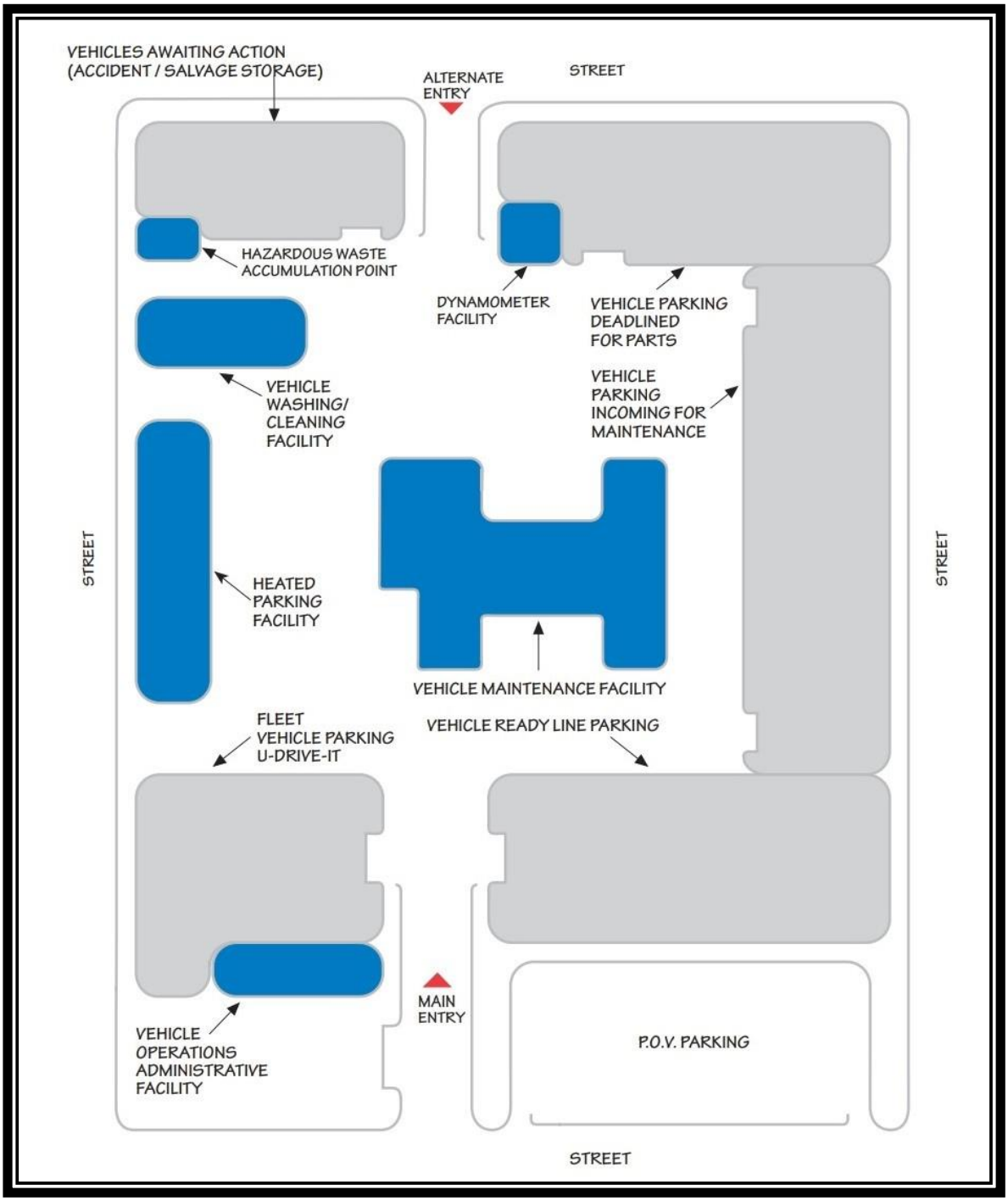
3. Close the door and recheck the adjustment. If necessary, repeat the adjustment procedures to attain the proper adjustment.

4. Once the adjustment is completed, reinstall the door panel.

# CHAPTER-5

# SERVICE STATION

## Location And Layout Of Service Station:



A service station is a place where in addition to care of the motor vehicle like mechanical service and minor repairs, petrol is supplied, cars are lubricated, and cleaned, washed and other types of simpler services that are required daily are performed. In general it includes a number of sections like garage general it includes a number of sections like garage general service, mechanical service, major repair shop, tire shop, paint shop, body shop.

Location of a service station is always inside or, outskirt of the city or, town where people of each and every corner of the city or, town can easily communicate.

A service station is addition to the equipment available is garage is usually run in conjunction with a sales agency for a particular type of motor vehicle to provide comprehensive repair service for that particular vehicle.

## Equipment For Service Station:

The equipment available, in a general garage will be added with specialized equipment like lifting tackle, and different types of jigs, fixtures and tools specially designed for checking, adjusting and repair of particular type and make of the vehicle. A service station may consist of a machine shop having a lathe, drilling machine etc.

In case of big service station special types of machines like crank shaft grinding machine, valve reface, surface grinder, re boring and boring machine, and brake drum lathe also will be equipments.

**Special Equipments For Service Station:**

1. Compressed air plant
2. Car washing machine
3. Lifting tackles

(a) Hydraulic jack

(b) Car lift

(c) Axle stands

(d) Jib crane

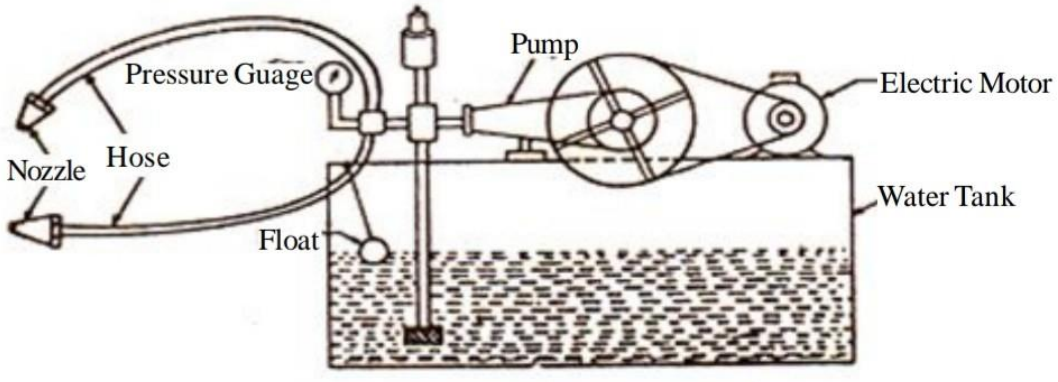
(e) A chain hoist

4. Chassis dynamometer
5. Wheel balancer
6. Tire remover
7. Brake drum lathe
8. Brake shoe lining riveting machine
9. Spark plug tester
10. High pressure grease gun
11. Wheel alignment gauges
12. Degreasing plant

## Equipment Required To Install A Service Station:

### Car Washing Machine:

Regular chassis washing of both cars and commercial vehicles to remove grease, oil, mud and other corrosive deposits is most essential. This type of cleaning is a time representative of preventive maintenance. This is easily done by a spray of water with a solvent, at high pressure (above 25 kg/cm2).
Car washer consists of a pump which is driven by a electric motor. The pump sucks water from a well or from water tank filled beneath it and delivers to the nozzle through a pipe of hoses with high pressure.



There are two types of car washers as follows.

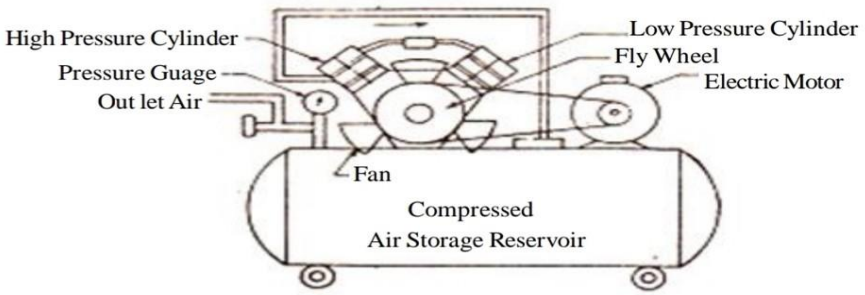
1.That provided with single hose which can be used to wash only one vehicle at a time.
2.That provided with twin hoses which can be used to wash two vehicles at a time.
The nozzles are adjustable, so that the delivery of water can be regulated at variable force from fine spray to solid jet.

Automatic Washing:

The automatic car wash machine has a three horse power pumping station which pumps up to 100ltrs of water per minute through 15 numbers of nozzles, 12 of which spray as a pre-wash arch which washes tires, wheels and rocker panels and rest three nozzles sprays on back top brush. The machine dispenses a specially formulated foaming, high pressure chemical during a pre-wash pass which is applied along with high pressure wash. The high pressure spray automatically adjusts to the vehicle's dimensions by the use of P L C based control panel and lastly, high pressure air blowers maintain the best air-steam helps to dry the complete vehicle surfaces.

**Air Compressor:**

Air compressors are used to compress the air which can be used for a number of purpose like washing of vehicle, cleaning of engine, spraying of lubricating oil, spraying of paint, tyre inflation, greasing a vehicle, for lifting hoist, for pneumatic grinder, for spark plug cleaning etc.



The air compressor is coupled to electric motor. An automatic pressure controller is provided between motor and main current line, to break the circuit when the pressure inside the air tank reduces a maximum valve. Compressor piston draws air into the cylinder during suction stroke through the inlet valve. As piston moves upward during its next stroke, the inlet valve closes and the air gets compressed and delivered to the air tank through outlet valve. One pressure gauge is fitted on air tank for observing the filling position.

**Lubrication Equipments:**

Lubrication is the most important factors in the maintenance of the car. If this is neglected in anyway the mechanism wears more rapidly and troubles are apt to occur. On the other hand liberal lubrication means long life and efficient running, with general freedom from trouble. To lubricate certain components beneath the chassis with the help of lubrication equipments, grease guns and high pressure lubrication equipments are used.

**Grease guns:**

Grease guns are used to lubricate the chassis components with grease. Several types of hand operated grease guns are available. They are.

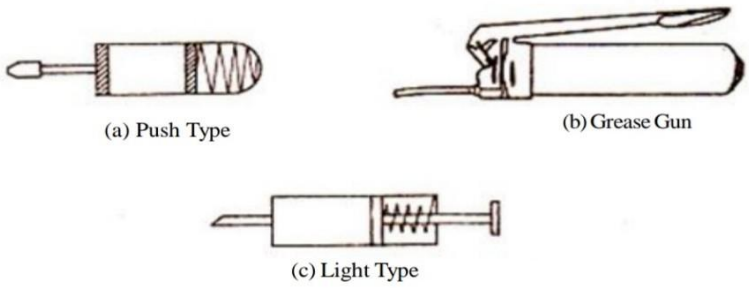
(a) Push type
(b) Grease gun
(c) Light type, and
(d) Bucket type

**Hand and compressed air- operated:**

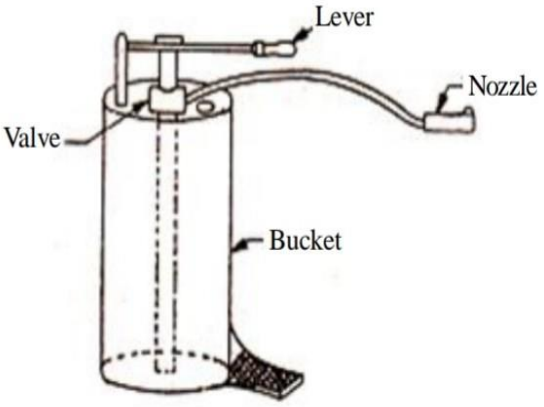
Depending upon the type of lubricant and pressure used the first three types of hand operated grease guns.

**Push type grease guns** consist of a cylindrical barrel one end of which is fitted with a nozzle cup, a piston moves inside the barrel. The piston rod assemble cap is screwed

tightly to barrel. To and fro movement of piston rod develops pressure inside the barrel. When lever is depressed grease comes out of the nozzle under high pressure.

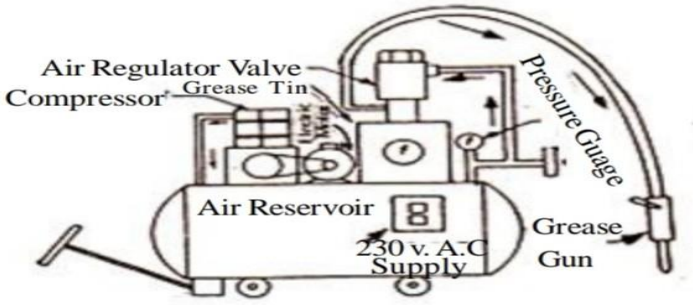



**Bucket type grease gun** valve will be operated by a fever which sucks grease from the central tube and delivers through outer tube and hand nozzle.




**High Pressure Lubrication Equipment:**

It is similar to hand operated grease gun but operated under air pressure. A separate container for grease filling is arranged on compressor tank and valve is fitted on it.



Grease gun pipe and air compressor pipe are connected to valve. It is necessary that lubricant should be forced into the bearing until the old lubricant is forced out new lubricant appears.

## Tools In Service Station :

### Hand tools

Many kind types and sizes of tools are used in automobile work.

- **Double Ended spanner set**

  These are most commonly used type of spanner in garage. The opening should be the right size to fit the nut or bolt. If the spanner opening is too large, it could round off the corners of the hex. These make the use of the proper spanner more difficult. These spanners are available in different sizes ranging from 6 to 32 mm.
- **Ring Spanner**

  In ring spanners the end openings completely enclose the nut or the bolt head so that they do not slip and cause damage. Further, the end holes in the ring spanner are twelve sided, because of which they can be used in restricted spaces, since the nut or the bolt head can be worked upon even when the swing of spanner is restricted to 15 .
- **Tubular Spanner**

  These are also used for the same purpose as ring spanner. It will be like a long tube having hexagonal ends at each end of different size. They may vary in size from 8mm to 32mm. It can be used where double end and ring spanner cannot be used.
- **Socket Spanner**

  These type of spanners are useful in restricted spaces where common type of spanners cannot be used. They consist of sockets of different sizes which can be used with various types of handles. The handles have projections at one end around which the sockets fit. One type of handle has a universal joint at the

projection end which makes it possible to work with the handle at an inclination with the socket. A ratchet handle is also available which obviates necessity of lifting of the socket from the nut or the bolt head.

- **Adjustable Wrench**

  This wrench has jaws that can be adjusted to fit nuts and bolt heads of various sizes. These types of wrenches have advantage that these can be suitable for a large number of nut and bolt head sizes.

- **Torque Wrench**

  Important nuts and bolts in automobile work have to be tightened with a specified amount of torque, because excessive torque may result in their breakage while less torque they will remain loose. This is made possible by a torque wrench it is a specialized form of socket spanners.

- **Screw Drivers**

  The screw driver is used to drive, or turn screws. The most common type has a single flat blade for driving screws with slotted heads. There are also the Phillips head and reed, and prince screw drivers.

- **Hammer**

  A medium of weight ball pen hammer is the one commonly used in automobile work. It should be gripped on the end of the handle. When you swing the hammer, the face should strike the object squarely, and not an angle.

- **Pliers**

  Pliers are a special type adjustable wrench. The two legs (handle) move on a pivot so that items of various sizes can be gripped. There are two types. Gripping pliers and Cutting pliers.

- **Pullers**

  Pullers come in variety of types and sizes and are used to remove wheels, gears and bearings from the shafts from housings. Each pulling operation differs from the other, and are must be exercised to prevent damage to the parts during pulling.

- **Spark Plug Spanner**

  It is used for removing or tightening spark plugs.

- **Feeler Gauge**

For measurements such as valve clearance, spark plug gap, contact breaker gap etc., we use feeler gauge which are simply blades of different thickness.

- **Valve spring compressor**

  Valve spring compressor or lifters are used to compress the valve spring to facilitate the removal of the valve retain lock or keeper from the valve stem.

- **Piston ring compressor**

  Piston ring compressors are places around the piston covering the rings. As the compressor is tightened, it compresses the piston rings into their grooves on the piston. Then the piston and rod assembly is installed into the cylinder.

- **Piston ring Expander**

  It is generally use to expand and remove the piston rings from their grooves without breaking.

- **Dial Indicator**

  It is a gauge that uses a dial face and a needle to register measurements. It can be used to measure the endplay in shafts or gears. Also it can be used to measure taper in engine cylinder.

- **Hydrometer**

  The float type hydrometer has a float with a stem that sticks up above the electrolyte level in the tube. The float stem is marked to indicate the specific gravity of the electrolyte. The height of the stem above the electrolyte indicates the battery state of the charge. It varies from a high 1280 in a fully charged (good condition) battery to a low 1.125 in a completely discharged (bad condition) battery.

## Services Carried Out In Service Station And Its Procedure:

Majority of automobile service nothing, but maintenance. In general it includes oil changes, chassis lubrication, tire service, engine tune ups, and servicing of transmission parts, brakes, springing system as well as wheel repair.

For servicing a vehicle, it should be mounted on a lift or hoist or on the ramp. A four post lift which enables a car to be lifted and also allows a car to be lifted with its wheels free, is the best for all working conditions as it enables the inspection and repair of wheel

hubs and the brakes and drives to be worked on quite easily. In the case of hoist, all four wheels are stripped off to enable servicing to be done at the time of fitting them back. The position of the wheels is interchanged diagonally.

The service procedure may be carried out in the following steps:

**Step 1:** The under-frame of the vehicle is cleaned with water and dried with air. A mixture of mobile oil and kerosene is then sprayed on the under-frame under pressure. The under-frame is then rubbed with cloth soaked in the above mixture of oils and later washed with water again and dried with compressed air.

**Step 2:** To clean engine of dirt, grease, etc. spray method with compressed air is used. A kerosene spray under pressure is sprayed on the engine, wheels, spindles, springs, steering knuckles etc. After sometime, it is sponged off with soap suds (linseed oil soap) followed by rising with cold water and then sponged off dry.

**Step 3:** For cleaning engine the exhaust system, the exhaust manifold pipe and muffler are taken apart and soaked in kerosene oil overnight. Alternately, a long wire packed with kerosene soaked waste, may be drawn through it for cleaning the pipe and manifold.

**Step 4:** Grease all points with a grease gun. Open the front wheel axle cups and grease.

**Step 5:** Check the mobile oil of the engine differential gear box oil, steering column oil and hydraulic brake oil.

**Step 6:** For proper maintenance of 12 V battery carry out the following:

(a) Wash and dry the top of the battery.
(b) Wash the corrosion product from the hold-down frame.
(c) Dry it thoroughly and apply black acid resistant paint, if necessary.

Use cell testers for checking individual cells and also check for gravity.

# CHAPTER-6

# SERVICES OF MOTOR VEHICLE

## Services And Its Necessity:

Different parts of an automobile usually fail or get out of adjustment due to long use. This long use and high speed running have greatly increased the necessity of maintenance and servicing of motor vehicles. By proper servicing, the vehicles become more comfortable, safer and easier to drive. Servicing in general is the process of either maintaining or restoring the vehicle to its original high state of perfection and performance. It is the sincere desire of establishing or maintaining of various original qualities of motor vehicle like appearance, performance, economy, safety comfort and control.it is necessary to visit the service station as soon as a defect is found the vehicle. If it is neglect, it is not desirable on safety point of view. Hence the repair whether it is major or minor as it to be done immediately.

## Types Of Services:

The servicing of a motor vehicle is of following types

1. Cleaning of the motor vehicle and its parts
2. Inspection and repair of different parts
3. Adjustments
4. Greasing and lubrications

## Cleaning Of The Motor Vehicle And Its Components:

A layer of oil, grease and dirt gets coated to the motor vehicle and its parts with passage of time and usage. Before performing servicing of the vehicle (i.e., disassembly,

inspection and repair), the unwanted layer should remove. This can be done by hand cleaning or by means of certain cleaning methods, hand cleaning which seems to be quite cheap and easy is the most expensive process.
The cleaner equipment selected the method application used greatly influence the speed, thoroughness and economy of the cleaning operation. Most commonly used methods of cleaning automobiles and its parts are steam cleaning, water pressure cleaning, solution cleaning and vapour bath cleaning.

## Steam Cleaning:

Out of all the ways you can clean your engine bay, you will get the best results by steam cleaning. Steam, applied at the right temperature and angle, is powerful in removing crud that is deeply seated in between small nooks and crannies. It is also safer because it does not damage sensitive engine components like electrical wirings and sensors the way high-pressure water sprays and chemical cleansers can. And because you only use a fraction of the amount of water you usually consume with a regular wash, steam cleaning is also the more economical choice.

The heat produced by steam is an effective means of cleaning and sanitizing various surfaces. Car seats are no exception. Cleaning car seats with a steam cleaner will not only remove dirt and grime from the upholstery, but will also disinfect the seats. Furthermore, steam cleaning is safe on both cloth and leather car seats. Steam clean upholstery for a quick, non-toxic way to wash car seats.

Step 1
Vacuum loose dust, dirt and debris from the car seats. Use the hose attachment on the vacuum cleaner to sweep the backs, sides and bottoms of the seats.

Step 2
Place water in the steam cleaner water reservoir. Refer to the owner’s manual for specific operating instructions and the amount of water to use as this will vary among models of steam cleaners.

Step 3
Allow the steam cleaner to heat up. This can take anywhere from two to 20 minutes or more, depending on the model of steam cleaner you are using. Refer to the owner's manual for the specific amount of time it takes to heat up the steam cleaner.

Step 4
Clean the car seats one section at a time. Run the steam cleaner hose attachment slowly over the car seats. Use a vertical motion when cleaning and overlap your strokes to ensure that no area is missed. Make one pass over each section, moving from top to bottom (or back to front).

Step 5
Hold the steam cleaner onto any stained areas of the car seats for about 15 seconds. This will loosen the stain from the fabric. Avoid doing this on leather car seats as too much moisture may damage the leather.

Step 6
Add more water to the machine as needed. Some steam cleaners will have an indicator light to let you know that the machine is empty. Others will simply stop producing water when empty.

Using a steam cleaner on your car's carpet, leather trim, seats and upholstery doesn't just leave you with a clean car interior — it also sanitizes your car, killing bacteria that can cause illness and odours. You can use a steam cleaner to clean items inside your car as well, such as child safety seats and seat covers.

## Cleaning Out Side Of The Engine:

To clean engine of dirt, grease etc., spray method with compressed air should be used. For this purpose a kerosene spray under pressure is sprayed on engine. For cleaning

engine exhaust system (exhaust manifold, pipe and the muffler), take them apart and soak them in kerosene oil overnight. A pack of kerosene soaked waste attached to a long wire may be drawn through it for cleaning the pipe and the manifold.

## Precautious Of Minimize Carbon:

The formation of harmful deposits can be controlled by adding detergent-dispersants to gasoline, the most common of which is polybutene succinimide. Used with a petroleum carrier oil, detergent-dispersants help keep the intake manifold and ports clean. These chemicals are more effective than the carburetor detergents that were once used in gasoline, but they must be used at concentrations that are three to five times higher than that of the older carburetor detergents.

Some gasoline companies and car manufacturers point to the use of high-quality gasoline with good detergents to help prevent carbon deposits. While gasoline can keep fuel injection systems clean, there is not much it can do about carbon build up.

## Methods Of De-Carbonizing:

It is the operation of removing carbon deposits on cylinder, exhaust port, piston ring grooves, combustion chamber in the cylinder head and piston crown.

Carbon is deposited in cylinder due to rich mixture supply, use of wrong grade oil, unnecessary idling, too much oil. Poor fitted piston and piston rings.

Deposition of carbon causes engine knockings, missing of explosions and burnt valve resulting in loss of power. The carbon collector at the valve head make the head unable to dissipate heat resulting its burning or warping sometimes. The carbon depositing in between valve and seat and impact of valves causes pits in the seat. Therefore, a loss of compression, reduced power, greater fuel consumption are caused. There, are in general three methods of decarbonising or decoding-

1. Scraping method
2. Oxygen decarbonising method
3. Chemical method of decarbonising.

1. Scrapping method :

The scraping of the carbon is done usually by hand scraping with the help of tools. To remove carbon from the piston, remove it from the cylinder. Now scrap the carbon removing brushes may be fixed in the chuck of an electric portable drill. To clean valve grinder, valve stems etc., special wire brushers may also be use.

2. Oxygen decarbonising method :

It is the process of removing carbon from the inside of the cylinder and head of the piston without removing the cylinder head by means of an oxygen flame. The equipment consists of an oxygen tank fitted at an initial pressure of 156kg/cm2. The oxygen is applied to the combustion space by inserting a flexible delivery jet through a valve plug orifice or spark plug hole by slightly bending or turning it. The oxygen flame will burn away all the carbon deposits completely.

3. Chemical method of decarbonising :

The chemical method consists in injecting into each cylinder head trough the spark plug hole a special chemical in liquid form. The engine should be in a warm condition so that the liquid can act more efficiently, after standing for about12 hours the carbon is loosened, so that upon starting up the engine it is blown out of the exhaust pipe.