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Mechanical & Auto Mobile Technician

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Intermediate Vocational Course

PAPER I : **WORK SHOP TECHNOLOGY -2**
PAPER II : **AUTO COMPONENTS AND OTHER SYSTEMS**
PAPER III : **Automobile Servicing & Maintenance**

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Mechanical & Auto Mobile Technician

Paper - I

WORKSHOP TECHNOLOGY _2

INDEX

Workshop Technology- 2

1. Lathe

INTRODUCTION:

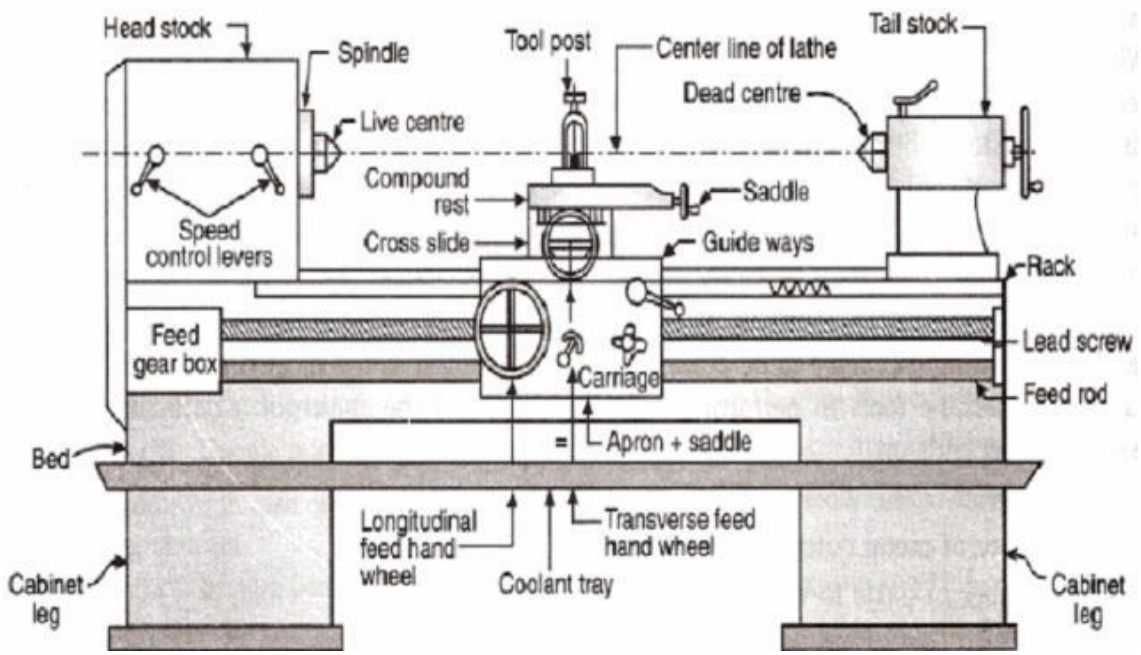
Latheisamachinewhichisusedinproductionside.Byusingthelathemachineremovetheexcess materialontheworkpiecebycuttingtooltogetrequiredshapeandsize.Lathe machine is one of the most important machine tools which is used in the **metalworking industry.**

WORKING PRINCIPLE:

Lathe machine operates on the principle of a rotating work piece and a fixed cutting tool. The cutting tool is feed into the work piece which rotates about its own axis causing the work piece to form the desired shape. The lathe is a machine which holds the work piece between two rigid and strong supports called centres or in a chuck or face plate which revolves. The cutting tool is rigidly held and supported in a tool post which is fed against the revolving work. The normal cutting operations are performed with the cutting tool fed either parallel or at right angles to the axis of the work. The cutting tool may also be fed at an angle relative to the axis of work for machining tapers and angles.

PARTS OR COMPONENTS OF LATHE:

ThemaincomponentsofLathemachineare1.Bed2.Headstock3.Tailstock4.Carriage5.Toolp ost6.Leadscrew7.Feedrod.



1. **Bed**: Itisthebaseofthemachine.Itgivessupporttoalltheparts.Ithasguidewaystomovecarriage and tailstock.

2. **Headstock**: ItislocatedonleftsideoftheLathe.Itisnotmoving.Itcontainslathespindle,cone pulley, speed change gears, back gear and spindle driving mechanism.

3. **Tailstock**: It is located at right side of the lathe. It can move on the guide ways. It can give support to hold long work piece.

4. **Carriage**: It consists of saddle and apron. The saddle move on the guide ways and give support the cross slide and compound rest. It contains gears and feed mechanism to transmit the motion from lead screw to carriage and to cross slide. Compound rest is mounted on the cross slide and can swivel required angle to produce taper.

5. **Tool post**: Tool post is kept on the compound rest to hold the cutting tool.

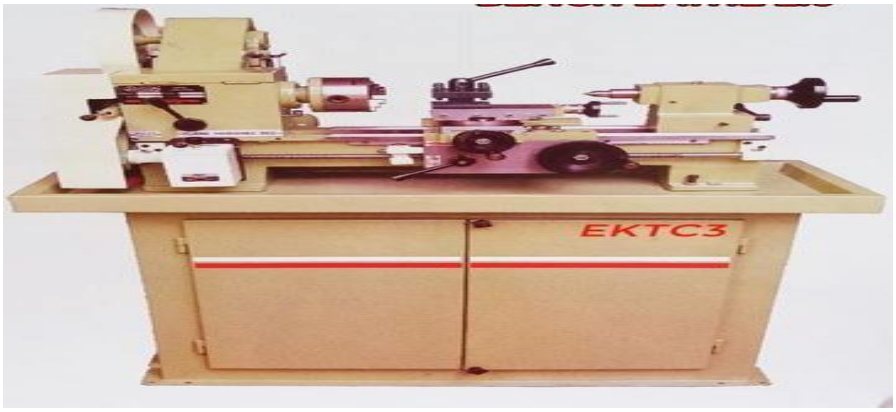
6. **Leads crew**: It is used for the read cutting operation. It is front side of the machine passing through carriage.

7. **Feed rod**: It is used for automatic feed.

TYPES OF LATHE:

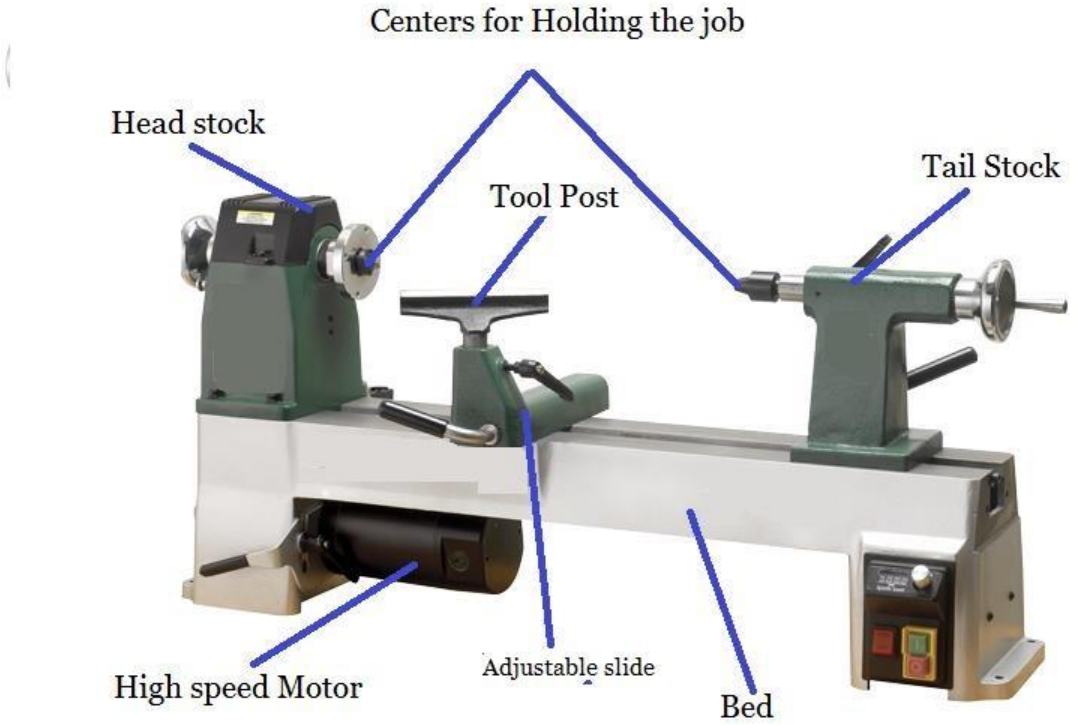
1. Bench Lathe:

It is a very small lathe and is mounted on a separately prepared bench or cabinet. It is used for small and precision work since it is very accurate. It is usua lly provided with all the attachments, which a larger lathe carries, and is capable of performing almost all the operations which a larger lathe can do.



2. Speed Lathes:

These lathes may be of bench type or they may have the supporting legs cast and fitted to the bed. These lathes have most of the attachments which the other types of lathe carry but have no provision for power feed. They have no gear box, carriage and the lead screw. With the result, the tool is fed and actuated by hand.



Speed Lathe

Usually the tool is either mounted on a tool post or supported on a T-shaped support. Such lathes are usually employed for wood turning, polishing, centering and metal spinning, etc. Thus, they can be considered as merely of a theoretical value so far as the modern machine shops are concerned. They are named so because of the very high speed at which the spindle rotates.

3. Engine Lathe:

It is probably the most widely used type of lathe. The name Engine Lathe is a little confusing in modern practice as all these lathes are now made to have an individual motor drive. However, it carries a great historical significance that in the very early days of its development it was driven by a steam engine. From this, it derived the name which is popular even today.

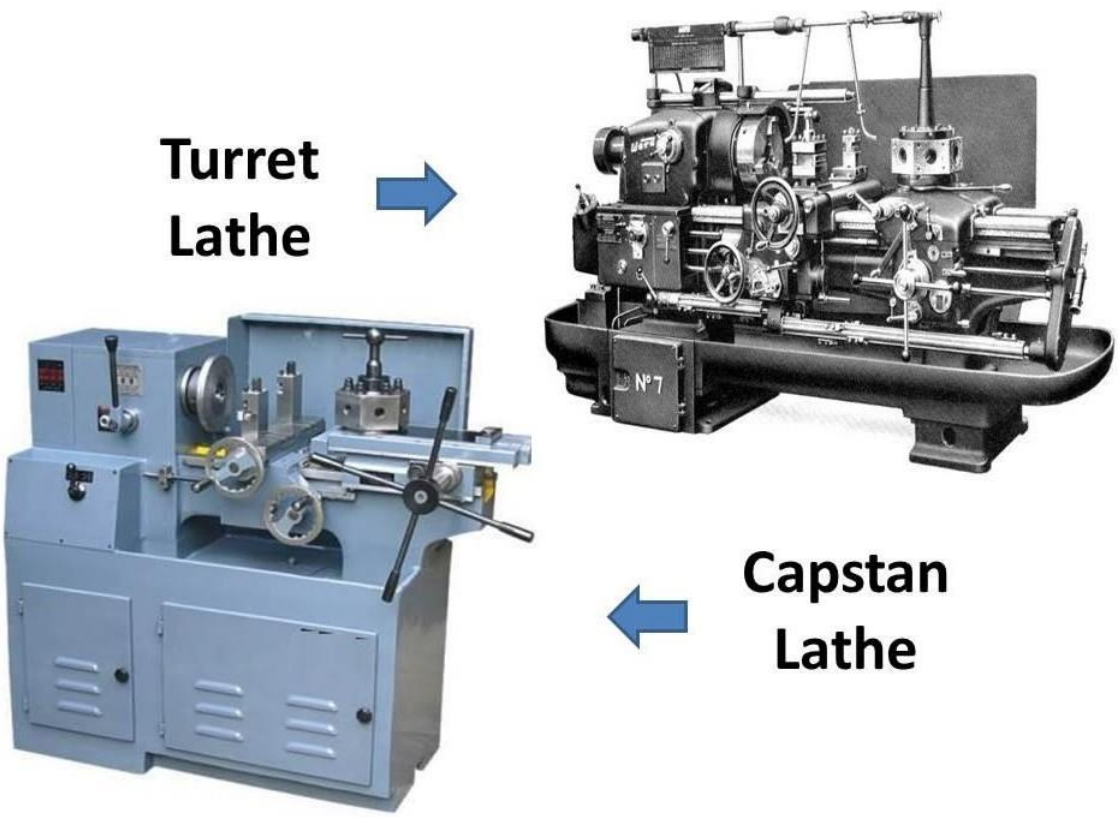
Although it practically resembles a speed lathe in most of its features, but its construction is relatively more robust. Its headstock is bigger in size and more robust, incorporating suitable mechanism for providing multiple speeds to the lathe spindle. The headstock spindle may receive power, from a lathe shaft or an individual motor, through belts. In that case, it will have a cone pulley with back gears in the headstock to provide different speeds to the spindle. It carries a combination of gears, instead of the cone pulley and back gears combination, the lathe is known as geared head lathe and the headstock as all geared head stock.

4. Tool Room Lathe:

It is nothing but the same engine lathe but equipped with some extra attachments to make it suitable for a relatively more accurate angle of speeds and feeds. The usual attachments provided on a tool room lathe are taper turning attachment, follower rest, collets, chucks, etc. This lathe is made to have a comparatively smaller bed length than the usual engine lathe. The most commonly used lengths are 135 to 180 cm.

5. Capstan and Turret Lathe:

These lathes form as very important and useful group and are vastly used in mass production. These machines are actually of semi-automatic type and a very wide range of operations can be performed on them. In operating these machines, a very wide range of operations can be performed on them.



In operating these machines, a very little skill is required of the operator. Whatever skill is needed of the operator is only in the setting of tools in the turret or capstan head, and once this setting has been successfully accomplished further operation of these machines is more or less automatic. They carry special mechanisms for indexing of their tool heads.

6. Automatic Lathe:

These lathes help a long way in enhancing the quality as well as the quantity of production. They are so designed that all the working and job handling movements of the complete manufacturing process for a job are done automatically. No participation of the operator is required during the operation. Another variety of this type of lathes includes the semi-automatic lathes, in which the mounting and removal of work is done by operator whereas all the operations are performed by the machine automatically. Automatic lathes are available having single or multi spindles. They fall in the category of heavy duty, high speed lathes mainly employed in mass production.

7. Special Purpose Lathes:

A large number of lathes are designed to suit a definite class of work and to perform certain specified operations only. They prove to be more efficient and effective as compared to the common engine lathe so far as this specified class of work is concerned. A brief description of these machines will be given in the following table.

Name of Machine	Special Description	Application
Precision Lathe	Capable of giving a dimensional accuracy of 0.002 mm.	Precision turning of previously rough-turned work piece. In many cases, replace a high class grinding machine because of its fine dimensional accuracy.
Facing Lathe	In this, the carriage is driven by a separate motor, independent of the main spindle. It carries no tailstock	Used to machine the end faces of bulky cylindrical jobs.
Frontal Lathe	In this, two carriages are provided, one on each end. Also, two tool heads are provided. This enables machining of two jobs simultaneously	Its specific use is in machining short jobs
Vertical Lathe	It carries a vertical column, on which are fitted the cross slide and vertical slide. A heavy base at the bottom carries a face plate to hold the jobs.	It is used for turning and boring very large and heavy rotating parts which cannot be otherwise supported on other types of lathes. These machines are specifically employed for jobs like heavy flywheels and large gear blanks etc.
Crankshaft Lathe	It carries all the attachments, like taper turning and threading, etc. In addition, a number of rests (supports) for the shafts.	It is used for turning very long parts such as turbine and engine shafts and crankshafts.
Production Lathe	It distinguishes itself by its bed which is made inclined towards the rear for ensuring an efficient chip removal.	Its special design makes it suitable for mass production of cylindrical parts. Its use increases the rate of production of such items. It is not very suitable for repair work.
Duplicating Lathe	It carries a special tracer attachment connected to the carriage, which moves along a template and guides the carriage.	It is used for mass production of identical parts where either a previously machined part works as a template or a separate template is prepared and used for this purpose.
Screw Cutting Lathe (automatic)	It is operated through cams and cam plates.	It is used for mass production of screwed parts. Especially suitable for precision screw work.

Table: Applications of Special Purpose Lathes

The classification of lathes cannot be confined merely to the broad outlines given above. They can be further classified according to the type of drive they possess and their sizes, etc.

According to the height of centres (Above the bed) lathes can be grouped as:

- – Small Lathes: Having height of centres up to 150 mm.
- – Medium Size Lathes: Having height of centres from 150 to 300 mm.

- – Heavy Duty Lathes: Having height of centres above 300 mm.

According to the type of drive, the lathes can be grouped as:

- Having step-cone pulley drive and the back-gears to provide various speeds to the work. This type of drive calls for the use of a countershaft which carries a similar cone pulley to that provided on the lathe spindle. This countershaft, in addition to the step pulley, carries two clutch pulleys also, which are connected to the main shaft through belts. One of these pulleys carries an open belt and the other a cross belt.

- With this arrangement of belts the machine spindle can be rotated in opposite directions according to the requirement by making use of any one of these belts at one time. With suitable combination and selection of different steps on cone pulleys and the engagement or disengagement of back gears, a fairly wide range of speeds can be obtained for lathe spindle.

- Lathes having step-cone pulley drive as usual and the back gears, but having individual motor drive, thus eliminating the use of main shaft. In such machines, the countershaft is provided within the machine and it carries a stepped cone pulley. Another pulley is provided at the end of this shaft which is connected usually by 'V' belts, to the motor pulley. In this type, the drive is conveyed from the motor to the counter shaft and then to the machine spindle. Here again the same range of speeds can be obtained with suitable combination as described above.

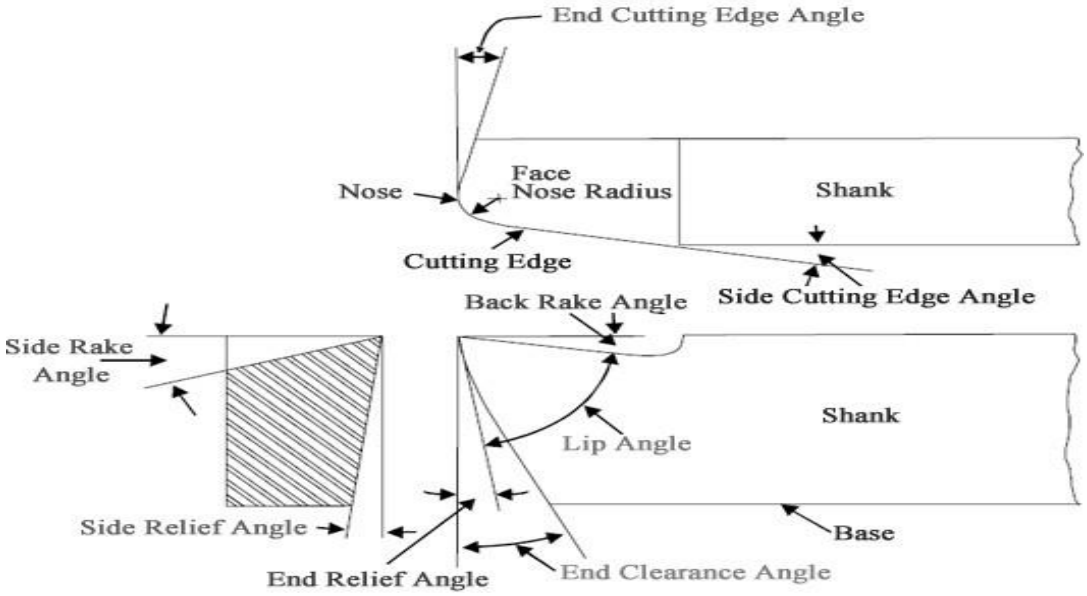
- Lathes having single pulley constant speed or geared-head drive. In this, a single pulley is driven by means of 'V' belts by the motor and then the internal mechanism of the head stock, which is designed to have various speed gears inside, enables a wide range of speeds of the spindle. The quick-change gears provide power feed to the carriage. Although, these machines can be made to receive power from main shaft through the countershaft, but the individual motor drive is the prevailing practice in modern times.

LATHE CUTTING TOOL:

Single point cutting tool consists of only one main cutting edge that can perform material removal action at a time in a single pass.

It is to be noted that in insert based cutting tools, multiple cutting edges may present in a single tool; however, only one cutting edge can engage in material removal action at a time.

SINGLE POINT CUTTING TOOLNOMENCLATURE



NOMENCLATURE OF SINGLE POINT CUTTING TOOL

Single Point Cutting Tool Types:

There are only two types of tool:

1. Single and
2. Multi-Point cutting tool.

1. Single Point cutting tool:

One cutting point or tip is available

Example: Lathe Machine, Planning Machine tool

2. Multi-Point cutting tool:

More than One cutting point or tip is available

Example: Milling cutter, Grinding wheel, drill tool, extra.

Single Point Cutting Tool Material:

This tool can be made from several materials like:

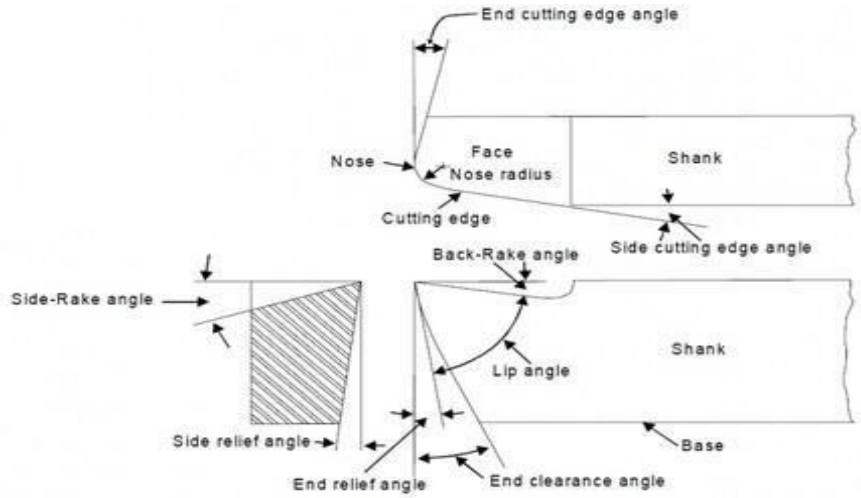
- High carbon steel
- High-speed steel
- Ceramics
- Cerements
- Diamonds
- Ucon
- Cemented carbide
- CBN (Cubic boron nitrite)

Single Point Cutting Tool Geometry / Nomenclature:

1. Shank
2. Flank
3. Face
4. Heel
5. Nose
6. Nose radius
7. Cutting Edges

Angle:

1. Side Cutting edge angle
2. End cutting edge angle
3. Side relief angle
4. End relief angle
5. Back Rack angle
6. Side rack angle



Single-point cutting tool

1. Shank:

This is the main body of the tool. The shank is used to hold the tool (i.e tool holder).

2. Flank:

The surface or surface below and adjacent to the cutting edge is called flank of the tool.

3. Face:

The surface on which the chips slide is called the face of the tool.

4. Heel:

It is the intersection of the flan and the base of the tool. It is a curved portion at the bottom of the tool.

5. Nose:

It is the point where the side cutting edge and end cutting edge intersects.

6. Noise radius:

The nose radius will provide long life and also good surface finish with it a sharp point on the nose.

7. Cutting edge:

It is the edge on the face of the tool which removes the material from the workpiece.

The tool cutting edge consists of side cutting edge (major cutting edge), end cutting edge (minor cutting edge and the nose).

Angles:

1. Side cutting edge angle:

This angle also is known as the lead angle. This is the angle between the side cutting edge and side of the tool shank.

2. End cutting edge angle:

This is the angle between the end cutting edge and a line normal to the tool shank.

3. Side relief angle:

It is the angle between the portion of the side flank immediately below the side cutting edge and a line perpendicular to the base of the tool and measured at the right angle to the end flank.

4. End relief angle:

It is the angle between the portion of the end flank immediately below the end cutting edge and a line perpendicular to the base of the tool and measured at the right angle to the end flank.

5. Back rack angle:

It is the angle between the tool face and a line parallel to the base of the tool and measured in a plane perpendicular through the side cutting edge. The back rack angle is positive if the side cutting edge slopes downwards from the point towards the shank and The back rack angle is negative if the slope is side cutting edge is reversed.

6. Side rack angle:

It is the angle between the tool face and a line parallel to the base of the tool and measured in a plane perpendicular to the base and the side cutting edge.

This angle gives the slope of the face of the tool from the cutting edge.The side rack angle is negative if the slope is toward the cutting edge. And the side rack angle is positive if the slope is away from the cutting edge.

Single Point Cutting Tool Advantages:

1. Design and fabrication are easy.
2. This tool is a little cheaper in price.

Single Point Cutting Tool Disadvantages:

1. There is having little high tool wear rate.
2. Shorter tool life.
3. Low metal removal rate.
4. Low productive.

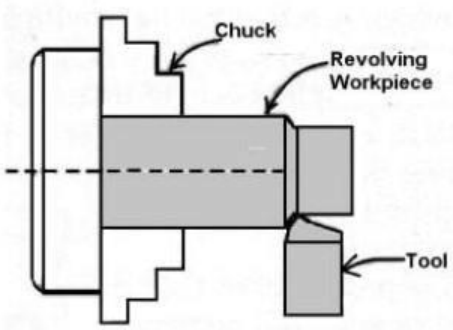
Single Point Cutting Tool Application:

This tool is used in several machines for producing a flat surface like:

- Lathe machine
- Shaper Machine and more

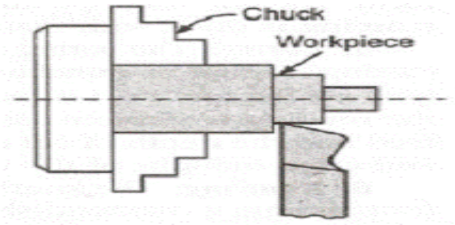
LATHEMACHINEOPERATIONS:

1. **Turning:** The removal of excess material along the work piece by cutting tool is known as turning. The various turning operations are straight turning, step turning, taper turning.

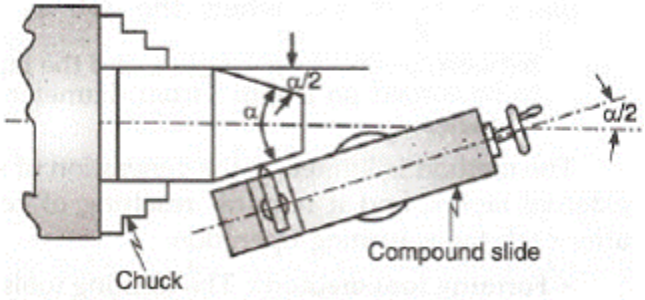


Turning Operation

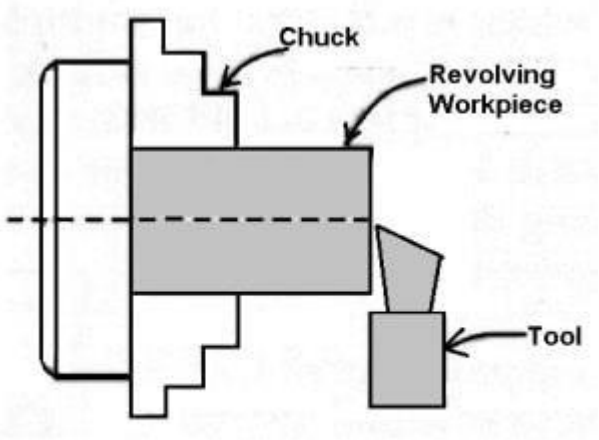
2. **Step turning:** Step turning is an operation performed on lathe machine where the excess material is removed from the work piece to obtain various steps of different diameters.



3. **Taper turning:** Taper turning as a machining operation is the gradual reduction in diameter from one part of a cylindrical work piece to another part.

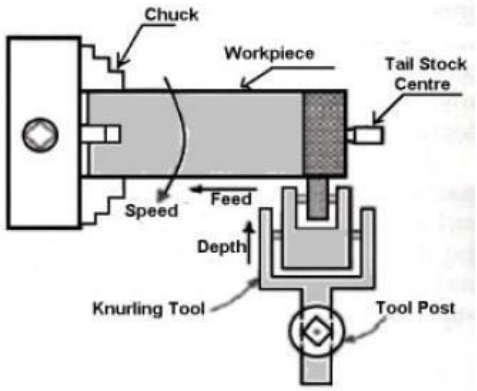


4. **Facing:** The removal of material from the end of the work piece by cutting tool to produce a flat surface is known as facing.



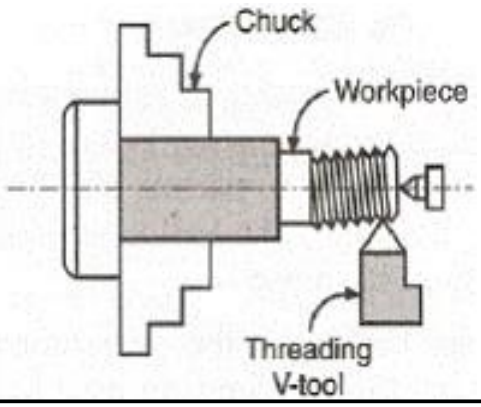
Facing Operation

5. **Knurling**: Knurling is a manufacturing process, typically conducted on a lathe, whereby a pattern of straight, angled or crossed lines is rolled into the material. It is the process of making grip surface on the work piece. It is done by using knurling tool.



Knurling

6. **Threading:** Threading on the lathe is a process that produces a helical ridge of uniform section on the work piece. This is performed by taking successive cuts with a threading tool bit the same shape as the thread form required.



CNC Lathe Machine

1.7.1 Introduction:

NC is control by numbers. NC is control by recorded information called part program, which is a set of coded instructions given as numbers for automatic control of machine in a pre-determined sequence.

Rapid development in the field of Electronics, such as Integrated Circuits, and development of minicomputers lead to the development of mini-computer based CNCsystems.Further,developmentsandtheelectronics"Chip"revolutionhaveusheredinthecurrent generation "compact and power full" microprocessor based CNC systems.

A form of NC was used in the early days of the industrial revolution, asearlyas1725,when knitting machines in England used punched cards to form various pattern in cloth. In olden days, rotating drums with prepositioned pins were used to control the chimes in European Cathedrals and some American churches, were considered to be the first application of NC principle.

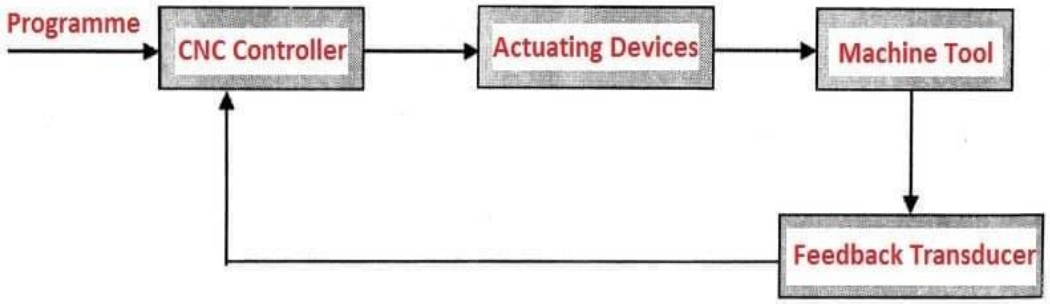
Numeric control (NC) was developedinearly1950'stomeetthecritical requirements of aerospace industry. Many components used in aircraft and space vehicles (rockets, satellites etc) have complicated features. In order to do machining these components with conventional machine tools, positioning movements of the machine tool slides. Manual operation under these circumstances is not only tedious due to machining errors. So numerical control was developed for automation of machine tools. Automation of machine tools means controlling the machine tool without an operator's assistance. As a part of the automation the information required to activate and control slides was coded numerically, this technology came to be known as numerical control.

The numerical controls the operation of machine tool or a process by a series of coded instructions comprising of numbers, letters and other symbols to carry out specific task. Number, letters of the alphabet and symbols which the machine control unit (MCU) can be understand. These instructions are converted into electrical pulses of current, which the machine's motors and controls follow to carry out machining operations

The numbers, letter and symbols are coded instructions which refer to specific distances, positions, functions or motions which the machine tool can understand as it machines the workpiece.

CNC CONCEPT:

A CNC system can be described in terms of three major elements:



Concept of CNC

1. Hardware,
2. Software and
3. Information.

1. Hardware:

A Hardware includes microprocessors that affect control system functions and peripheral devices for data communication, machine tool status monitoring and machine tool interfacing.

2. Software:

The software includes programs that are performed by system microprocessors and there are different types of software associated with CNC.

3. Information:

Information about the dynamic characteristics of the machine and many other information related to the process. When any of these deceptive components fail, the diagnostics subsystem will automatically separate the faulty component from the system and activate the unnecessary component in place of the damaged one so that the newly installed component can perform its task.

Features of CNC machines

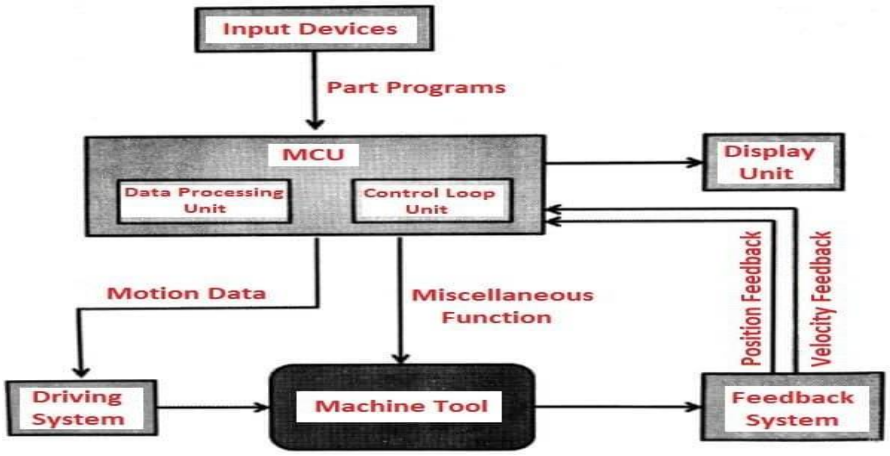
The feature of CNC machines are as follows:

- Part program input may be through the keyboard.
- The part program is entered into the computer and stored in the memory. Then it is used again and again.

- The entered part program can be edited for any errors or design changes.
- A graphical display of the cutter path and shape of the finished work is possible before actually running the program (simulation).
- Tool wear compensation is possible.
- Able to get machine utilization information's like the number of components produced, time per component, time for setting the job etc.,
- The sub-program facility is also possible for repetitive machining sequences.

Basic Elements of the CNC Machine

The main parts of the CNC machine are:



Basic Elements of CNC Machine

1. Input devices
2. Machine control unit (MCU)
3. Machine tool
4. Driving system
5. Feedback system
6. Display unit

1. Input Devices:

These are devices that are used to input the part program into a CNC machine. There are three generally used input devices and these are punch tape reader, magnetic tape reader and computer via RS-232-C communication.

2. Machine Control Unit (MCU):

Machine control unit called the heart of the CNC machine. It performs all the control functions of the CNC machine, there are various tasks performed by MCU are

- It reads the coded instructions given in it.
- Machine control unit decodes the coded instruction.
- This axis implements interpolation (linear, circular and helical) to generate motion commands.
- Machine control unit feeds the axis motion command to the amplifier circuit to drive the axis mechanism.
- It takes a feedback signal of position and speed for each drive axis.
- It implements the auxiliary control functions such as coolant or spindle on/off and tool change.

3. Machine Tool:

A CNC machine tool always has a sliding table and a spindle to control the position and speed. The table of the machine is controlled in the X and Y-axis direction and the spindle is controlled in the Z-axis direction.

4. Driving System:

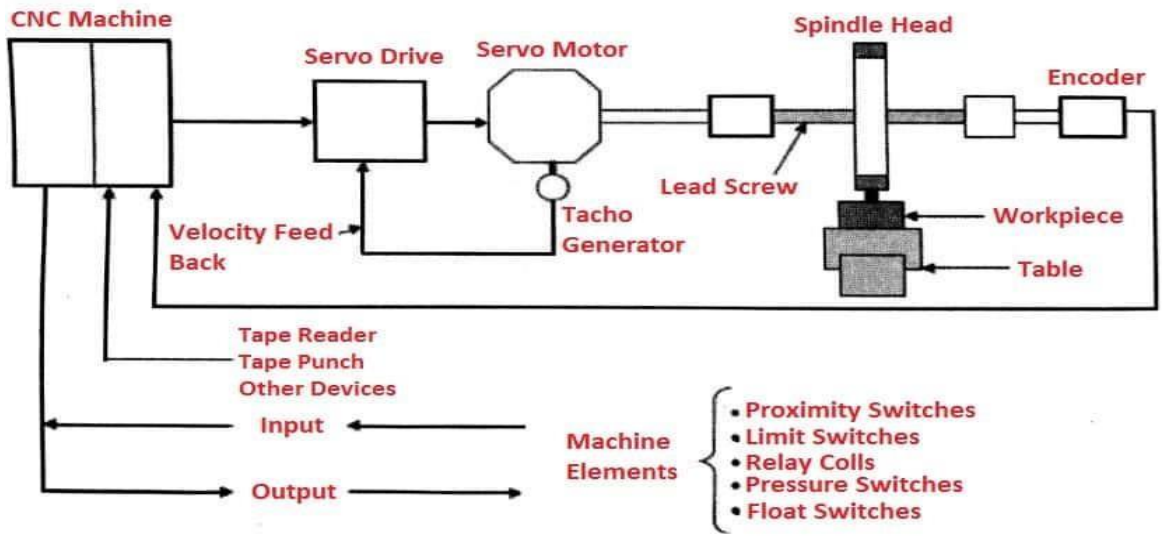
The driving system of a CNC machine include of an amplifier circuit, drive motors and ball lead screws. The MCU supplies the signals (ie, of position and speed) of each axis to the amplifier circuits. The control signals are then augmented (increased) to actuate the drive motors. And the actuated drive motors rotate the ball lead screw to put in a position the machine table.

5. Feedback System:

The feedback system has the transducers that act as sensors. It is also called a measuring system. It consists of position and speed transducers that continuously monitor the position and speed of the cutting tool located at any given moment.
The MCU receives signals from transducers and it uses the difference in reference signals and feedback signals to generate control signals to correct position and speed errors.

6. Display Unit:
The monitor is employed to display programs, commands and other useful data of the CNC machine.

How CNC Machine Works
The figure shows the **CNC machine working**:



CNC Machine Tool

- First, the part program is entered into the MCU of the CNC.
- The MCU processes all the data and according to the program prepared, it prepares all the motion commands and gives it to the driving system.
- The drive system acts as motion commands sent by the MCU. The drive system manages the motion and velocity of the machine tool.
- The feedback system records the position and velocity measurements of the machine tool and gives a feedback signal to the MCU.
- In the MCU, the feedback signals are compared with reference signals and if errors occur, it corrects it and sends new signals to the machine tool to be corrected.
- The display unit is used to see all the programs, commands and other data. It works like the eye of the machine.

WORKING PRINCIPLE OF CNC MACHINE

It consists of two separate controls, a CNC controller that doses the function of program decoding interpolation, diagnostics machine actuation, etc. Another is the programmable logic controller (PLC), which dose spindle on-off, coolant on-off, turret operation etc.

Slides are transferred via their own feed drive (AC or DC) servomotors or ball screws and nut drives. The feed drive controllers the feed drive motors. Suitable transducers have been fitted to either the table or the motor, which measures the slide position.

Also, the position is monitored and checked through the feedback transducers to ensure the accuracy of positioning. The spindle is provided with stepped motors of AC or DC. A suitable control is used to vary is the speed of the spindle motor. A suitable feedback device connected to the shaft monitors the speed. This is how the **CNC machine works.**

G Code & M- codes:

PreparatoryfunctionsarecalledG–Codes.

S.No.	Code	Functions
1	G00	Rapid travelers or positioning.
2	G01	Linear interpolation (Cutting feed).
3	G02	Circular interpolation(Clock wise direction).
4	G03	Circular interpolation (Anti clock wise direction).
5	G04	Dwell.
6	G05	Hold /delay.
7	G 07.1 / G107	Cylindrical interpolation.
8	G10	Programmable at a input.
9	G11	Programmable at a input cancel.
10	G 12.1 / G112	Polar coordinate Interpolation mode.
11	G 13.1 /G113	Polar coordinate interpolation cancel mode.
12	G17	XY plane selection.
13	G18	ZXplaneselection.
14	G19	YZplaneselection.
15	G20	Input in“Inch”.
16	G21	Input in“mm”.
17	G22	Stored stroke check function **on**.
18	G23	Stored stroke check function **off**.
19	G25	Spindle speed function detection **off**.
20	G26	Spindle speed function detection **n**.

21	G27	Reference position return check.
22	G28	Return to reference position.
23	G30	2^{nd}, 3^{rd} and 4^{th} reference position return.
24	G31	Skip function.
25	G33	Thread cutting.
26	G34	Variable lead thread cutting.
27	G36	Automatic tool compensation X.
28	G37	Automatic tool compensation Z.
29	G40	Tool nose radius compensation cancel.
30	G41	Tool nose radius compensation left.
31	G42	Tool nose radius compensation right.
32	G 50.2 / G250	Polygonalturningcancel.
33	G 51.2 / G251	Polygonal turning.
34	G52	Loci coordinate system setting.
35	G53	Machine coordinate system setting wont piece coordinate system selection.
36	G54	Workpiececoordinatesystem1–selection.
37	G55	Workpiececoordinatesystem2–selection.
38	G56	Workpiececoordinatesystem3–selection.
39	G57	Workpiececoordinatesystem4–selection.
40	G58	Workpiececoordinatesystem5–selection.
41	G59	Workpiececoordinatesystem6–selection.
42	G63	Thread cutting cycle.
43	G65	Macro calling.

44	G66	Macro model call.
45	G67	Macro model cancel.
46	G70	Finishing cycle.
47	G71	Stock removal in turning.
48	G72	Stock removal in facing.
49	G73	Pattern repeating.
50	G74	End face peck drilling.
51	G75	Outer diameter /Internal diameter drilling.
52	G76	Multiple threading cycle.
53	G77	Outer diameter / Internal diameter cutting cycle.
54	G79	End face turning cycle.
55	G80	Canned cycle for drilling cancel.
56	G83	Cycle for face drilling.
57	G84	Cycle for face tapping.
58	G86	Cycle for face boring.
59	G87	Cycle for side drilling.
60	G88	Cycle for side tapping.
61	G89	Cycle for side boring.
62	G90	Absolute programming.
63	G91	Incremental programming.
64	G92	Zero preset.
65	G94	Speed per minute feed.
66	G95	Feed per revolution feed.

67	G96	Constant surface speed command.
68	G97	Spindle surface command.
69	G98	Return to initial level.
70	G99	Return to point level.

MiscellaneousfunctionsarecalledM–Codes

S.No.	**Code**	**Function**
1	M00	Program stop.
2	M01	Optional stop.
3	M02	End of program.
4	M03	Spindle start (Clock wise direction).
5	M04	Spindle start (Anti clock wise direction).
6	M05	Spindle stop.
7	M06	Tool change.
8	M08	Cool ant **on**.
9	M09	Cool ant **off**.
10	M10	Job clamp.
11	M11	Jo bun clamp.
12	M13	Tool drive forward.
13	M14	Tool drive reverse.
14	M15	Tool drive **off**.
15	M16	Spindle brake **on**.
16	M17	Spindle brake **off**.
17	M20	Tail stock forward.

18	M21	Tail stock retract.
19	M22	C – axis **on**.
20	M23	C – axis **off**.
21	M26	Tool driven gage.
22	M27	Tool drive disengage.
23	M30	End of the program with rewind.
24	M98	Calling of subprogram.
25	M99	End of subprogram.

PART PROGRAMMING AND CNC MANUAL OPERATIONS, CNC OFFSETS AND ENTERING OFFSETS :

The part program is a sequence of instructions, which describe the work, which has to be done on a part, in the form required by a computer under the control of computer numerical control (CNC) software. It is the task of preparing a program sheet from a drawing sheet. All data is fed into the CNC system using a standardized format. Programming is where all the machining data are compiled and where the data are translated into a language which can be understood by the control system of the machine tool.

The machining data is as follows :

1. Machining sequence classification of process, tool start up point, cutting depth, tool path, etc.
2. Cutting conditions, spindle speed, feed rate, coolant, etc.
3. Selection of cutting tools.

ADVANTAGES AND DISADVANTAGES OF CNCTECHNOLOGY

Most of the advantages derived from CNC technology are because of high level of automation and high flexibility of CNC machines and the inability to combine multi-function machining requirements in minimum number of work stations and set-ups.

ADVANTAGES:

1. High accuracy and repeatability.
2. Reduced inspection.
3. Ease of assembly and interchange ability.
4. Lose scrap and rework.

5. Space savings.
6. Less material handling.
7. Less paperwork.
8. Less lead time.
9. Less inventory cost.
10. High flexibility for design changes.
11. Design freedom for complex shapes and contours.
12. Reduced tooling.
13. Ownership of skill.
14. Better machine utilization.
15. Better production management and overall management and control.
16. Ability for higher level-of integration, such as;
    (a) Distributed Numerical Control(DNC)
    (b) Flexible Manufacturing System(FIV1S)
    (c) Adaptive Control(AC)
    (d) Computer Aided Design(CAD)
    (e) Computer Aided Manufacture(CAM)
    (f) Computer Integrated Manufacture (CIM)etc.

6.2 DISADVANTAGES:

As with every system, the CNC systems too have certain disadvantages as below:

1. Higher Investment cost
2. Higher Maintenance Cost
3. Costlier CNC Personnel
4. Planned Support Facility

APPLICATIONS OF CNC MACHINES:

Almost every manufacturing industry uses CNC machines. With an increase in the competitive environment and demands, the demand for CNC usage has increased to a greater extent. The machine tools that come with the CNC are late, mills shaper welding etc.

The industries which are using CNC machines are the automotive industry, metal removal industry, fabricating metals industry, electrical discharge machining industry, wood industry etc.

The following parts are normally done in practice on CNC machines

1. Aerospace equipment.
2. Automobile parts.
3. Complex shapes.
4. Electronic industry uses CNC e.g. Printed circuit board.
5. Electrical industry uses CNC e.g. Coil winding.
6. For small to medium batch quantity.
7. Where the set-ups are very large.
8. It used where tool storage is a problem.
9. Where much metal needs to be removed.
10. When the part geometry is so complex.
11. The operations are very complex.
12. For parts subjected to regularly design changes.
13. When the inspection is required 100%.
14. It used when the lead time does not permit the conventional tooling manufacture.
15. When the machining time is very less as compared to down.
16. Where tool storage is a problem.
17. Where repetitive operations are required on the work

Comparison between CNC & conventional machines

S. No.	CNC Machine	Conventional Machine
1.	Uses re circulating ball screws whose efficiency more than 90% efficiency frictional resistance is very less.	Uses Lead screw which has high frictional resistance and low.
2.	Uses infinitely variable speed with drives fixed ratios with induction motor.	Uses multistage gearboxes.
3.	Eliminatesskillofoperatorandenablest oproduceanycomplicatedcontour.	Skilled operator is highly essential.

4.	Enables to have literature like pitch can not be compensated error. Backlash compensation, Tool offsets, automatic coordinate system tool life management etc.	Machining and machine errors.
5.	Multitasking facilities like available back ground editing, auto tool changing etc.	Multitasking facilities are not available.
6.	Troubleshootingiscomplicatedcomparativelybutitismadeasierbypowerfuldiagnosticfeatures.	Trouble shooting is easy.

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Short answer questions

1. Write the parts of Lathe Machine.
2. Write the types of Lathe Machine.
3. Write the types of Lathe cutting tools.
4. Write the features of CNC Machining.
5. Write the advantages of CNC technology.
6. Write the applications of CNC machines.

Long answer questions

1. Draw the sketch of Lathe and explain its parts.
2. Explain the Lathe machine operations.
3. Explain concept of CNC Lathe machine.
4. Write the working of CNC machine.
5. Write the comparison between CNC and conventional machines.

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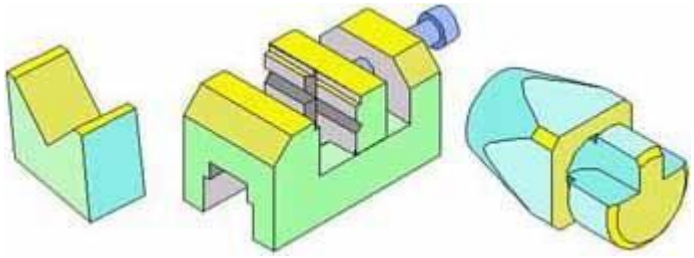
2. Milling Machine

2.1 Introduction:

Milling machine is one of the most versatile conventional machine tools with a wide range of metal cutting capability. Many complicated operations such as indexing, gang milling, and straddle milling etc. can be carried out on a milling machine.

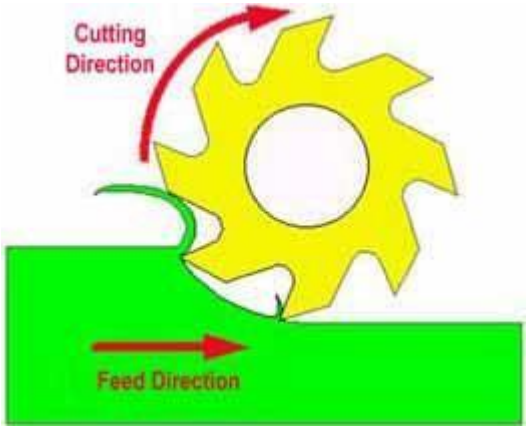


This training module is intended to give you a good appreciation on the type of milling machines and the various types of milling processes. Emphasis is placed on its industrial applications, operations, and the selection of appropriate cutting tools.

Working principle:

(a) Milling Processes:

Milling is a metal removal process by means of using a rotating cutter having one or more cutting teeth as illustrated in figure.



Cutting action is carried out by feeding the work piece against the rotating cutter. Thus, the spindle speed, the table feed, the depth of cut, and the rotating direction of the cutter become the main parameters of the process. Good results can only be achieved with a well balanced settings of these parameters.

Spindle Speed:

Spindle speed in revolution per minute (R.P.M.) for the cutter can be calculated from the equation :-

$$N = \frac{CS \times 1000}{\pi d}$$

where --

N = R.P.M. of the cutter

CS = Linear Cutting Speed of the material in m/min. (see table)

d = Diameter of cutter in mm

Feed Rate:

Feed rate (F) is defined as the rate of travel of the work piece in mm/min. But most tool suppliers recommend it as the movement per tooth of the cutter (f). Thus

$$F = f . u . N$$

Where: **F** = table feed in mm/min]

f = movement per tooth of cutter in mm (see table)

u = number of teeth of cutter

N = R.P.M. of the cutter

Where:

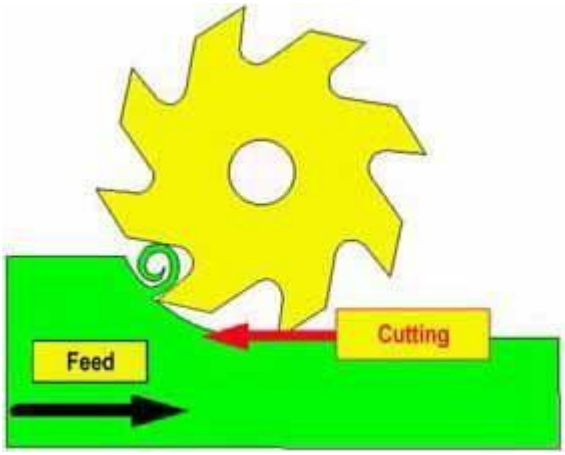
C.S. and feed rate for some common material:-

C.S. and feed rate for some common material :- **Tool Material**	**High Speed Steel**		**Carbide**	
Material	Cutting Speed	Feed (f)	Cutting Speed	Feed (f)
Mild Steel	25	0.08	100	0.15
Aluminium	100	0.15	500	0.3
Hardened Steel	---	---	50	0.1

Depth of Cut: Depth of cut is directly related to the efficiency of the cutting process. The deeper the cut the faster will be the production rate. Yet, it still depends on the strength of the cutter and the material to be cut. For a certain type of cutter, a typical range of cut will be recommended by the supplier. Nevertheless, it should be noted that a finer cut is usually associated with a better surface finish as well as a long tool life.

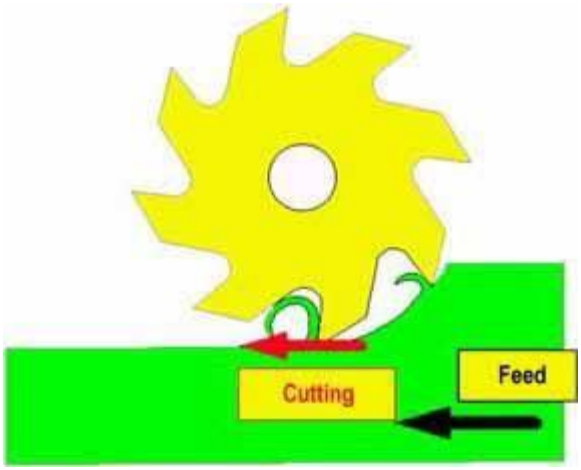
(b) Direction of Cutter Rotation:

Up Cut Milling: In up cut milling, the cutter rotates in a direction opposite to the table feed as illustrated in figure. It is conventionally used in most milling operations because the backlash between the lead screw and the nut of the machine table can be eliminated.



Down Cut Milling:

In down cut milling, the cutter rotates in the same direction as the table feed as illustrated in figure. This method is also known as Climb Milling and can only be used on machines equipped with a backlash eliminator or on a CNC milling machine. This method, when properly treated, will require less power in feeding the table and give a better surface finish on the work piece.



2.3 Parts of milling machine:

Milling machine which is used to remove metals from the work piece with the help of a revolving cutter called milling cutter.

It is used to machined the flat, rough and irregular surfaces and this is done by feeding the work piece against a rotating milling cutter.

Main Parts of Milling Machine: The milling machine main parts are

1. Column & Base: Column including base is the main casting that supports all other parts of milling machine. The column contains an oil reservoir and a pump which lubricates the spindle.

- The column rests on the base and base contains coolant reservoir and a pump which is used during machining operation that requires coolant.

2. Knee: It is a casting that supports the saddle and table. All gearing mechanism is enclosed within the knee.

- It is fastened to the column by dovetail ways.
- The knee is supported and adjusted by a vertical positioning screw (elevating screw).
- The elevating screw is used to adjust the knee up and down by raising or lowering the lever either with the help of hand or power feed.

3. Saddle and Swivel Table: Saddle is present on the knee and supports the table. It slides on a horizontal dovetail on the knee and dovetail is parallel to the axis of the spindle.

- The swivel table (in universal machines only) is attached to the saddle that can be swiveled (revolved) horizontally in either direction.

4. Power Feed Mechanism: It is the knee which contains the power feed mechanism. It is used to control the longitudinal (left and right), transverse (in and out) and vertical feeds.

- To get the desired rate of feed on the machine, the feed selection lever is positioned as indicated on the feed selection plates.
- On some universal knee and column milling machine, the feed is obtained by turning the speed selection handle until the desired rate of feed is indicated on the feed dial.
- Most of the milling machines have a rapid traverse lever that can be engaged when a temporary increase in the speed of the longitudinal, transverse or vertical feeds is required. For example this lever would be engaged when the operator is positioning or aligning the work.

5. **Table**: It is a rectangular casting which is present on the top of the saddle. It is used to hold the work or work holding devices.

- It contains several T-slots for holding the work and work holding devices (i.e. jigs and fixtures).
- The table can be operated by hand or by power. To move the table by hand, engage and turn the longitudinal hand crank. To move it through power, engage the longitudinal direction feed control lever.

6. Spindle: It is the shaft which is used to hold and drives the cutting tools of the milling machine.

- Spindle is mounted on the bearings and supported by the column.
- Spindle is driven by the electric motor through gear trains. The gear trains are present within the column.
- The face of the spindle which lies near to the table has an internal taper machined on it. The internal taper at the front face of the spindle permits only tapered cutter holder or arbor. It has two keys at the front face which provides positive drive for the cutter holder or arbor.
- The draw bolt and jamnut is used to secure the holder and arbor in the spindle.

7. Over Arm / Overhanging Arm: It is a horizontal beam present at the top face of the column. It may be a single casting which slides on the dovetail ways present on the top face of the column.

- The over arm is used to fastened arbor support. It may consist of one or two cylindrical bars which slide through the holes in the column.

8. Arbor Support: It is a casting with bearing that supports the outer end of the arbor. It also helps in aligning the outer end of the arbor with the spindle.

- It prevents the springing of outer end of the arbor during cutting operations.
- There are generally two types of arbor supports used in the milling machine. The first one has small diameter bearing hole, 1-inch in maximum diameter. And the other one has large diameter bearing hole, usually up to 23/4 inches.
- The arbor support has an oil reservoir that lubricates the bearing surfaces. It can be clamped anywhere on the over arm. The arbor support is used only in the horizontal types of milling machine.

9. Ram: The overhanging arm in the vertical machine is called ram. One end of the ram is mounted on the top of the column and on the other end milling head is attached.

- The ram can be a moved transversally (in and out) on the column by a hand lever.

2.4. Types of milling machine

Most of the milling machine are constructed of ¡¥column and knee¡¦ structure and they are classified into two main types namely Horizontal Milling Machine and Vertical Milling Machine. The name Horizontal or Vertical is given to the machine by virtue of its spindle axis. Horizontal machines can be further classified into Plain Horizontal and Universal Milling Machine. The main difference between the two is that the table of an Universal Milling Machine can be set at an angle for helical milling while the table of a Plain Horizontal Milling Machine is not.

Horizontal Milling Machine:

Figure shows the main features of a Plain Horizontal Milling Machine.

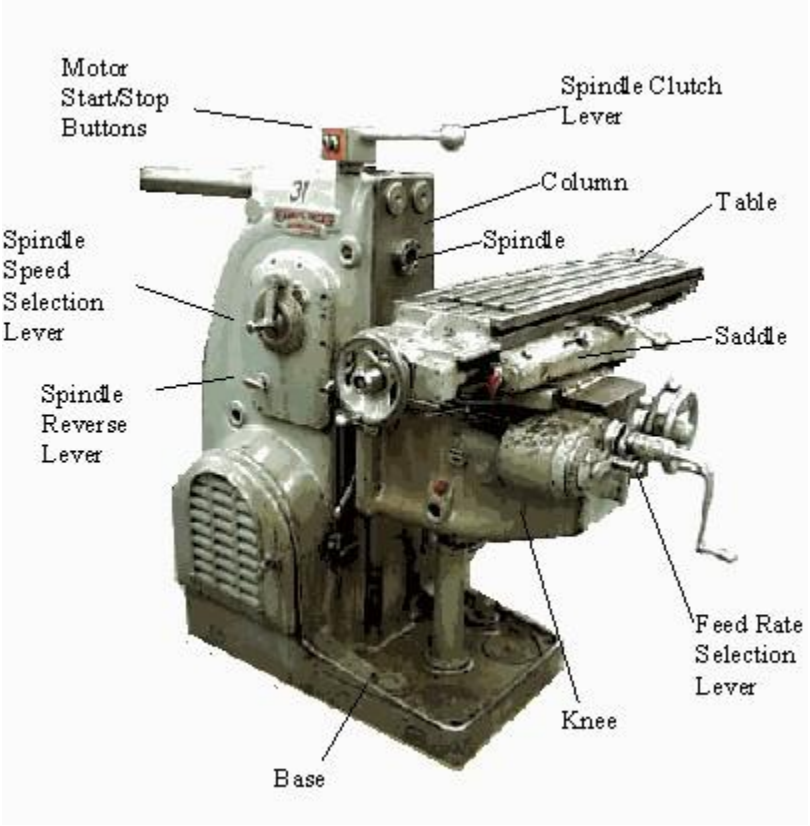
Their functions are: - 3

a. Column: The column houses the spindle, the bearings, the gear box, the clutches, the shafts, the pumps, and the shifting mechanisms for transmitting power from the electric motor to the spindle at a selected speed.

b. Knee: The knee mounted in front of the column is for supporting the table and to provide an up or down motion along the Z axis.

c. Saddle: The saddle consists of two slide ways, one on the top and one at the bottom located at 90º to each other, for providing motions in the X or Y axes by means of lead screws.

d. Table: The table is mounted on top of the saddle and can be moved along the X axis. On top of the table are some T-slots for the mounting of work piece or clamping fixtures.



e. Arbor: The arbor is an extension of the spindle for mounting cutters. Usually, the thread end of an arbor is of left hand helix.

f. Base: The base of the milling machine, along with the column, is the major structural components. They hold, align, and support the rest of the machine.

g. Spindle: The spindle holds the tool and provides the actual tool rotation.

h. Spindle Reverse Lever: The position of this lever determines the spindle direction. The three positions of the handle are; In, Middle, and Out. The middle position is the neutral position. Never move the spindle reverse lever when the spindle is turning.

i. Spindle Speed Selection Lever: The spindle speed selection lever is used to change the spindle R.P.M. setting. This type of machine has a geared head so the spindle speed can only be changed when the spindle is stopped.

j. Spindle Clutch Lever: The spindle clutch lever engages the spindle clutch to the motor. By manipulating the spindle clutch lever the operator can start and stop the spindle.

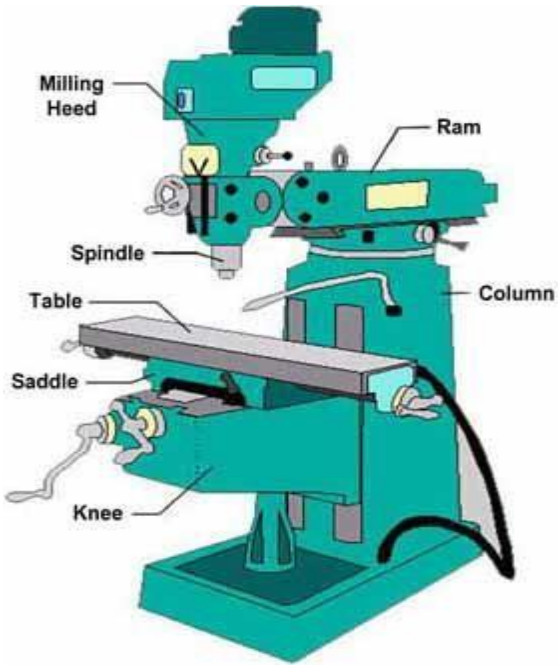
k. Feed Rate Selection Lever: The feed rate selection lever is used to change the feed rate setting. The feed rate settings are expressed in inches per minute.

m. Motor Start and Stop Buttons: The motor start and stop buttons control the power to the main motor for the machine

Vertical Milling Machine:

Figure shows a vertical milling machine which is of similar construction to a horizontal milling machine except that the spindle is mounted in the vertical position.

a. Milling head: The milling head consisting the spindle, the motor, and the feed control unit is mounted on a swivel base such that it can be set at any angle to the table.



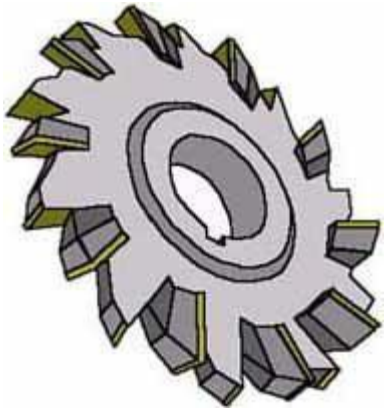
Vertical Milling Machine

b. Ram: The ram on which the milling head is attached can be positioned forward and backward along the slide way on the top of the column.

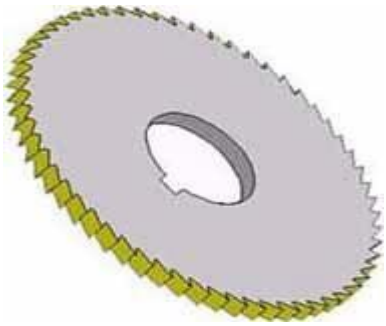
Cutting Tools:

Slab Mills: For heavy cutting of large and flat surfaces.

Side and Face Cutters: This type of cutters has cutting edges on the periphery and sides of the teeth for cutting shoulders and slots.

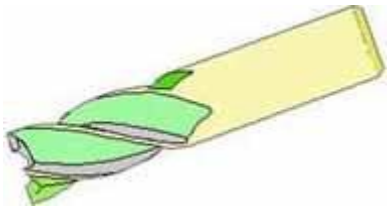


Slitting Saws: For cutting deep slots or for parting off.

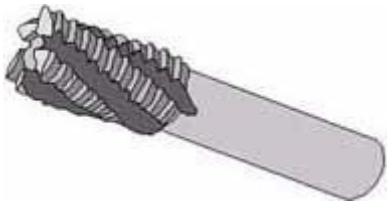


Cutting tools for Vertical Milling:

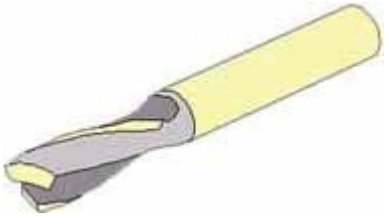
End Mills Commonly used for facing, slotting and profile milling.



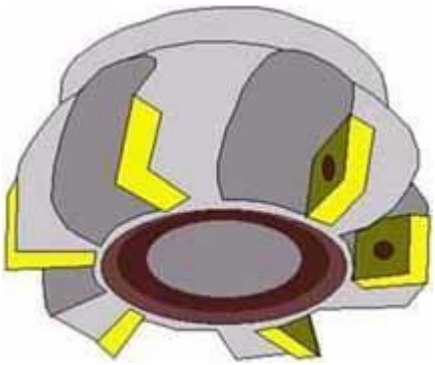
Rough Cut End Mills For rapid metal removal.



Slot Drills For producing pockets without drilling a hole before hand.



Face Milling Cutters For heavy cutting.



Involute gear cutter

The image shows a Number 4 cutter from an in volute gear cutting set. There are 7 cutters (excluding the rare half sizes) that will cut gears from 12 teeth through to a rack (infinite diameter).

- 10 DP (diametrical pitch) cutter
- That it is No. 4 in the set
- that it cuts gears from 26 through to 34 teeth
- It has a 14.5 degree pressure angle

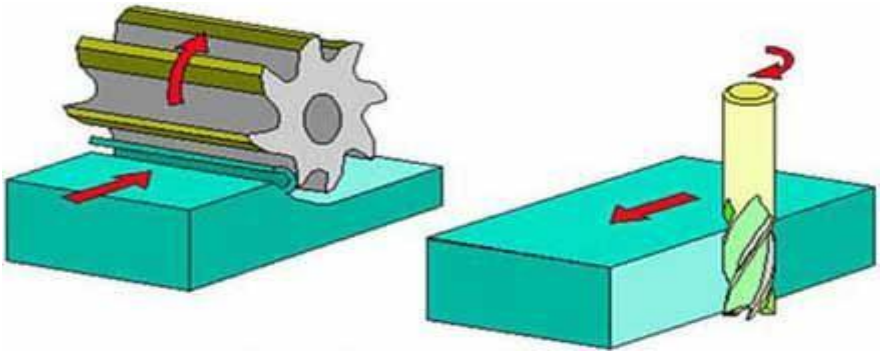
Hobbing Cutter

These cutters are a type of form tool and are used in hobbing machines to generate gears. A cross section of the cutters tooth will generate the required shape on the work piece, once set to the appropriate conditions (blank size). A hobbing machine is a specialized milling machine.

Operations on Milling Machine

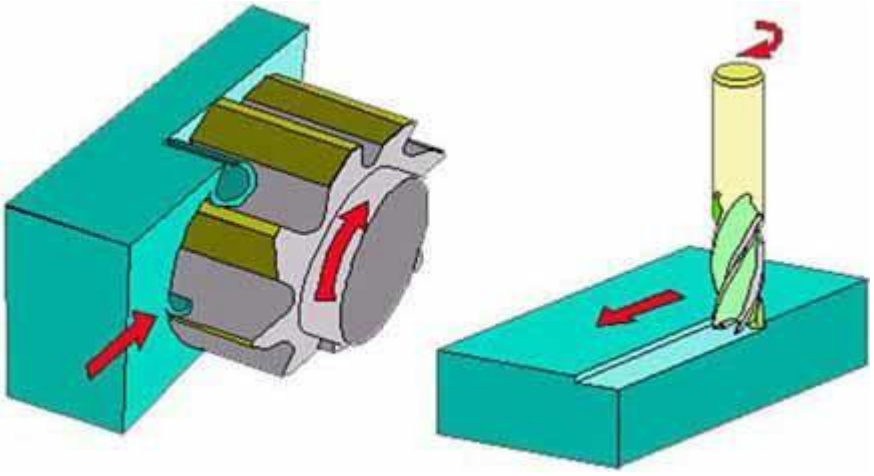
Plain Milling

Plain milling is the milling of a flat surface with the axis of the cutter parallel to the machining surface. It can be carried out either on a horizontal machine or a vertical machine



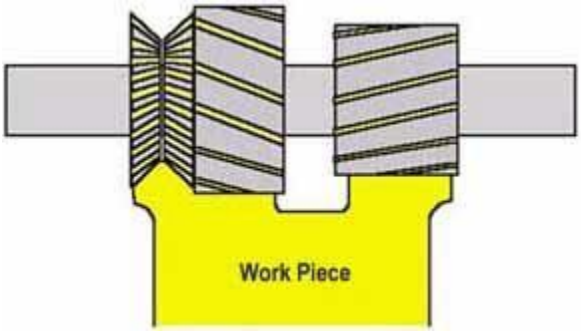
End Milling:

End Milling is the milling of a flat surface with the axis of the cutter perpendicular to the machining surface



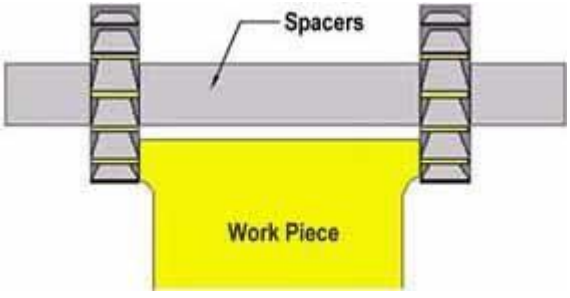
Gang Milling:

Gang milling is a horizontal milling operation that utilizes three or more milling cutters grouped together for the milling of a complex surface in one pass. Different type and size of cutters should be selected for achieving the desire profile on the work piece.



Straddle Milling

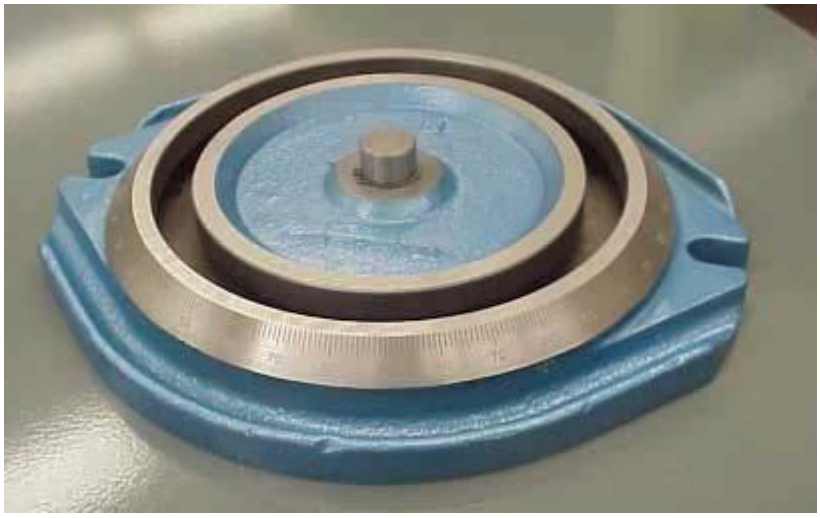
In straddle milling, a group of spacers is mounted in between two side and face milling cutters on the spindle arbor as shown in figure. For the milling of two surfaces parallel to each other at a given distance.



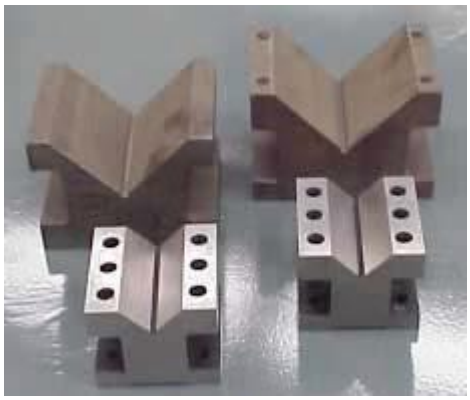
Milling machine vices

The milling machine vise is the most common type of work holding devise used on the milling machine

The plain milling machine vise is used for holding work which has parallel sides. The vise is bolted directly to the table using the T-slots in the machine table. The plain vise can be accompanied by a swivel base



V – Blocks: V-Blocks hold and support round work for milling or drilling. V-Blocks come in many different sizes. On milling machines, V-Blocks are typically clamped directly.



Angel plates: An angle plate is an L shaped piece of Cast Iron or Steel that has tapped holes or slots to facilitate the clamping of the work piece. Angle plates are used when parts need to have machining operations performed at a 90 degree angle to the axis.

CNC Milling and main components:

Frame: Frame lies above the ground or foundation of CNC milling machine. It works as a support and

also damper for the machine vibration. The material of the frame may be Cast Iron or granite filled welded structure. Barely steel is not used generally as a milling machine frame because it has some spring properties and very less dampening ability. Though steel is very stiff, Cast Iron is a better choice. Another innovative idea is using epoxy resins with different sizes of stones in a welded steel container. Epoxy granite mixture is a good damper and when it is confined in a steel container the strength is also improved. At times aluminium is also used in the mixture. There are arrangements for putting foundation bolts on the frame so that it is rigidly connected to the ground.

Axes: CNC milling machine axes are connected to the frame for providing motion to each direction. As the machine is computer controlled it is done by the program. It can also be done manually. A common CNC is called 3 axis CNC. and can move in 3 directions. The components attached to a CNC axis include motor, different types of ways, table, limit switches and lead screw. Generally, the axes move in X, Y and Z directions but sometimes optional 4th Axis is necessary and it is kept in the list of accessory. 5 axes millings are also seen but not very common. The motor provides the motion to the table and the ways provide smooth sliding motion. Dovetail ways and linear ways are frequently used in the axes assembly. Lead screw provides the linear motion while it is extracting the rotary motion of the motor.

Spindle: The spindle is the rotating tool holder. The tools are installed in the tapered part of the spindle. The spindle has different RPMs. From the main transmission speed, the spindle speed may vary. The spindle speed is set up according to the properties of the material needed to be machined. Mainly three different types of spindles are seen. These are cartridge spindles, self-contained spindles, and fabricated spindle.

CNC Controller: The CNC controller in a CNC milling machine gives signals to the motor of the machine to move in CNC axes. It is the electronic control that works as the brain of the machine. This electrical and electronics equipment executes the code given as the input.

Table: The table is placed on the top of the saddle. It holds the jobs and also the job holding devices. A number of T slots are there for holding the work piece and jigs and fixtures. In CNC milling operation the table is moved by the motor which gets signals from the program codes.

Importance of CNC milling

CNC milling, or computer numerical control milling, is a machining process which employs computerized controls and rotating multi-point cutting tools to progressively remove material from the work piece and produce a custom-designed part or product. This process is suitable for machining a wide range of materials, such as metal, plastic, glass, and wood, and producing a variety of custom-designed parts and products.

Several capabilities are offered under the umbrella of precision CNC machining services, including mechanical, chemical, electrical, and thermal processes. CNC milling is a mechanical machining process along with drilling, turning, and a variety of other machining processes, meaning that material is removed from the work piece via mechanical means, such as the actions of the milling machine’s cutting tools.

This article focuses on the CNC milling process, outlining the basics of the process, and the components and tooling of the CNC milling machine. Additionally, this article explores the various milling operations and provides alternatives to the CNC milling process.

Overview of CNC Milling Process:

The CNC milling process utilizes computerized controls to operate and manipulate machine tools which cut and shape stock material. In addition, the process follows the same basic production stages which all CNC machining processes do, including:

- Designing a CAD model
- Converting the CAD model into a CNC program
- Setting up the CNC milling machine
- Executing the milling operation

The CNC milling process begins with the creation of a 2D or 3D CAD part design. Then the completed design is exported to a CNC-compatible file format and converted by CAM software into a CNC machine program which dictates the actions of the machine and the movements of the tooling across the work piece. Before the operator runs the CNC program, they prepare the CNC milling machine by affixing the work piece to the machine's work surface (i.e., worktable) or work holding device (e.g., vise), and attaching the milling tools to the machine spindle. The CNC milling process employs horizontal or vertical CNC-enabled milling machines—depending on the specifications and requirements of the milling application—and rotating multi-point (i.e., multi-toothed) cutting tools, such as mills and drills. When the machine is ready, the operator launches the program via the machine interface prompting the machine to execute the milling operation.

Once the CNC milling process is initiated, the machine begins rotating the cutting tool at speeds reaching up to thousands of RPM. Depending on the type of milling machine employed and the requirements of the milling application, as the tool cuts into the work piece, the machine will perform one of the following actions to produce the necessary cuts on the work piece:

1. Slowly feed the work piece into the stationary, rotating tool
2. Move the tool across the stationary work piece
3. Move both the tool and work piece in relation to each other

As opposed to manual milling processes, in CNC milling, typically the machine feeds moveable work pieces with the rotation of the cutting tool rather than against it. Milling operations which abide by this convention are known as climb milling processes, while contrary operations are known as conventional milling processes.

Generally, milling is best suited as a secondary or finishing process for an already machined work piece, providing definition to or producing the part's features, such as holes, slots, and threads. However, the process is also used to shape a stock piece of material from start to finish. In both cases, the milling process gradually removes material to form the desired shape and form of the part. First, the tool cuts small pieces—i.e., chips—off the work piece to form the approximate shape and form. Then, the workpiece undergoes the milling process at much higher accuracy and with greater precision to finish the part with its exact features and specifications. Typically, a completed part requires several machining passes to achieve the desired precision and tolerances. For more geometrically complex parts, multiple machine setups may be required to complete the fabrication process.

Once the milling operation is completed, and the part is produced to the custom-designed specifications, the milled part passes to the finishing and post-processing stages of production.

CNC Milling operations (Face Milling, plain milling, Angular milling, Form Milling)

CNC milling is a machining process suitable for producing high accuracy, high tolerance parts in prototype, one-off, and small to medium production runs. While parts are typically produced with tolerances ranging between +/- 0.001 in. to +/- 0.005 in., some milling machines can achieve tolerances of up to and greater than +/- 0.0005 in. The versatility of the milling process allows it to be used in a wide range of industries and for a variety of part features and designs, including slots, chamfers, threads, and pockets. The most common CNC milling operations include:

- Face milling
- Plain milling
- Angular milling
- Form milling

Face Milling:

Face milling refers to milling operations in which the cutting tool's axis of rotation is perpendicular to the surface of the work piece. The process employs face milling cuters which have teeth both on the periphery and tool face, with the peripheral teeth primarily being used for cutting and the face teeth being used for finishing applications. Generally, face milling is used to create flat surfaces and contours on the finished piece and is capable of producing higher quality finishes than other milling processes. Both vertical and horizontal milling machines support this process.

Types of face milling include end milling and side milling, which use end milling cutters and side milling cutters, respectively.

Plain Milling:

Plain milling, also known as surface or slab milling, refers to milling operations in which the cutting tool's axis of rotation is parallel to the surface of the work piece. The process employs plain milling cutters which have teeth on the periphery that perform the cutting operation. Depending on the specifications of the milling application, such as the depth of the cut and the size of the work piece, both narrow and wide cutters are used. Narrow cutters allow for deeper cuts, while wider cutters are used for cutting larger surface areas. If a plain milling application requires the removal of a large amount of material from the work piece, the operator first employs a coarse-toothed cutter, slow cutting speeds, and fast feed rates to produce the custom-designed part's approximate geometry. Then, the operator introduces a finer toothed cutter, faster cutting speeds, and slower feed rates to produce the details of the finished part.

Angular Milling:

Angular milling, also known as angle milling, refers to milling operations in which the cutting tool's axis of rotation is at an angle relative to the surface of the work piece. The process employs single-angle milling cutters—angled based on the particular design being machined—to produce angular features, such as chamfers, serrations, and grooves. One common application of angular milling is the production of dovetails, which employs 45°, 50°, 55°, or 60° dovetail cutters based on the design of the dovetail.

Form Milling:

Form milling refers to milling operations involving irregular surfaces, contours, and outlines, such as parts with curved and flat surfaces, or completely curved surfaces. The process employs formed milling cutters or fly cutters specialized for the particular application, such as convex, concave, and corner rounding cutters. Some of the common

applications of form milling include producing hemispherical and semi-circular cavities, beads, and contours, as well as intricate designs and complex parts with a single machine setup.

Other Milling Machine Operations

Besides the aforementioned operations, milling machines can be used to accomplish other specialized milling and machining operations. Examples of the other types of milling machine operations available include:

Straddle milling: Straddle milling refers to milling operations in which the machine tool machines two or more parallel work piece surfaces with a single cut. This process employs two cutters on the same machine arbor, arranged such that the cutters are at either side of the work piece and can mill both sides at the same time.

Gang milling: What is gang milling? Gang milling refers to milling operations which employ two or more cutters—typically of varying size, shape, or width—on the same machine arbor. Each cutter can perform the same cutting operation, or a different one, simultaneously, which produces more intricate designs and complex parts in shorter production times.

Profile milling: Profile milling refers to milling operations in which the machine tool creates a cut path along a vertical or angled surface on the work piece. This process employs profile milling equipment and cutting tools which can be either parallel or perpendicular to the work piece's surface.

Gear cutting: Gear cutting is a milling operation which employs in volute gear cutters to produce gear teeth. These cutters, a type of formed milling cutters, are available in various shapes and pitch sizes depending on the number of teeth necessary for the particular gear design. A specialized lathe cutter bit can also be employed by this process to produce gear teeth.

Other machining processes: Since milling machines support the use of other machine tools besides milling tools, they can be used for machining processes other than milling, such as drilling, boring, reaming, and tapping.

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Short answer question

1. Define milling.
2. Write the types of milling machines.
3. Write the cutting tools used in Milling.
4. Write the importance of CNC Milling.
5. Name the Milling machine vices.

Long answer questions

1. Explain the working principle of milling machine with sketch.
2. Explain main parts of milling machine.
3. Explain Milling operations.
4. Explain main components of CNC Milling machine.
5. Explain CNC milling operations.

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3.Shaper and Slotter

3.1. Introduction

A shaper is a machine tool that uses reciprocating straight line motion of the tool and a perpendicular feed of the job or the tool. By moving the work piece across the path of the reciprocating tool a flat surface is generated regardless of the shape of the tool. With special tools, attachments and devices for holding the work, a shaper can also be used to cut external and internal key ways, gears, racks, dovetails, T-slots and other miscellaneous shapes.

Shaping is essentially an inefficient method of metal removal but the simplicity of the process coupled with short set up time and cheap tooling makes it extremely useful for single job.

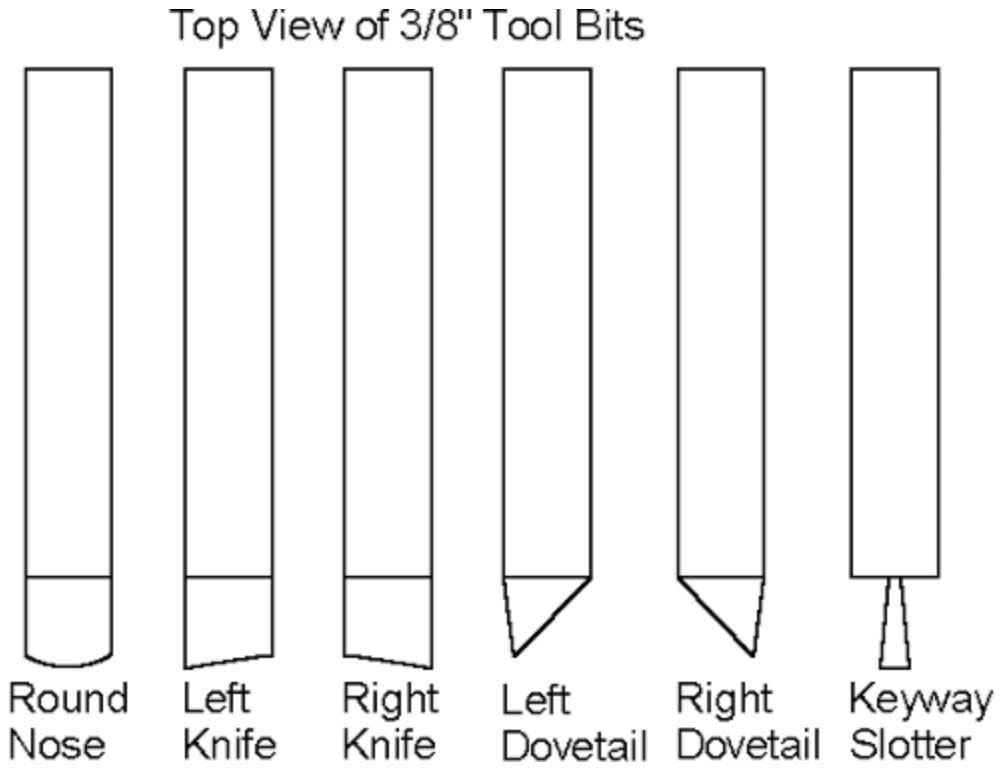
The most common type of horizontal shapers is the production push cut shaper. This type of shaper consists of a frame or column supported on abase, a reciprocating ram and a work table. The frame houses the drive mechanism of the shaper. The top of the frame provides guide ways for the ram.The front of the frame provides guide ways for a cross rail which can be moved up and down. Sliding along the cross rail, perpendicular to the line of motion of the ram is a saddle which carries the work table. On the front end of the ram is fitted a tool head which holds the tool and is provided with means for feeding the tool into the work.

The reciprocating motion of the ram provides the straight line motion to the tool which is the speed for cutting. The vertical movement of the cross rail permits jobs of different heights to be accommodated below the tool and is a machine setting. Motion of the table along the cross rail provides the feed motion for horizontal shaping. The motion of the tool slide on the tool head in conjunction with the swivel base provides feed motion for vertical and angular cuts. The motion of the table along the cross rail for feeding is powered by a paul and ratchet arrangement and timed by actuating the paul by the shaper ram drive the feed is provided at the end of return stroke.

The tool slide swivel base is held on the circular seat on the ram and is graduated to indicate the angle of swivel. The apron consisting of the clapper box, the clapper block and the tool post is clamped on the vertical slide by a screw. It can be swivelled about the apron swivel in by releasing the clamping screw. The clapper block which carries the tool post is connected to the clapper box by means of a hinge pin. The clapper box-blocks assembly provides a rigid support to the tool in the forward or cutting stroke but on the return stroke the clapper block is lifted out of the clapper box to clear the tool from the work piece. This prevents scratching of the work piece and wear of the tool due to tool dragging.

3.2 Cutting Tools, Parts of a Shaper Machine with Function:

A shaper machine holds the Single point cutting tool in ram and workpiece is fixed over the table. The ram holding the tool reciprocates over the workpiece and metal is cut during the forward stroke called a cutting stroke and. No metal is cut during its return stroke is called an Idle stroke.



Base:

- The Base is designed to take the entire load of the machine tool and it is bolted to the floor of the shop.
- This is made of grey cast iron to resist vibration and to take the compressive load.

Column:

- The column is a Box like casting made up of cast iron and mounted on a base.
- It is provided with accurately machined guide ways on the top on which the ram reciprocates.
- The guide ways are also provided on the front vertical face for the movement of cross rail. The column encloses the ram driving mechanism.

Cross rail:

- The cross rail is mounted on the ground vertical guide ways of the column.
- It consists of two parallel guide ways on its top perpendicular to the ram axis is called as a saddle to move the table in crosswise direction by means of a feed screw.

- The table can be raised or lowered to accommodate different sizes of the job by rotating elevating screw which causes the cross rail to slide up and down on the vertical face of the column.

Saddle:

- It is mounted on the cross rail to hold the table firmly on its top.
- The crosswise movement of the saddle causes the table to move crosswise direction by rotating the cross feed screw.

Table:

- It is mounted on the **saddle**.
- It can be moved crosswise by rotating the cross feed rod and vertically by rotating the elevating screw.
- The table is a box-like casting with accurately machined top and side surfaces. These surfaces having t-slots for clamping the work.
- In Universal shaper, the table may be swivelled on a horizontal axis and its upper part may be tilted up or down.
- In heavy Shaper, the front face of the table is supported by adjustable table support to give more rigidity.

Ram:

- It is a reciprocating member of the shaper which holds the tool and the reciprocates on the guide ways on the top of the column by means of quick return motion mechanism.
- It houses the screwed shaft for altering the position of the RAM with respect to the work. The RAM is in semi-cylindrical form and heavily ribbed inside to make it more rigid.

Tool Head:

- The tool head holds the cutting tool firmly and provides both vertical and angular movement to the tool with the help of a down feed screw handle.
- The head allows the tool to have an automatic relief during the return stroke.
- The vertical slide of a tool head consists of a swivel base which is graduated in degrees. So, the vertical slide can set at any angle with the work surface.
- The amount of feed or depth of cut may be adjusted by a micrometer dial on top of the down feed screw.

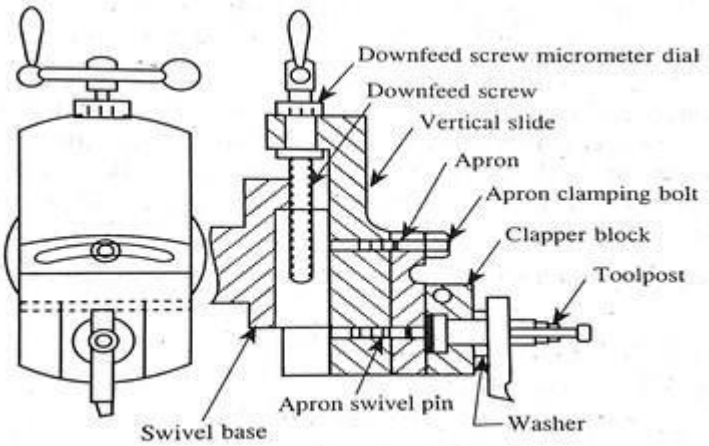
A tool head again consists of:

- Apron
- Clapper box and clapper block

Apron consisting of clapper box and tool post is clamped on the vertical slide by the screw.

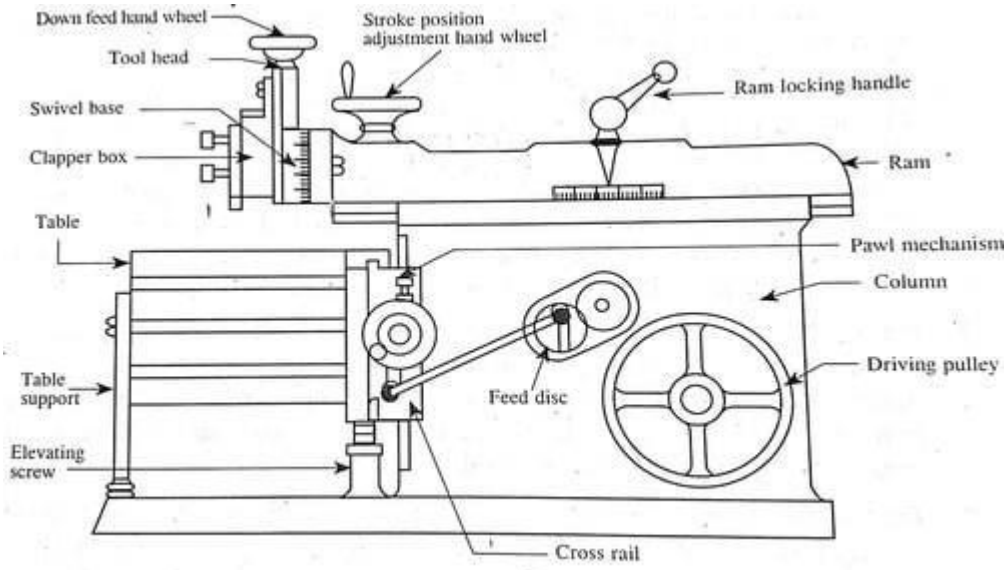
- The **apron** can be swivelled upon the apron swivel pin towards left or right.
- The **clapper box** houses the **clapper block** by means of a hinge pin.

- The **tool post** is mounted on the **clapper block**.
- During forwarding cutting stroke the clapper block keeps the rigid support to the tool by fitting securely into clapper box and while returning stroke the tools slide over the work by lifting, the block out of clapper boxes shown in the above figure



Toolhead of a shaper

Diagram is shown the principal parts of the Shaper Machine



Shaper

Shaper Machine

Specification of Shaper Machine:

The specification of shaper machine depends upon the following:

- The maximum length of stroke ram
- Types of the drive (Crank, Gear and Hydraulic type)
- Power input of the machine
- Floor space required to establish the machine
- Weight of the machine in tone.
- Feed

- Cutting to return stroke ratio.
- Angular movement of the table.

3.3 Shaper Mechanisms

In a shaper rotary movement of the drive is converted into reciprocating movement by the mechanism contained within the column or frame of the machine. The ram holding the tool gets the reciprocating movement. In a standard shaper metal is removed in the forward cutting stroke, while the return stroke goes idle and no metal is removed during this period. This mechanism is known as quick return mechanism. The reciprocating movement of the ram and quick return mechanism of the machine usually obtained by any one of the following methods:

1. Crank and slotted link mechanism
2. Whitworth quick return mechanism
3. Hydraulic shaper mechanism

The principle of quick return motion is illustrated in fig. when the link is in the position PM, the ram will be at the extreme backward position of its stroke, and when it is at PN, the extreme forward position of the ram will have been reached. PM and PN are shown tangent to the crank pin circle stroke, therefore, takes place when the crank rotates through the angle C_1KC_2 and the return stroke takes place when the crank rotates through the angle C_2LC_1. It is evident that the angle C_1KC_2 made by the forward or cutting stroke is greater than the angle C_2LC_1 described by there turn stroke.

The angular velocity of the crank pin being constant the return stroke is, therefore, completed within a shorter time for which it is known as quick return motion.

Cutting time to return time ration usually varies between 2:1 and the practical limit is 2:2.

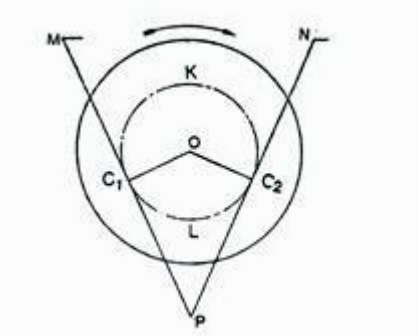
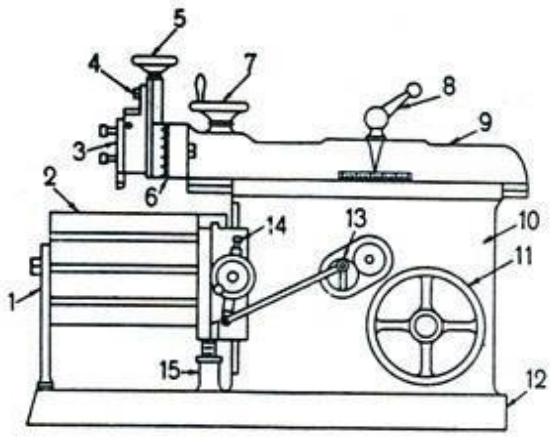


Fig. Principle of quick return



1. Table support, 2. Table, 3. Clapper box, 4. Apron clamping bolts, 5. Downfeed hand wheel, 6. Swivel base degree graduations, 7. Position of stroke adjustment handwheel, 8. Ram block locking handle, 9. Ram, 10. Column, 11. Driving pulley, 12. Base, 13. Feed disc, 14. Pawl mechanism, 15. Elevating screw

Fig.Parts of a standard shaper

Hydraulic Shaper Mechanism in Shaper Machine:

- ✓ In a **hydraulic shaper machine**, a constant speed motor drives a hydraulic pump which delivers oil at a constant pressure to the line.
- ✓ A regulating valve admits oil under pressure to each end on the piston alternately.
- ✓ At the same time allowing oil from the opposite end of the piston to return to the reservoir.
- ✓ The piston is pushed by the oil and being connected to ram by piston rod, pushes the ram carrying the tool.
- ✓ The admission of oil to each end of the piston, alternately, is accomplished with the help of trip dogs and pilot valves.
- ✓ As the ram moves and complete its stroke (Forward and Return) a trip dog will trip the pilot valve which operates the regulating valve.
- ✓ The regulating valve will admit the oil to the other side of the piston and the motion of the ram will get reversed.
- ✓ It is clear that the length of the ram stroke will depend upon the position of trip dogs.
- ✓ The length of the ram stroke can be changed by unclamping and moving the trip dogs to the desired position.

A hydraulic shaper looks like this:

3.4 Types of shaper machine:

Shapers are mainly classified as standard, draw-cut, horizontal, universal, vertical, geared, crank, hydraulic, contour and traveling head, with a horizontal arrangement most common. Vertical shapers are generally fitted with a rotary table to enable curved surfaces to be machined (same idea as in helical planning). The vertical shaper is essentially the same thing as a slotter (slotting machine), although technically a distinction can be made if one defines a true vertical shaper as a machine whose slide can be moved from the vertical. A slotter is fixed in the vertical plane.

Based on the type of driving mechanism types of shaper machines.

- Crank type (Example: Quick return Motion Mechanism)
- Geared type shaper
- Hydraulic type(I mentioned the working principle of hydraulic shaper machine below in this article)

Based on ram travel types of shaper machines.

- Horizontal Shaper
- Vertical Shaper

Based on the table design types of shaper machines.

- Standard or Plain Shaper
- Universal shaper

Standard or Plain Shaper:

- ✓ In this machine, the table has only two motion: crosswise in the horizontal plane and vertical movement (up and down).
- ✓ The table is not provided with a swivelling motion.

Universal shaper:

- ✓ This machine is similar to plain shaper except that the table can be tilted at a various angle, making it possible to inclined flat surfaces.
- ✓ The table can be swivelled about 360 degrees about a central axis parallel to the cutting stroke direction and also perpendicular to it, that is, around two horizontal axes.
- ✓ The table also has a movement in the horizontal plane and vertical direction (up and down) as in plain shaper.

A universal Shaper Machine

Based on cutting stroke types of shaper machines.

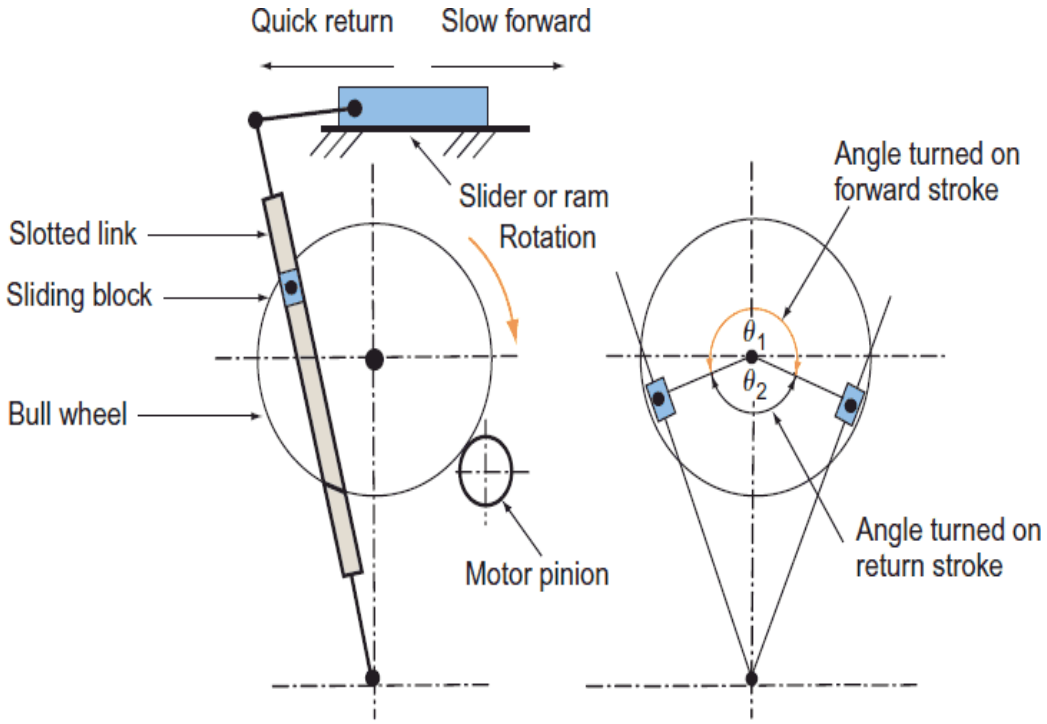
- Push type shaper machine
- Draw type shaper machine

Construction and Working

- A shaper machine holds the Single point cutting tool in ram and work piece is fixed over the table.
- The ram holding the tool reciprocates over the work piece and metal is cut during the forward stroke called a cutting stroke and
- No metal is cut during its return stroke is called an Idle stroke.
- The feed is given at the end of the cutting stroke.
- Generally, the cutting stroke is carried out at slow speed and the idle stroke is carried at high speed with the help of quick return mechanism.

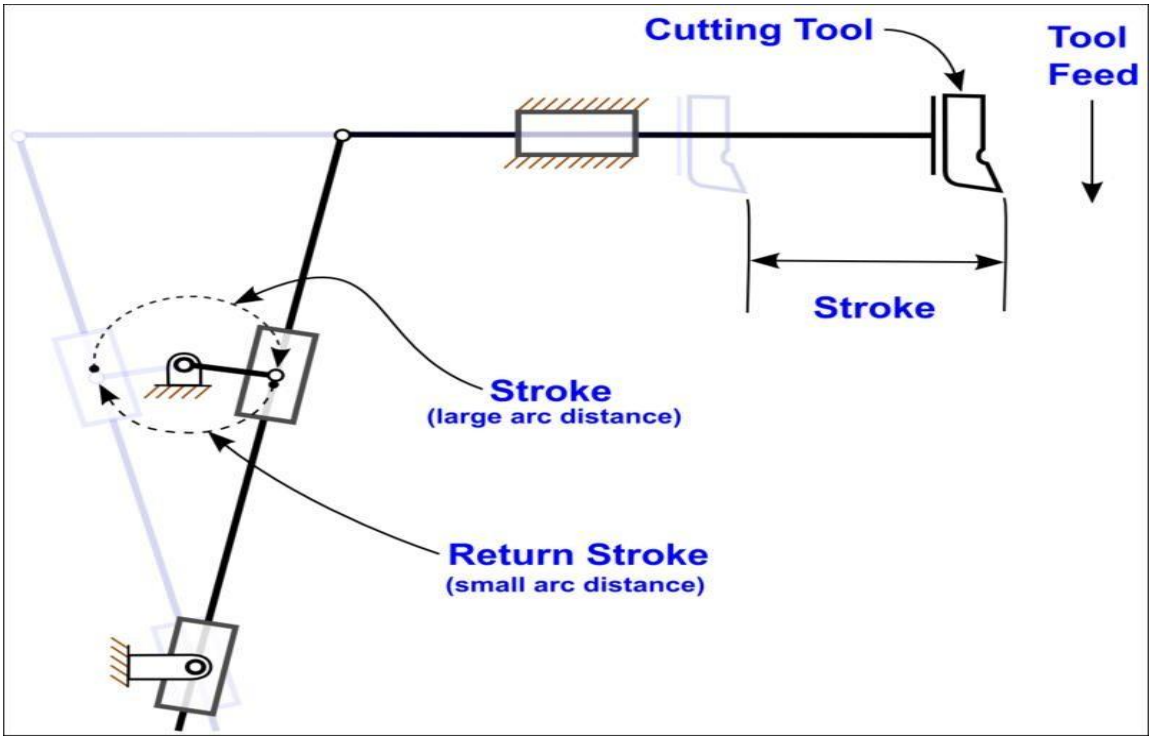
In the shaper machine, there is another mechanism called Quick return Motion Mechanism**.**

In the forward stroke, the Slider moves fast and removing the material from the work piece. Whereas in the return stroke, the Slider moves faster than the forward stroke that means Quick return, it takes less time to return, called a return stroke.



Operations on Shaper

The work piece mounts on a rigid, box-shaped table in front of the machine. The height of the table can be adjusted to suit this work piece, and the table can traverse sideways underneath the reciprocating tool, which is mounted on the ram. Table motion may be controlled manually, but is usually advanced by automatic feed mechanism acting on the feed screw. The ram slides back and forth above the work. At the front end of the ram is a vertical tool slide that may be adjusted to either side of the vertical plane along the stroke axis. This tool-slide holds the clapper box and tool post, from which the tool can be positioned to cut a straight, flat surface on the top of the work piece.



The tool-slide permits feeding the tool downwards to deepen a cut. This flexibility, coupled with the use of specialized cutters and tool holders, enable the operator to cut internal and external gear teeth. The ram is adjustable for stroke and, due to the geometry of the linkage, it moves faster on the return (non-cutting) stroke than on the forward, cutting stroke. This return stroke is governed by a quick return mechanism.

There are 4-types of operations performed in a shaper machine, and those are:

- Horizontal cutting
- Vertical cutting
- Inclined cutting
- Irregular cutting

Horizontal cutting:

- ✓ Horizontal surfaces are machined by moving the work mounted on the machine table at a cross direction with respect to the ram movement.
- ✓ The clapper box can be set vertical or slightly inclined towards the uncut surface.
- ✓ This arrangement enables the tool to lift automatically during the return stroke. The tool will not drag on the machined surface.

Vertical cutting:

- ✓ A vertical cut is made while machining the end of a work piece, squaring up a block or machining a shoulder.

- ✓ The feed is given to the tool by rotating the down feed screw of the vertical slide.
- ✓ The table is not moved vertically for this purpose.
- ✓ The apron is swivelled away from the vertical surface being machined.

Inclined cutting:

- ✓ An angular cut is done at any angle other than a right angle to the horizontal or to the vertical plane.
- ✓ The work is set on the table and the vertical slide of the tooth head is swivelled to the required angle either towards the left or towards right from the vertical position.

Irregular cutting:

- ✓ A round nose tool is used for this operation.
- ✓ For a shallow cut the apron may be set vertical but if the curve is quite sharp, the apron in swivelled towards the right or left away from the surface to be cut.

Advantages, Disadvantages and applications:

Advantages of Shaper Machine:

- The single point tool used is inexpensive or we can say low tooling cost.
- The cutting stroke having a definite stopping point.
- The work can be held easily in the shaper machine.
- The set up is very quick and easy and also can be readily changed from one job to another job.

Disadvantages of Shaper Machine:

- By nature, it is a slow machine because of its straight-line forward and returns strokes the single point cutting tool requires Several strokes to complete a work. (They are slow)
- The cutting speed is not usually very high speeds of reciprocating motion due to high inertia force developed in the motion of the units and components of the machine.

Applications of Shaper Machine:

- To generate straight and flat surfaces.
- Smooth rough surfaces.
- Make internal splines
- Make gear teeth.
- To make dovetail slides.
- Make key ways in pullies or gears.
- Machining of die, punches, straight and curved slots.

3.8. Slotter Introduction:

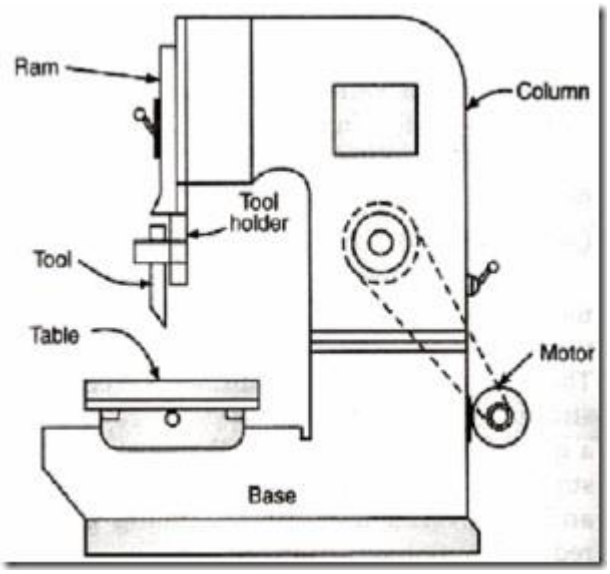
The slotter machine operates almost on the same principle as that of a shaper. The major difference between a slotter and shaper is that in a slotter the ram holding the tool reciprocates in a vertical axis, whereas in a shaper the ram holding the tool reciprocates in a horizontal axis. A slotter is therefore, considered a vertical shaper, and they are almost similar to each other as regards their construction, operation, and use.

The slotter is used for cutting grooves, key ways, and slots of various shapes, for making both internal and external regular and irregular surfaces.

3.9 Construction and working

Construction: The slotter can be considered as a vertical shaper and its main parts are**:**

1. Base, column and table
2. Ram and tool head assembly
3. Saddle and cross slide
4. Ram drive mechanism and feed mechanism.



The base of the slotting machine is rigidly built to take up all the cutting forces. The front face of the vertical column has guide ways for Tool the reciprocating ram. The ram supports the tool head to which the tool is attached. The work piece is mounted on the table which can be given longitudinal, cross and rotary feed motion.

The slotting machine is used for cutting grooves, keys and slots of various shapes making regular and irregular surfaces both internal and external cutting internal and external gears and profiles The slotter machine can be used on any type of work where vertical tool movement is considered essential and advantageous.

The different types of slotting machines are:
1. **Punch slotter**: a heavy duty rigid machine designed for removing large amount of metal from large forgings or castings
2. **Tool room slotter**: a heavy machine which is designed to operate at high speeds. This machine takes light cuts and gives accurate finishing.
3. **Production slotter**: a heavy duty slotter consisting of heavy cast base and heavy frame, and is generally made in two parts.

3.10. Slotter Machine Parts:

A slotter machine consists of these following parts:

- Base
- Column
- Saddle
- Cross-slide
- Rotating or Circular table
- Ram and tool head
- Ram drive
- Feed drive

Base:

- It should be sufficiently rigid to take up the entire load of the machine.
- It has to take all the load (dynamic and Impact loading) while operating.
- The guide ways perpendicular to the column face should be accurately finished to move the saddle easily and accurately.
- Generally, it is made of Cast Iron.

Column:

- The right vertical cast integral rigid part of the base is the column; it serves the following purposes:
- It houses the driving mechanism of the ram, which reciprocates on its front vertical face.
- It also houses the feeding mechanism of the table.

Saddle:

- It moves on guide ways on the base to provide a longitudinal feed of the table, i.e. in a perpendicular direction to the front vertical face of the column.
- It also provides guide ways on its top face, perpendicular to the guide ways on the base for the cross-slide.
- The longitudinal feed may be given either manually or by power.

Cross-Slide:

- It is mounted on the guide ways of the saddle and can provide cross-feeding of the table.
- It holds the circular table.
- It provides the arrangement of cross-feeding either manually or by power.

Circular table or Rotating Table:

- It can rotate on cross-slide to provide circular feeding of the work.
- It can hold the work by clamping, using fixtures, fixing vice, etc.
- It has the arrangement of rotary feeding either by hand or by power
- On some machines, the table may be graduated in degrees for indexing.

Ram and Tool Head:

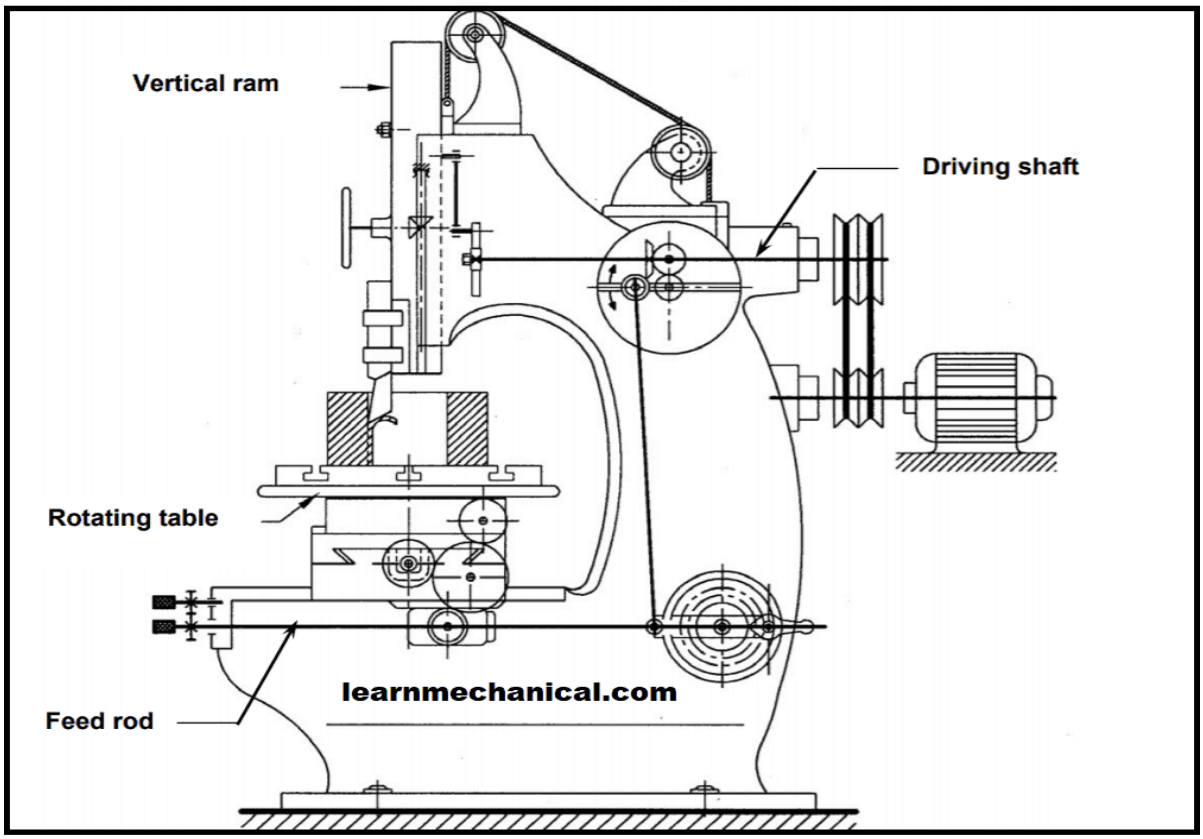
- Ram slides on the guide ways mounted on the front vertical face of the column.
- Ram provides a slot for changing the position of the stroke.
- Ram carries the tool, which is mounted at the bottom – end of the tool head.

Ram Drive:

- It provides the circular motion of the motor to the reciprocating motion of the ram in a vertical plane.
- It also provides the arrangement of slower speed during the cutting or forward stroke and greater speed during the return stroke to reduce the idle time.

Feed Drive:

- It provides the arrangement of longitudinal and cross–a feed of the table either by power or manual.
- It also provides the arrangement of circular or rotary feeding of the table on a vertical axis.
- Intermittent feeding of the table is supplied at the beginning of each cutting or forward stroke of the ram.



Kinematic System of Slotter Machine

3.11 Slotter Machine Mechanism:

- **Hydraulic Drive** (Greater speed Flexibility, Smoother operation, Stroke length can be adjusted)
- **Variable Speed Motor Drive** (In this Multi-speed arrangement)

Hydraulic Drive:

- A speed motor drives a hydraulic pump that delivers oil at a constant pressure to the line.
- A regulating valve admits oil under pressure to each end on the piston alternately.
- At the same time allowing oil from the opposite end of the piston to return to the reservoir.
- The piston is pushed by the oil and being connected to ram by piston rod, pushes the ram carrying the tool.
- The admission of oil to each end of the piston, alternately, is accomplished with the help of trip dogs and pilot valves.
- As the ram moves and complete its stroke (Forward and Return) a trip dog will trip the pilot valve which operates the regulating valve.

- The regulating valve will admit the oil to the other side of the piston and the motion of the ram will get reversed.
- The length of the ram stroke will depend upon the position of trip dogs. The length of the ram stroke can be changed by unclamping and moving the trip dogs to the desired position.

Variable Speed Motor Drive:

- In this type of slotter, speed is obtained by different gears present in the gearbox and the shaft rotates with the help of an electrical motor.
- Basically it is used in modern large slotting machines.

Working Principle of Slotter Machine:

The working of the Slotter machine is similar to the shaper machine do but the main difference between them is the Shaper machine works horizontally whereas Slotter machines work vertically.

- Now the ram is connected to the crank and crank connected to the gears. So what happened here is when we increase or decrease the gear speed, the rotation of crank increases and decreases. And as per these, the ram moves up and down.
- We have attached the work piece into the work table and manually we bring the ram near to the work piece and according to the ram we adjust the worktable and then we have to clamp it.
- Now we supply the power as per gear the crank rotates and the crank is connected to the ram so ram moves up and down.
- During down (ram moves down) the cutting stroke takes place and while moving up or return stroke there is no cut.
- If we have to cut at the different sections then manually we give feed to the work table and as per requirement, it cuts this is how it works.

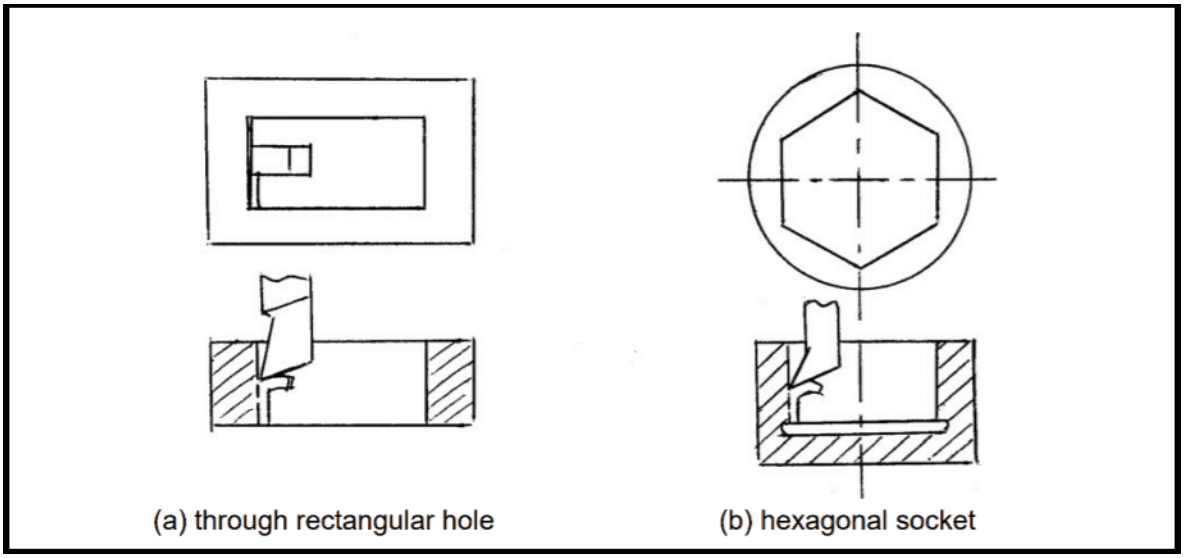
Here I would like to add some more points on Work holding device in which work is attached or fixed.

- T bolts and step block
- Clamps
- Vice
- Parallel strips
- Chuck
- Special fixtures for holding
- Adjustable block and more

Operations on Slotter

It is used for various operations like:

- Internal and external Flat surface Machining.
- The internal recess of circular, semi-circular, concave and convex surfaces.
- Internal and External Circular surfaces Machining.
- Blind Holes Internal machining.
- For shaping internal and external forms or profiles.
- The machine operates vertical, Horizontal and at Some angle too (Inclined Surfaces).
- Irregular surface machining.
- Machining operation of Dies and Punches.
- The operation like slots, grooves, splines, and keyways for both internal and external surfaces.
- Internal and external gear teeth machining.



Machining Operations of a Slotter Machine

Some of the Important Terms to Remember:

The main factor for explaining these terms is: It explains how and what will be the rate of material to be removed?

Cutting speed:

- The cutting speed is defined as the rate at which the work moves with respect to the tool.
- This is expressed in RPM (Revolution per minute).

Depth of cut:

- The depth of cut is defined as the distance measured between the machined surface and the un-machined surface is called depth of cut.
- It is expressed in mm.

Feed :

- The feed is defined as the distance the tool travels during 1 revolution of the parts.
- These three terms give the details of surface finish, power requirements, and material removal rate.

Types of Slotter Machine:

Slotter Machines are can be categorized in these 4-types.

- Punch Slotter
- Precision Tool rooms lotter
- Production Slotter and
- Special Purpose Slotter Machine

Punch Slotter:

- This is a heavy and rigid type of machine.
- This machine designed for the removal of a large amount of metal from forged or cast material.
- The length of the puncher slotter is large it may be as long as 1800 to 2000 mm.

How does Punch Slotter work?

- The ram is usually driven by a spiral pinion meshing with the rack teeth cut on the underside of ram.
- The pinion is driven by a variable speed reversible electric motor similar to that of a planer machine.
- The Feed is controlled by electrical gear.

Precision Tool room Slotter:

- The tool room slotter works with good machine speed and produces an accurate surface finish.

Production Slotter:

- This type of slotter is used for machining tapered jobs by ram swivel to 10 to 30 degrees.

Special Purpose Slotter Machine

- This type of slotter machines offer a high volume of production at low cost, also it gives greater accuracy too.
- Key seater is one of the special purposes of slotter machines. It is used for machining keys on the wheel and gear hub.

3.15 Slotter Machine Specification:

The specifications of a Slotter Machine are depended on the several factors some of these are:

- Power Input
- Type of drive
- Maximum table drive
- The maximum length of ram stroke
- Number of speed
- Number of feed
- Table feed
- Floor space required
- The diameter of the Work Table in MM
- kW of motor

Slotter Machine Application:

These are the applications of a Slotter Machine:

- It is used for cutting Slots, Spline and Keyways, both internal and external.
- It is also used for the Machining of internal and external gears.
- Internal machining of blind holes.
- It is used for light cuts.

Advantages of Slotter Machine:

The advantages of Slotter Machines are:

- This is a light machine.
- The tool uses here is a single-point cutting tool.
- Low-cost machine.
- Low Maintenance.
- Accurate surface finish.
- Machine efficiency is more.

Disadvantages of Slotter Machine:

The disadvantages of Slotter Machines are:

- Rigid in construction.
- Skilled worker requires to operate.

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Short answer question

1. Write the components of shaper machine.
2. Write the specifications of shaper machine.
3. Write the types of shaper machine.
4. Write the types of slotter machine.
5. Write the applications of shaper machine.

Long answer questions

1. Explain main parts of shaper.
2. Write the operations of shaper machine.
3. Explain working principle of slotter machine.
4. Explain main parts of slotter machine.

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4. Quality control and measuring tools

Concept of Quality control and Concept of total quality management

Quality control (QC) is a process through which a business seeks to ensure that product quality is maintained or improved. Quality control requires the company to create an environment in which both management and employees strive for perfection.

A core definition of total quality management (TQM) describes a management approach to long-term success through customer satisfaction. In a TQM effort, all members of an organization participate in improving processes, products, services, and the culture in which they work.

The basic concept of TQM are : customers-orientation (both internal and external), never-ending improvement , statistical control of business processes, upstream preventive maintenance, participative management, on going preventive action, cross-functional management and committed leadership and commitment.

What are the types of quality inspection?

- Pre-Production Inspection (PPI)
- During Production Inspection (DPI)
- Pre-shipment inspection (PSI)
- Container loading/loading supervision (LS)
- Piece-by-piece Inspections

Following are the important objectives of quality control:

1. To create an environment for management and employees strive for perfection.

2. To discover flaws or variations in the raw materials and the manufacturing processes in order to ensure smooth and uninterrupted production.

3. To evaluate the methods and processes of production and suggest further improvements in their functioning.

TQM is considered a customer-focused process and aims for continual improvement of business operations. It strives to ensure all associated employees work toward the common goals of improving product or service quality, as well as improving the procedures that are in place for production.

Importance and Advantages of Quality control

- Greater efficiency and less waste.
- Better and consistent control of major business processes.
- A better understanding of customer needs.
- Regulation of successful working practices.
- Improved risk management.
- Increased customer satisfaction.
- Improved participation of employees.
- Better internal communication.

Present era is the 'Era of Quality'. In this age of cutthroat competition and large scale production, only that manufacturer can survive who supplies better quality goods and renders service to-the consumers. In fact quality control has become major consideration before establishing an industrial undertaking. Proper quality control ensures most effective utilization of available resources and reduction in cost of production.

The word quality control comprises of two words viz., quality and control. It would be appropriate to explain these two words separately to understand clearly the meaning of quality control.

According to Dr. W.K. Spiegel "The quality of a product may be defined as the sum of a number of related characteristics such as shape, dimension, composition, strength, workmanship, adjustment, finish and colour".

In the words of John D. McMillan, "Quality is the degree to which a product conforms to specifications and workmanship standards".

It is clear from these definitions that quality refers to various characteristics of a product and their excellence. Quality is a relative term and is never absolute depending upon the use of the product and circumstances under which it is used.

It involves many steps to be undertaken viz:

(a) Product must possess a minimum level of quality so that it could be easily sold in the market.

(b) In order to measure quality, accurate standard measurements must be established.

Quality control process

Quality control (QC) is a process through which a business seeks to ensure that product quality is maintained or improved. This is done by training personnel, creating bench marks for product quality, and testing products to check for statistically significant variations.
Quality control is a key component of a well-run business. A quality control program helps to ensure your small business is delivering a consistent product, service and customer experience. Developing quality control processes allows your business to operate without you, making it easier to expand into new locations, delegate duties and even sell your business when the time comes.

Business growth requires careful attention to both dollars and people, and quality control helps ensure you're monitoring both. If your products or services are poor quality, you'll spend a lot of time and money redoing them and cutting into your profit margins. If customers aren't happy with the quality of your products and services, they'll stop doing business with you. As word spreads, you'll gain a reputation for poor quality, making it harder to attract and keep customers and employees.

Here are 6 steps to develop a quality control process:

1. Set your quality standards.

In some industries, you may have to meet quality standards set by an outside body, such as an industry association, the local health and safety inspector, or a government regulatory agency. In others, there aren't any official quality standards, so you'll need to set your own.

Each department of your business will have different quality control standards. However, they must all be objectively measurable. For example, if you're developing quality control standards for your customer service team, "sounding friendly on the phone" is not a measurable standard. Measurable standards might include:

- Answering all customer calls by the second ring
- Responding to all customer service emails within four hours
- Resolving customer service problems in five minutes or less

2. Decide which quality standards to focus on.

Of course, you want to ensure quality in all aspects of your operation. However, begin by focusing on the most important measures — those that have the biggest effect on your profits and your customer experience. This will enable you to get results quickly and also keeps you and your team from becoming overwhelmed.

For instance, if you own a restaurant, keeping the restrooms clean is definitely something to monitor in your quality control program—but not the most important thing. Getting orders out to customers quickly and accurately is a more important standard because it has

a more direct effect on the quality of experience and customer satisfaction.

3. Create operational processes to deliver quality.

W. Edwards Deming, the founder of modern quality control, believed that well-designed processes lead to high-quality products and services. If you create good processes, continually measure the results of the processes, and work to consistently improve the process, your product or service will get better and better.

Starting with your critical operations, create step-by-step processes that include benchmarks. For instance, in a B2B company's accounting department, operational processes might require preparing and delivering invoices within 24 hours after a job is completed or a product is delivered. In a restaurant, operational processes might require servers to pick up food for delivery to the customer's table within two minutes of it being prepared.

4. Review your results.

Most business software, from financial and accounting apps to customer relationship management or customer service tools, lets you customize the information you collect and use dashboards to view it at a glance. Review your data regularly to see how well your company is meeting its quality standards.

5. Get feedback.

Use measurable feedback from external sources, such as customer surveys, online ratings and reviews and net promoter scores (NPS), to get a fuller picture of product and service quality. Also, get regular feedback from employees. How well are the operational processes working to deliver quality? How could they be improved?

6. Make improvements.

Once you're meeting your quality control standards, don't stop there. For example, if you own a residential cleaning service business and you can cut the time it takes your maids to clean a home by 25 percent, you'll be able to handle 25 percent more business without hiring any additional employees. That will really boost your bottom line.

Tools used in Quality control

List of the 7 QC Tools

Cause and Effect Diagram

Cause and Effect Diagram also known as Fishbone Diagram helps in identifying the potential causes of an effect or a problem. In addition to sorting ideas in respective

categories, it also helps in understanding the areas of opportunity through effective brainstorming. Fishbone training empowers you to identify the potential cause in the problem.

Control Chart

Control charts are used to study how the processes have changed over a period of time. Further, by comparing current data to historical control limits, one could lead to the conclusion about whether the process variation is consistent as in under control or unpredictable as in out of the control due to being affected by special causes of variation.

Pareto Chart

Pareto Chart is based on the 80/20 rule where it shows the significant factors that have the highest impact on the identified problem.

Check Sheet

Check sheet is a structured process which helps to collect and analyzing data. It is an effective tool that can be for a variety of purposes.

Histogram

Histogram is commonly used a graph that shows the data and its frequency of distribution to help users identify each different value in a set of data occurs.

Scatter Diagram

Scatter diagram shows the relationship between two important factors i.e. pairs of numerical data, one variable on each axis to demonstrate the relationship.

Stratification

Stratification also known as a flow chart or run chart is a technique that separates the data gathered from a variety of sources so that patterns can be seen i.e., the path an entity has taken through a defined process.

Utilizing the 7 QC tools in six sigma or quality management process helps in taking a systematic approach to identify and understand the risk, assess the risk, control fluctuation of product quality and accordingly provide solutions to avoid future defects.

When should you use 7 QC Tools?

7 QC tools can be carried out during the quality management, quality improvement process, six sigma implementation processes or even the regular PDCA cycle for the quality purpose for enhanced quality management. In the first phase of measuring and identifying, Fishbone Diagram also known as cause and effect diagram, Pareto Chart and Control Chart can be utilized. In the next phases of assessment and analysis, Scatter Diagram, Histogram and Checklist can be carried out. The Control Chart can be utilized consistent quality improvement.

Benefits of 7 QC Tools

The 7 QC tools are structured and fundamental instruments that help businesses improve their management and production process for achieving enhanced product quality. From assessing and examining the production process, identification of key challenges and problems to controlling the fluctuation present in the product quality and providing solutions for prevention of defects in future, the easy to understand and implement, 7 QC tools are very effective. Some of the major business benefits of 7 QC tools are listed below.

- Provides a more structured path for problem-solving and quality improvement
- Easy to understand as well as implement yet extremely effective
- A scientific and logical approach for problem-solving
- Follows the 80/20 rule i.e. gain 80% result with 20% efforts
- Improve the quality of product and services
- Helps in identifying and analyzing problems during the process
- Fishbone training aides in root cause analysis and problem-solving
- Encourages team spirit and fosters a healthy culture
- Identifies roots cause and solve it permanently
- Enhance customer experience and customer satisfaction

List the Quality system and element of Quality system

Quality has been defined as "the degree to which something meets or exceeds the expectations of its consumers." The precise definition of quality can vary between industries and organizations. The processes and measurements used for quality assurance at a small manufacturing organization are entirely different from the checks and balances necessary for quality control in highly regulated industries such as pharma or medical devices.

Quality is a dynamic concept which is ultimately defined by customer expectations and satisfaction. QMS are designed to provide a framework for organizations to create and maintain customer relationships by understanding the customer’s preferences and needs. Customer satisfaction is achieved with QMS through the alignment of people, process, and technology throughout the product lifecycle.

One of the world's most broadly adopted QMS, ISO 9001:2015, includes a series of quality principles which are frequently reflected in other QMS standards:

1. Customer focus
2. Leadership
3. Engagement of people
4. Process approach
5. Continuous improvement
6. Evidence-based decision making
7. Relationship management

Organizations must adopt an interdisciplinary series of quality controls to achieve these principles. The nine core elements of a QMS should include quality objectives, a quality manual, organizational responsibilities, data management, and other practices.

1. QUALITY OBJECTIVES

The creation of quality objectives is a common requirement of QMS standards, including ISO 9001. These objectives are designed to encourage organizations to define strategic goals and a purpose for the QMS. Objectives translate an organization's vision into practice by creating a link between customer requirements and specific, measurable, and attainable goals. Well-written objectives lend purpose to a QMS initiative and establish a customer-centric culture in an organization.

A pharmaceutical start-up in the research phase may have identified a customer need for affordable therapeutics to treat a common skin condition. Since the product is being developed, the organization may create a quality policy with a stated goal "To develop a safe, effective treatment for eczema patients which is available at a lower cost than alternatives."

Quality objectives for this organization could include:

- To obtain total compliance with staff training requirements and raise average assessment scores from 90% to 95%.
- To successfully implement a QMS software within three months and eliminate paper and spreadsheet-based record keeping methods within six months.
- To achieve a successful initial synthesis of the drug and complete all necessary processes for FDA initial review within 12 months.

Quality objectives should provide a clear vision for every member of the organization to understand the company's purpose and the value of a QMS. The objectives should provide a clear metric for measuring progress against strategic goals, including the timeline for achievement and a measurable parameter of improvement.

2. QUALITY MANUAL

A quality manual is defined as the first documentation of a QMS. It states the motivation for adopting a QMS framework and the role of quality within the organization. ISO 9000 requirements for a quality manual prescribe that this document should:

- Describe the scope of the QMS
- Detail the requirements of the QMS standard or framework
- List any elements of the QMS which are excluded from the implementation
- Reference specific quality procedures used within the organization
- Provide visual documentation of critical processes via flowchart
- Explain the organization's quality policies and objectives

3. ORGANIZATIONAL STRUCTURE AND RESPONSIBILITIES

A QMS should include a clear and updated model of the organization's structure and responsibilities of all individuals within the organization. Documentation of structure and responsibilities should include visual guides such as flowcharts and clear documentation.

Within the context of a QMS, the organization is broadly defined in World Health Organization guidance as both people and structure. For a life sciences company in the early phases of the product development lifecycle, initial efforts to identify organizational components may reveal a list similar to the following:

- Personnel
- Equipment
- Information Systems
- Tools for Assessment
- Facilities
- Purchasing & Inventory
- Process Controls
- Documents & Records

Documenting organizational structure should address the entire product lifecycle using techniques such as flowcharts which depict the "path of workflow." Defining responsibilities requires an organizational chart with clearly defined roles which can be linked to standard operating procedures (SOPs).

4. DATA MANAGEMENT

Data is at the core of modern approaches to total quality management. Data quality and availability are critical to the success of a QMS framework to drive continuous improvement and preventative quality control activities. Organizations with ineffective data management practices can experience inconsistent product quality, operating inefficiencies, compliance risks, poor customer satisfaction, and low profitability.

An organization must be able to provide meaningful data evidence of effective quality controls. Data management systems should support continuous improvement efforts and corrective actions by defining the types of data that are gathered by the organization and third-party sources. The policy for data management should address data types, sources, collection methods, responsibilities, storage, disposal, and analysis.

The types of data required to demonstrate effective QMS performance can vary significantly between organizations. However, at a minimum it should include the following sources:

- Customer Satisfaction
- Supplier Performance
- Product and Process Monitoring
- Non-Conformances
- Trends
- Preventative or Corrective Action

5. PROCESSES

QMS are inherently process-driven approaches to quality control and assurance. Standards for quality management require organizations to identify and define all organizational processes which use any resource to transform inputs into outputs. Virtually every responsibility in the organization can be tied to a process, including purchasing.

Initial efforts to define processes should create a high-level picture of how processes serve the organization and intersect with resources such as employees, machines, or technology. After identifying processes, organizations can begin to define standards and success metrics:

- Identify organizational processes
- Define process standards
- Establish methods for measuring success
- Document a standardized approach to ensuring quality output
- Drive continual improvement

6. CUSTOMER SATISFACTION WITH PRODUCT QUALITY

A core component of QMS is the requirement for organizations to monitor customer satisfaction to determine if quality objectives are achieved. Some standards do not prescribe specific methods for measuring customer satisfaction since the definition of product quality and available data can vary significantly between organizations.

A first step to establishing monitoring systems for customer satisfaction should be the definition of appropriate methods for measuring customer attitudes and complaints. This could include:

- Satisfaction Surveys

- Complaints Procedures
- Analytical Applications to measure satisfaction trends
- Management Review of customer satisfaction

7.CONTINUOUS IMPROVEMENT

Continuous improvement and adaptation are necessary for organizations to drive benefits with the QMS and maintain customer satisfaction. QMS dictate that continual improvement is an organization-wide responsibility.

However, ISO 9001 is clear that leadership should play a core role in implementing a quality-driven culture. Clause 5.1.1 states "top management shall demonstrate leadership and commitment with respect to the quality management system by taking accountability for effectiveness."

Designing organizational processes to meet QMS standards for continuous improvement requires clear documentation of controls across the organization. Improvement documentation should encompass, at a minimum:

- Quality Planning Procedures
- Compliance Requirements
- Safety Design
- Risk-based Thinking
- Corrective Action (CAPA)
- Gradual and Breakthrough Improvement
- Innovation
- Assessment of the QMS

8. QUALITY INSTRUMENTS

The control and calibration of tools used to measure quality are integral to the success of a QMS. If machines or equipment are used to validate products or processes, this equipment must be carefully controlled and calibrated according to industry standards. Depending on the instrument, this could involve periodic calibrations or calibration before every measurement.

The QMS system design within an organization should dictate a clear policy for the maintenance of quality instruments based on nationally or internationally recognized standards for each piece of quality equipment.

This documentation should address:

- Intervals for instrument calibration
- Recognized Standards for instrument calibration
- Manufacturer Instructions for adjustment
- Procedures for identifying and documenting calibration
- Controls against tampering or adjustment post-calibration
- Methods to protect instruments and equipment from damage

In addition to these requirements, the QMS should address effective documentation of calibration results, including procedures for maintaining complete records of activities and calibration results.

9. DOCUMENT CONTROL

The definition of a document in a quality-driven organization is broad, according to ISO. It includes all records of:

- Communications
- Evidence
- QMS Conformity
- Knowledge Sharing

QMS dictate standards for the types of documentation which are necessary to support quality management at a minimum, which may not be reflective of all the documents needed for accurate quality control. This generally includes quality objectives, a quality manual, procedures, process documentation, and records keeping. Document management systems must contain all evidence necessary to prove QMS performance objectively.

List the pillars of Total Quality Management

A quality conscious organization has got five characteristics. These characteristics are called the five pillars of quality on which the organizational operations are supported. The foundation of these pillars is the organizational values since the pillars get support from these values. These values are honesty, commitment to customer satisfaction, and commitment to creating an environment in which the employees can give their best to the organization. These five pillars of quality are (i) customer focus, (ii) total involvement of employees (iii) measurement, (iv) systematic support, and (v) continuous improvement. These five pillars provide the organization with the quality advantage. These pillars of quality indicate the continuous improvement quality culture existing in the organization and are described below.

Quality control process evolution of ISO standards list standards and ISO 9000 series of Quality systems

ISO 9000 is defined as a set of international standards on quality management and quality assurance developed to help companies effectively document the quality system elements needed to maintain an efficient quality system. They are not specific to any one industry and can be applied to organizations of any size.

ISO 9000 can help a company satisfy its customers, meet regulatory requirements, and achieve continual improvement. It should be considered to be a first step or the base level of a quality system.

- ISO 9000 vs. 9001
- 30 years of ISO 9000
- ISO 9000 resources

Quality standards are defined as documents that provide requirements, specifications, guidelines, or characteristics that can be used consistently to ensure that materials, products, processes, and services are fit for their purpose.

Standards provide organizations with the shared vision, understanding, procedures, and vocabulary needed to meet the expectations of their stakeholders. Because standards present precise descriptions and terminology, they offer an objective and authoritative basis for organizations and consumers around the world to communicate and conduct business.

Beneficiaries of ISO 9000 and Concepts of ISO14000

- Higher perceived quality of customer service;
- Improved customer satisfaction;
- Competitive edge over non-certified competitors;
- Increased market share;
- Greater quality awareness;
- Improved employee morale;
- Better documentation.

Focuses on environmental management system that will ensure all operational processes are consistent and effective and will achieve environmental objectives of the organization.

A company should review and continually improve its environmental management system, with the objective of improving its overall environmental performance

Section 3.5 of ISO 14001 defines an environmental management system as "the part of the overall management system that includes organizational structure, planning activities, responsibilities, practices, procedures, processes, and resources for developing, implementing, achieving, reviewing, and maintaining the environmental policy. " Although ISO 14001 was developed independent of ISO 9000 to fulfill environmental rather than quality needs.

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Short answer question
1. Define Quality control.
2. Write the types of Quality Inspections.
3. Write the tools used in Quality control.
4. Define ISO9000
5. Write the advantages of Quality control.
6. Write the beneficiaries of ISO9000.

Long answer questions
1. Explain Quality control process.
2. Explain tools used in Quality control.
3. List the Quality system and Elements of Quality system.
4. Explain beneficiaries of ISO9000 and concept of ISO14000

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5.Auto Components- Reconditioning Machines

Reconditioning Machines

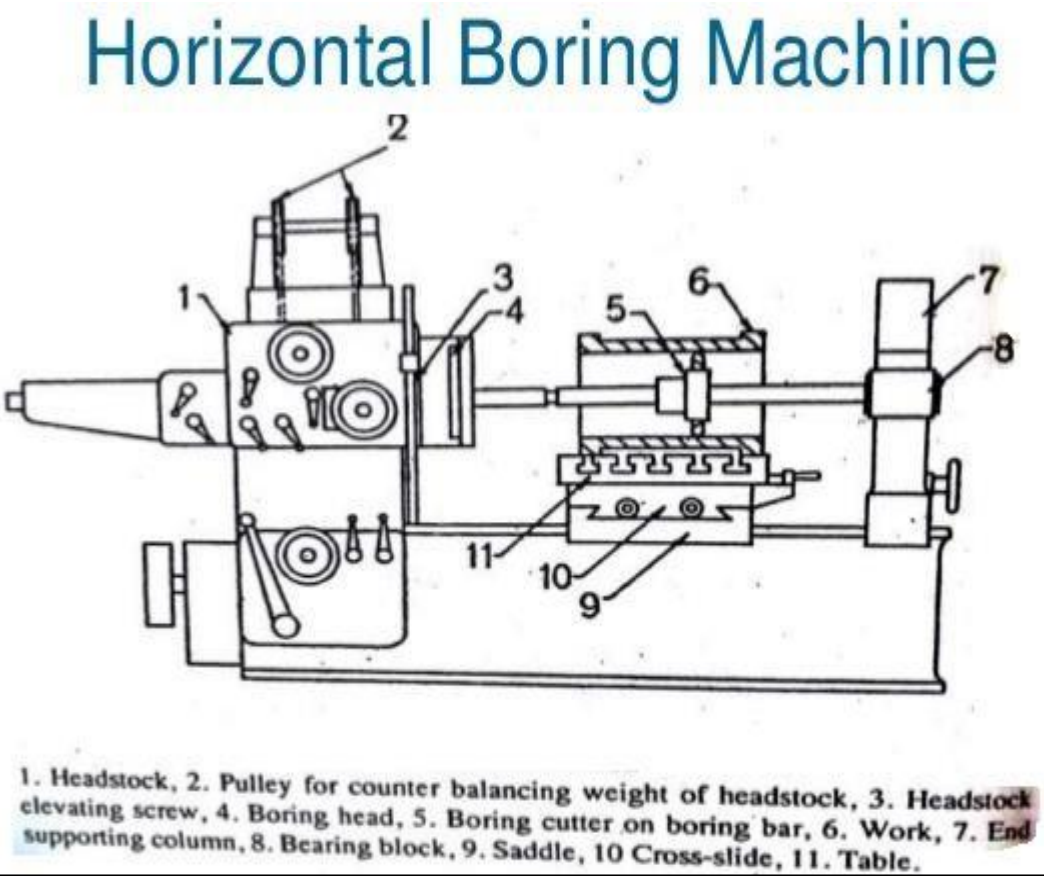
- Hydraulic Surface Grinding Machine for Heads and Cylinder blocks
- Cylinder Boring Machines
- Hydraulic Cylinder Honing Machines
- Line Boring Machine
- Crankshaft Grinding Machines

Cylinder Re-boring Machine

In machining, boring is the process of enlarging a hole that has already been drilled (or cast) by means of a single-point cutting tool (or of a boring head containing several such tools) such as in boring a gun barrel or an engine cylinder.

Multiple heads type horizontal boring machine.

- Table Type Horizontal Boring Machine. The table types are the most common of all horizontal boring machines.
- Floor Type Horizontal Boring Machine.
- Planer Type Horizontal Boring Machine.
- Multiple Head Type Horizontal Boring Machine.



1. Headstock, 2. Pulley for counter balancing weight of headstock, 3. Headstock elevating screw, 4. Boring head, 5. Boring cutter on boring bar, 6. Work, 7. End supporting column, 8. Bearing block, 9. Saddle, 10 Cross-slide, 11. Table.

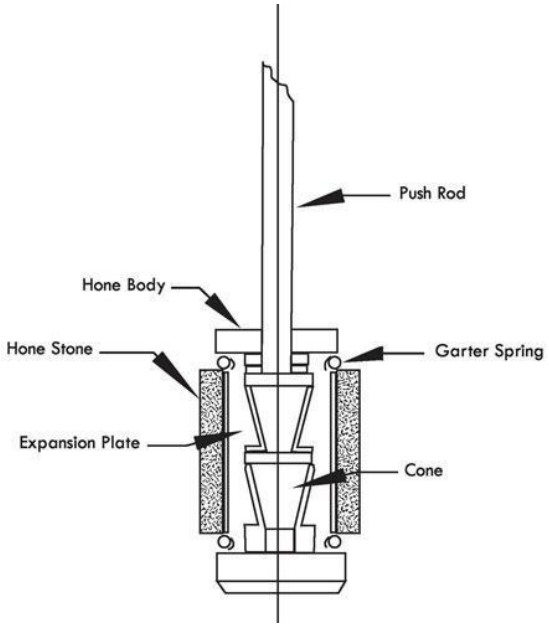
Honing Machine

Honing machines are metal abrading tools and the honing process utilizing hard tooling or honing stones and perishable abrasives stones for the correction of Diameter, Shape, Surface finish. Honing is an abrasive machining process that produces a precision surface on a metal work piece by scrubbing an abrasive grinding stone or grinding wheel against it along a controlled path. Honing is primarily used to improve the geometric form of a surface, but can also improve the surface finish.

Honing machines are metal abrading tools and the honing process utilizing hard tooling or honing stones and perishable abrasives stones for the correction of

- Diameter
- Shape
- Surface finish
- Positional tolerances of bores

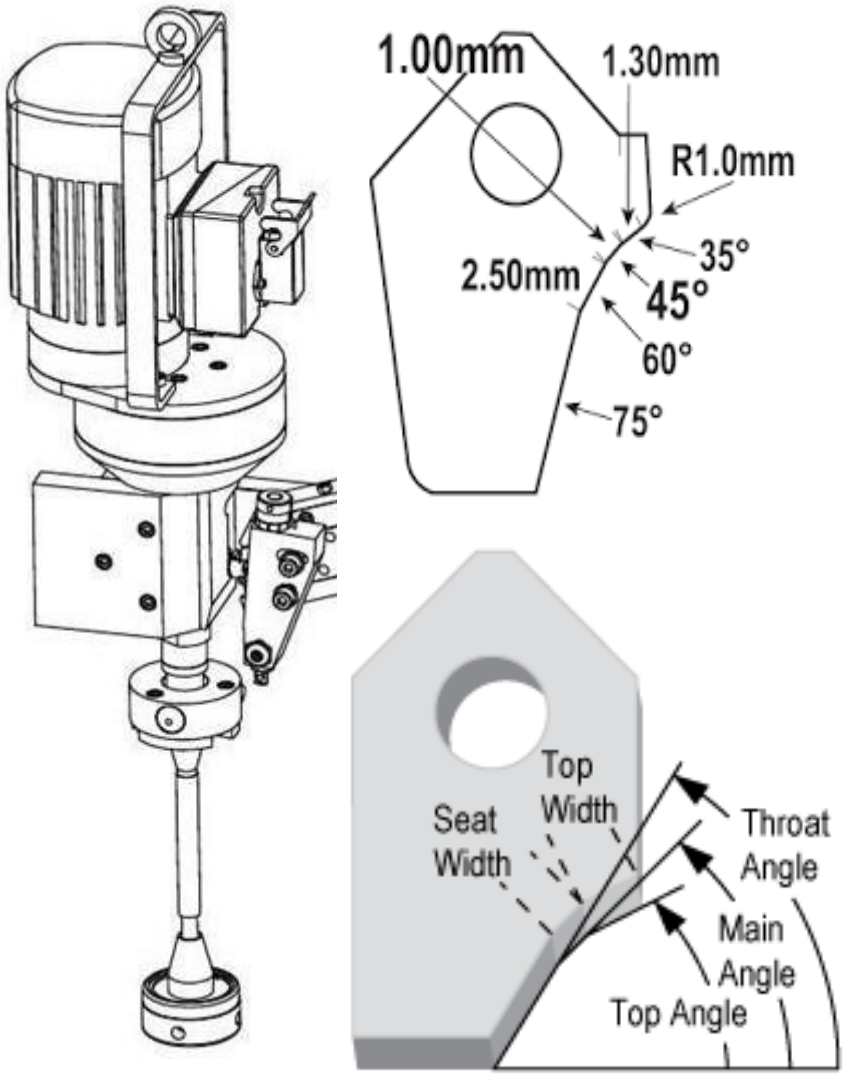
The honing process was developed to allow for perfection of bore geometry, size control, final surface finish and surface structuring. Lapmaster can help you learn the honing process that can provide the final sizing and creates the desired finish pattern on the interior of tubing or cylinder bores. Finishing is accomplished by expanding abrasive stones of suitable grit and grade against the work surface. The stones are rotated and reciprocated in the part with hone abrasive under controlled pressure. Combining rotation and reciprocation produces a cross-hatch pattern in the surface of the part being honed.



Line boring Machine

Line boring, which can also be called align boring, is a term used to describe an engine machining process. The task involved here is to create perfectly straight and aligned bores. These are used for the camshaft housing, which is also known as the saddles and tunnels, as well as the crankshaft.

Valve seat cutting and grinding machine



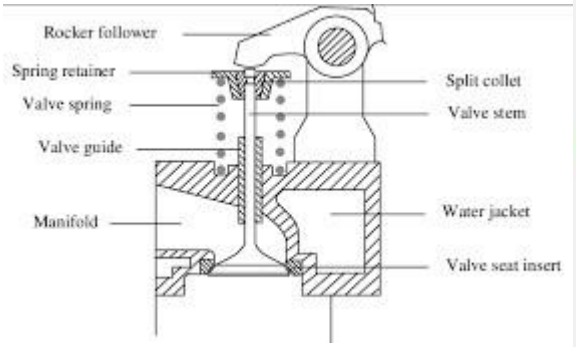
This is an automatically driven valve and valve seat griding machine, available in a number of versions intended for use on crosshead engine exhaust valves. The machine is adjustable to all valve and seat angles, operates reliably and complies with the requirements of engine designers.

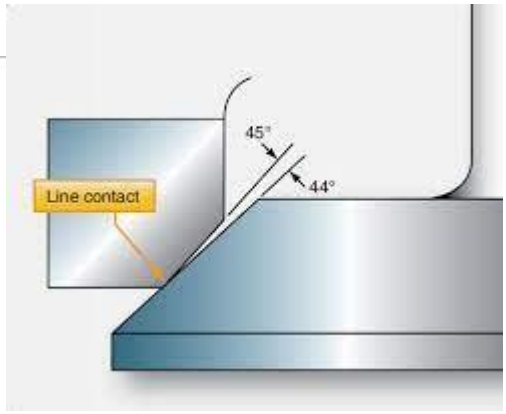
This is electrically driven and easy to operate. It is of robust construction and designed for grinding of valve spindles and valve seats, both onboard and ashore. Thanks to its sturdy design and incorporated features – high precision grinding spindle, automatic centring as well as insensibility to vibrations – the valve seat grinding machine delivers high quality grinding result, even under the most demanding operating conditions.

Advantages of using a seat cutter compared to a grinding stone include: – A number of cutting blades are secured at the correct seat angle in the cutting head of this valve seat reconditioning tool.

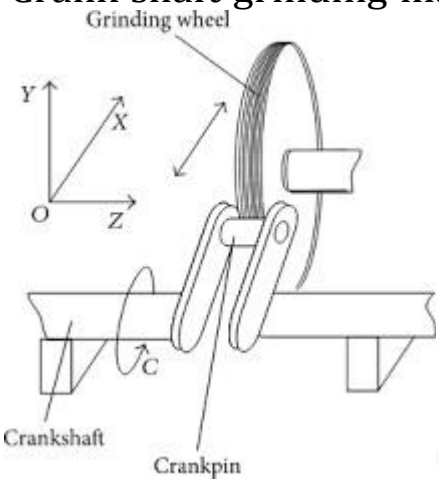
Valve Re-facing machine

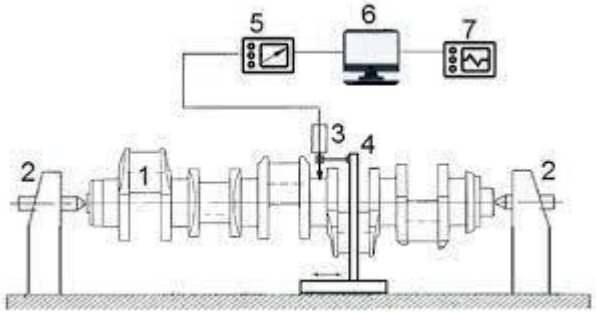
Grinding valve seats with abrasive stones has been around about as long as the internal combustion engine. This seat material is designed to prolong the ability of the valve seat to seal against the pounding of the valve head during engine operation.





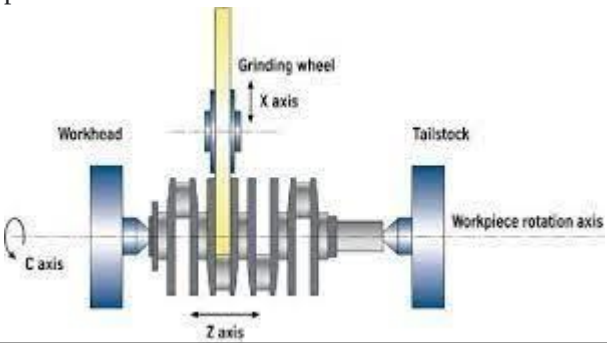
Crank shaft grinding machine





Crankshaft grinding machines are used for grinding journals and crank pins to remove material and refurbish the expensive yet vital part of an engine. Crankshaft grinding is usually done when rebuilding an engine, and it also provides performance enhancements.

Crankshaft grinding consists of removing a minute amount of finished material from the rod and main journals to rebuild the part back to OEM spec. ... A crankshaft consists of rod and main journals. These journals are the end bearings at the bottom of the connecting rods opposite the pistons.



Brake drum Lathe

- Dual Spindle Facilities – First Spindle can be used for Drum Brake and Second Spindle is used for Disc Brake.
- Quick Setting Sleeves – Various standard sleeves provided for four wheeler vehicles (including LCV, MCV, HCV)
- Ergonomic & Compact Design – Machine is designed sturdy for vibration free performance and can be install and work with smaller space options.
- Maintenance free Gear Box – 3 speed adjustment
- Micro adjustment lever for smooth finish
- Precision Twin Cutting Tools.
- Tool Storage Tray Located at Bottom

Specification	C9372
Rotor diameter	4"-24"(102mm-610mm)
Maximum rotor thickness	2.85"(73mm)
Drum diameter	6"-28"(152mm-711mm)
Drum depth	9"(229mm)
Flywheel diameter	6"-24"(152mm-610mm)
Spindle weight capacity(standard 1" Arbor)	1501bs(68kg)
Spindle speed	70-320RPM
Feed rates-rotor and drum	0"-0.026"(0mm-0.66mm)
Feed rate per minute	2.54"(64.5mm)
Motor	110V/220V 50/60HZ 0.6KW

Dual Heavy Duty Spindle *Disc Drum Brake Lathe* for Skimming, Grinding, Cutting, Resurfacing. Easy to Use *Machine* for Cars & Trucks,

Brake shoe riveting machine

Brake Shoe Lining Riveting Machine is Automatic feeding rivet machine which adopts mechanical device to select rivets and send it to the processing position. Brake Shoe Lining Riveting Machine is used to riveting brake shoe liner in high production for brake shoe factory, and also widely used in brake relining for repairing warehouse. Brake Shoe Lining Riveting Machine is used to riveting brake shoe liner in high production for brake shoe factory, and also widely used in brake relining for repairing warehouse.

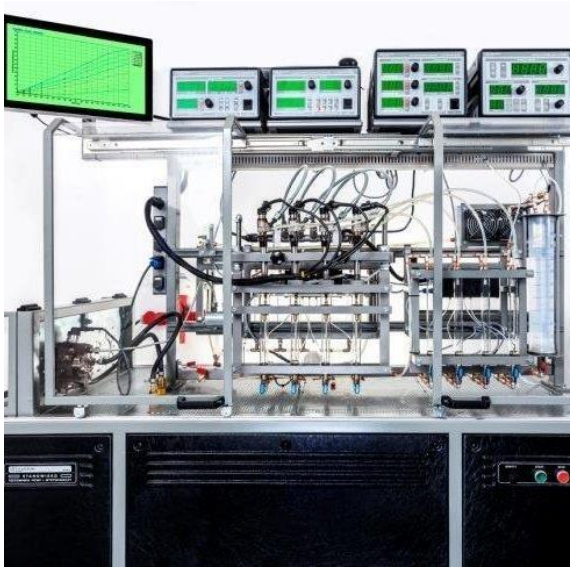
Brake lining rivet machine is an automatic riveting machine that performing automatic feeding rivets by turning feeder bowl, and auto riveting when stepping on the foot pedal. RMI has also manufacture Hydraulic Brake Relining Machine with riveting and de-riveting function, which is driven by hydraulic power for both riveting and de-riveting machines.

Applications

Brake Shoe Lining Riveting Machine is used to riveting brake linings in high production for brake shoe factory, and also widely used in brake relining for repairing warehouse. It is one kind of automatic feeding rivet machine, which feeds rivets automatically in bulk no matter tubular rivets, semi-tubular rivets and solid rivets. Workers operate the machine by stepping foot pedal and loading brake lining, it is unnecessary to manually feed rivets every time. To increase production and save labor cost, automatic feed riveting machines are widely used in many industries including drum brake replacement, clutch plate, baby stroller, folding chair, beach chair, etc.

Fuel injection pump test bench

Testing and calibrating the fuel-supply amount of each cylinder and fuel-supply uniformity of mechanical injection pump. Testing the fuel-supply spacing of each cylinder and fuel supply starting point in the static state. Testing and calibrating the performance of mechanical speeder.



Various servicing and testing procedures of fuel Injectors

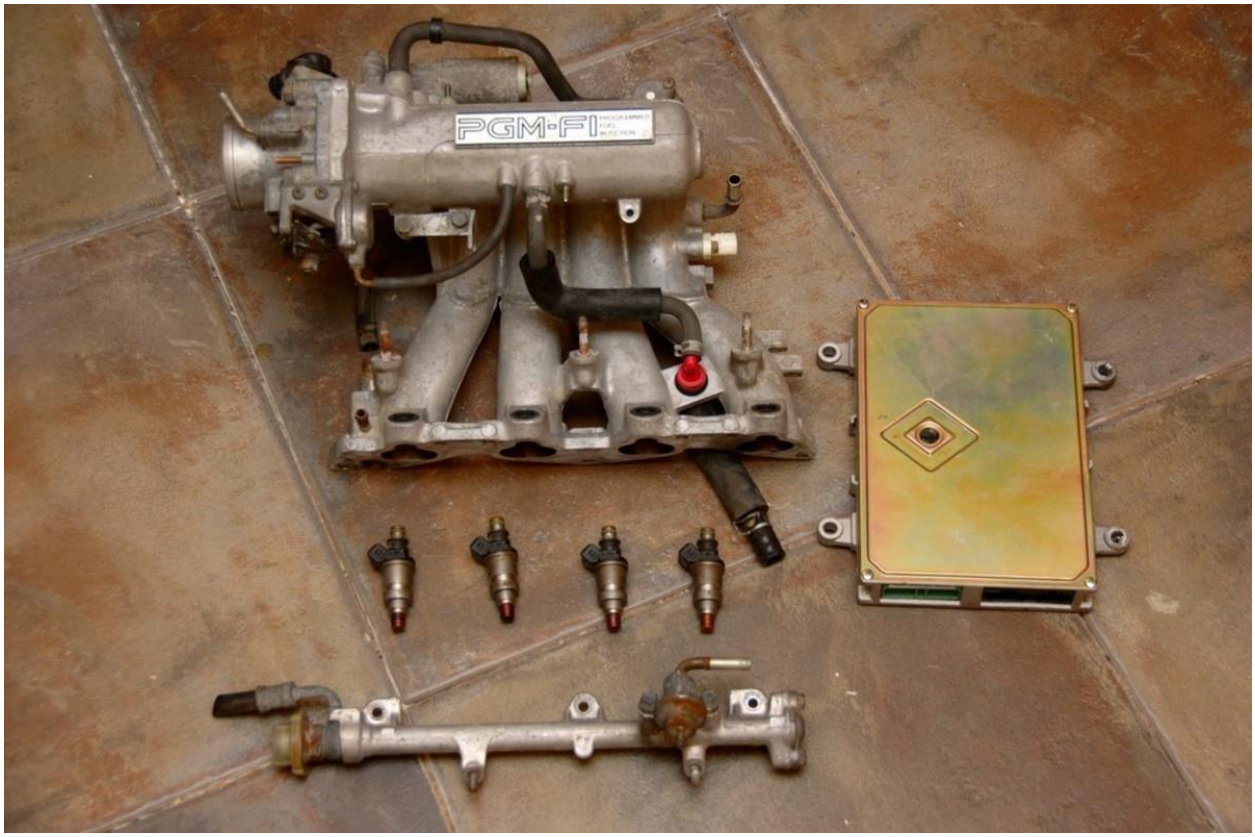
Checking Fuel Spray

1. Remove the cover off the air cleaner housing (where the air filter lives).
2. Ask an assistant to start (or crank the engine, if it doesn't start).
3. Check the spray pattern coming our of the injector.

* Fuel should come out partially atomized in an inverted V pattern. A single, solid spray or irregular pattern means the injector needs cleaning, or that an internal part wore out or broke.

***** On the other hand, if you don't see fuel coming out, there may be several reasons for this:

- Blocked fuel injector
- Bad injector
- Injector not receiving power
- Bad fuel pressure regulator
- Fuel filter clogged
- Bad fuel pump



How does fuel injection service work?

Fuel injector service is a must to preserve the performance of your vehicle. Fuel injectors are located in the intake manifold and spray fuel through a tiny nozzle. The fuel injector uses a special nozzle to spray the fuel as mist, instead of a strong jet stream. Just think of the nozzle on the hose you use in your yard. You can change how the water flows out of your nozzle. There can be jet stream, shower, mist, and many more settings. A fuel injector must spray fuel as a mist because it's easier for your engine to burn. When you step on your gas pedal, your vehicle's throttle valve (which is a valve that opens and lets air into your engine) works in conjunction with your fuel injectors. When the throttle valve opens, your fuel injector sprays fuel to mix with the air and then enters the engine's combustion cylinders. Fuel injectors can become dirty and clogged over time, which will lead to poor performance, bad gas mileage, and even dirty exhaust emissions.

A fuel injector can become clogged around its valve and nozzle. The opening on a fuel injector's nozzle is very minute; since a fuel injector's nozzle must spray a fine mist, any tiny build-up of fuel can affect the fuel injector's performance. Build-up can consist of wax, dirt, and other carbon deposits. Most build-up occurs from short trips, meaning a vehicle that normally travels for only fifteen minutes; low-quality gasoline that does not contain detergents also causes build-ups. Detergents can actually clean a fuel injector while you are driving, but many refineries are removing the detergents from their fuel to sell gas at a cheaper price.

If a fuel injector is dirty or clogged, your engine won't get the necessary flow of fuel to mix with the air, which will lead to poor acceleration, engine performance, and gas mileage.

Fuel injection service can be done with leaving the fuel injector in the vehicle or taking it out.

Almost all of the time, fuel injection service can be done with the fuel injector still in the car, unless it needs to be replaced. During a full fuel injection service, several things are done: your fuel pump's pressure and volume is checked; your pressure regulator is checked; your fuel rail, which is the pipe that sends the fuel from your pump to your fuel injector, and fuel injector screen is flushed; your fuel injectors are flushed and cleaned; your throttle valve and air passages are flushed; and your engine's computer is checked to make sure the air/fuel mixture is correct and all of the sensors are working.

Fuel Injector cleaning steps:

1. Injectors are ohm tested for resistance. If they fail this test no further attempt will be made to clean them.

2. Then the dirty injectors are externally cleaned, visually inspected, and numbered.
3. Leak testing is done.
4. The fuel injectors are then tested for inductance, shorts, and current draw.
5. Now spray pattern, and injector flow rate tests are performed and recorded.
6. Filter baskets, O-rings, and pintle caps are removed if needed or where applicable .
7. A three step **ultrasonic cleaning process** is performed. During this processes the injectors are pulsed at various rates. This ensures complete results. Only biodegradable environmental friendly chemicals are used .
8. After ultrasonic cleansing a high pressure back-flush is performed to remove any remaining particles that might be left inside the injector and to flush out water based ultrasonic cleaning fluids.
9. The injectors, fuel or air, are now retested for: leaks, spray pattern and flow, and the results are recorded.
10. New filter baskets, O-rings, and pintle caps are installed if and where applicable.
11. The injectors are lubricated and placed in sealed Poly bags.
12. A comprehensive test report is prepared and returned with the injectors

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Short answer question

1. What is direct measuring equipment?
2. Write the angular measuring equipment.
3. Write the Instruments on the dash board.

Long answer questions

1. Explain direct and indirect measuring equipment.
2. Explain any five instruments on the dash board.
3. Explain safety precautions
   A).in handling tools
   B). in auto garage.

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6. Measuring equipment & safety

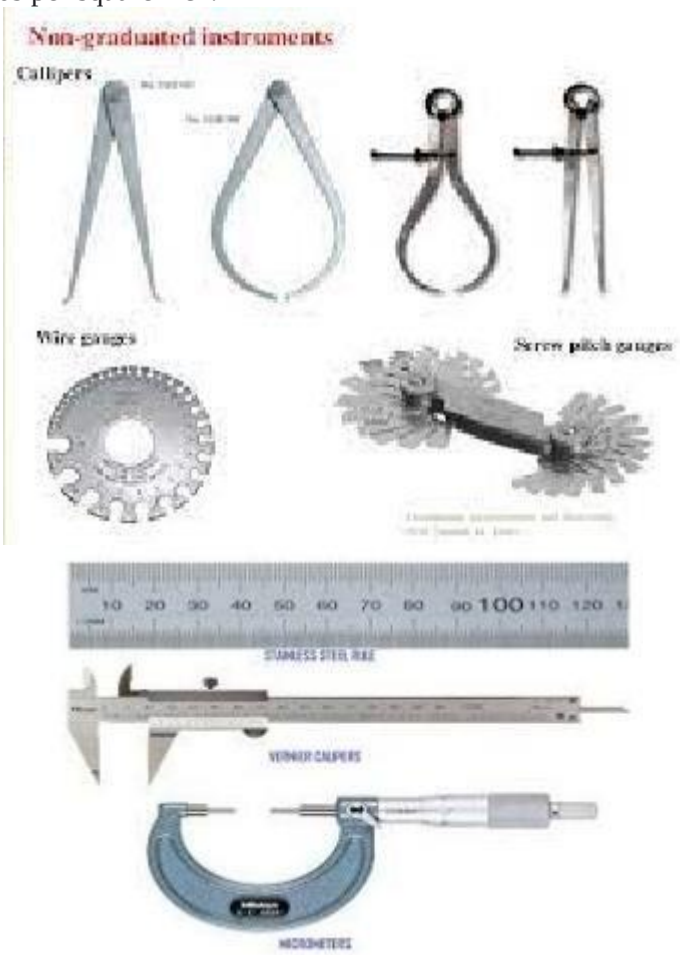
Direct and Indirect measuring equipment

There are two methods for performing dimensional measurements: direct measurement and indirect measurement. With direct measurements, measuring instruments such as Verniercalipers, micrometers, and coordinate measuring machines are used to measure the dimensions of the target directly.

Direct measures are those that measure student learning by assessing actual samples of student work. Examples include: exams/tests, papers, projects, presentations, portfolios, performances, etc.

Indirect Measures of student learning assess opinions or thoughts about student knowledge, skills, attitudes, learning experiences, and perceptions. Indirect measures include surveys, focus groups, and other activities that gather impressions or opinions about the program and/or its learning outcomes.

The indirect method of level measurement involves converting readouts and data of a known quantity, such as pressure ratio to the volume. Because all known substances have some weight and therefore exert a measurable force over a specific area within the equipment, this force can be measured in pounds per square inch.



Angular measuring equipment

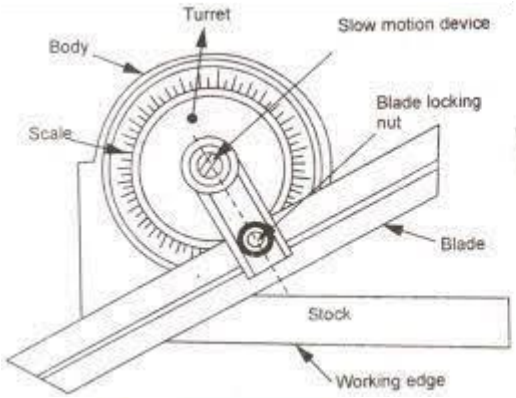
Types of Angular Measuring Instruments:

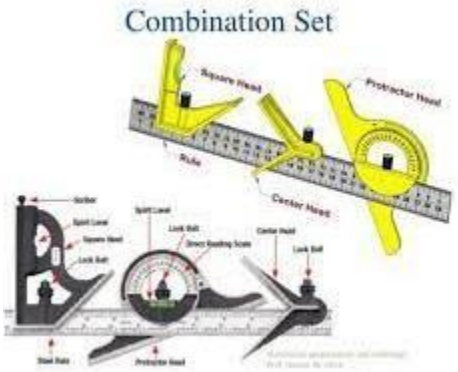
- Line Standard Angular Measuring Devices. Protractor. Universal Bevel Protractors.
- Face Standard Angular Measuring Devices. Sine bar. Angle Gauges.
- Measurement of Inclines. Spirit Level. Clinometers.
- Angle Comparators. Angle Dekker.

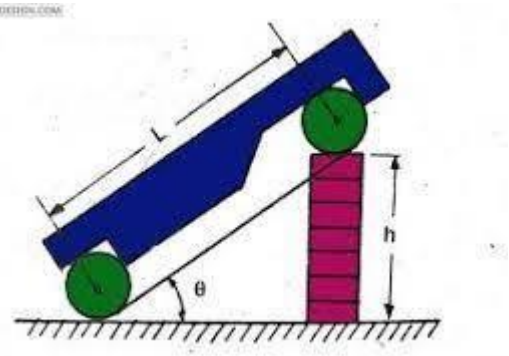
There are several types of measuring tools that measure angles and they fall into one of three categories: protractors, squares and compasses. There are many variations of these basic categories. A protractor is the most common device used to measure angles.

Vernier Bevel Protractor (Universal Bevel Protractor):

It is a simplest instrument for measuring the angle between two faces of a component. It consists of a base plate attached to a main body and an adjustable blade which is attached to a circular plate containing Vernier scale.







The combination set consists of scale, squaring-head, protractor and centre-head. It consists. Of a heavy scale, this is grooved all along its length. It is on this groove that sliding squaring head. is fitted. Combination square sets include a ruler and one or more interchangeable heads that can be affixed to it. 12-inch combination squares are common and adjustable square heads available as well. Combination squares are often used for measuring angles and industrial things properly.

A combination square is a multi-purpose measuring and marking tool used in metalworking, woodworking, and stonemasonry. It is composed of a rule and one or more interchangeable heads that can be attached to the rule.

The centre head is primarily used for determining the centre of round objects (such as rods) but can also be used to measure 45 degree angles (when attached to the rule) and to determine whether an angle is a right angle (when removed from the rule).

How to Use a Combination Square

1. Place the anvil of the square against the edge of the working surface you wish to cut.
2. Draw a line along the blade edge until your pencil reaches the anvil of the combination square.
3. Once completed, the line should be a perfect 90° angle with the edge of the working surface.

Dial Indicator/gauge and other gauges

The dial indicator is used to indicate the run-out (the misalignment between the work piece's axis of rotational symmetry and the axis of rotation of the spindle) of the work piece, with the ultimate aim of reducing it to a suitably small range using small chuck jaw adjustments.

The Dial Indicator has a plunger and reads how far the plunger is raised by the surface below. The Dial Test Indicator has an arm that sweeps an angle Once again, a Dial Indicator measures how far up the plunger moves while the Dial Test Indicator measures how far the tip of a needle moves when deflected sideways.

The Dial Indicator is a mechanical device that consists of pinions, gears or levers. By the means of a dial indicator precision of a work piece can be measured by an engineer. It is working as a comparator also.

Dial indicators are one of the primary measuring tools used in precision engine building. They are typically used to measure deck clearances, crankshaft thrust and straightness, lifter travel and other measurements that involve the distance between two surfaces or small amounts of component travel.

Remember that the larger gauge represents a smaller measurement, so while the small gauge might measure in tenths, the outer gauge measures in thousandths. If the hand is pointing at 30, then it means 30 thousandths. To calculate the measurement, divide the number by 1,000. For example, 30/1000=0.030-inches.

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

Instruments on the dash board of a vehicle

Contemporary dashboards may include the speedometer, tachometer, odometer, engine coolant temperature gauge, and fuel gauge, turn indicators, gearshift position indicator, seat belt warning light, parking-brake warning light, and engine-malfunction lights.

The minimum numbers of gauges on a passenger car dashboard are the speedometer and the fuel gauge. The most common additional gauge is the temperature gauge followed by the tachometer, voltmeter and oil pressure gauge.

Speedometer, which indicates the speed in both miles and kilometers per hour. Tachometer, which indicates rotations in the engine in revolutions per minute (RPMs) Odometer, which indicates the total number of miles your **car** has been driven since it was manufactured.

1. Oil Pressure Light.
2. Tire Pressure Warning Light.
3. Engine Temperature Warning.
4. Traction Control Light.
5. Anti-lock Brake Warning Light.
6. Traction Control Malfunction.
7. Engine Warning (Check Engine Light)
8. Battery Alert
9. Low Fuel Indicator
10. Automatic Shift Lock or Engine Start Indicator
11. Seat Belt Reminder
12. Air bag indicator

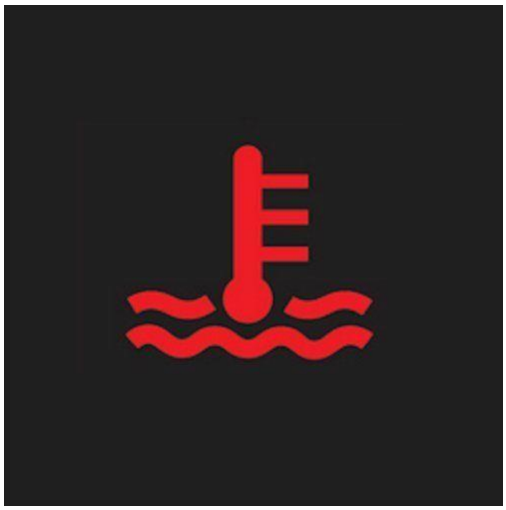
1. Oil Pressure Light

This old fashioned oil can image indicates that there is an issue with your car's oil pressure system. Either you're running low on oil or your oil pump isn't circulating enough fluid to properly lubricate the surfaces inside your vehicle. This should be addressed as soon as possible, as your engine can wear quickly without proper lubrication.

2. Tire Pressure Warning Light

Also known as the TPMS symbol, this image signals that the pressure in one or more of your tires is too low or too high and needs to be addressed. Driving on low- or high-pressure tires is unsafe and can cause additional damage to your vehicle. Usually, tire pressure should be between 30 and 35 psi (pounds per square inch).

3. Engine Temperature Warning



If you see this symbol pop up, it means that your engine is overheated. This most likely has to do with your coolant (also called antifreeze), but it can happen for a variety of reasons. It's important to address this immediately to avoid further damage.

4. Traction Control Light

This indicates that your vehicle's traction control system is activated. The traction control system utilizes your anti-lock brake system to determine if one wheel is spinning faster than another. If it detects that a wheel is slipping, it applies the brakes until it regains traction. This is most helpful if you're driving in rain or snow.

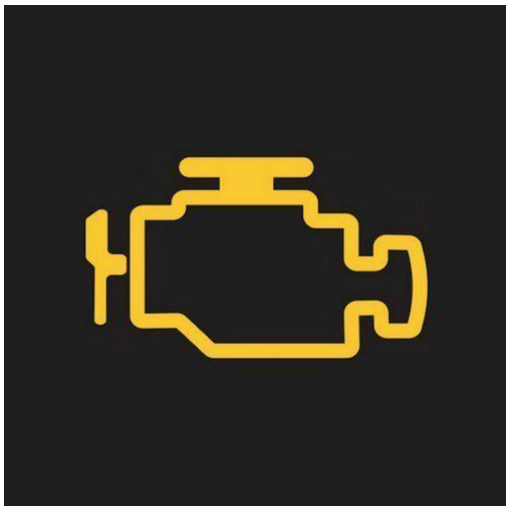
5. Anti-lock Brake Warning Light

Speaking of your anti-lock brakes, if this “ABS” warning lights up while you’re driving, it means that something is wrong with the system. As you know, your anti-lock brakes work to keep your car in contact with the road safely, so it’s important to diagnose the issue as soon as possible. Keep in mind, every time you turn on your vehicle, the system does a self-check, and may light up for just a few seconds. If it goes away immediately, your system is in working order.

6. Traction Control Malfunction

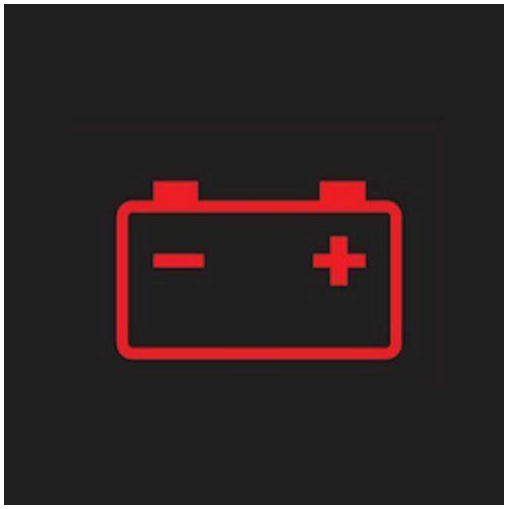
This light indicates that your vehicle’s traction control system might have a broken or damaged sensor or some other malfunction. In some cars, the same control module operates the anti-lock brakes and the traction control system, so the light sometimes comes on when there are problems with your ABS.

7. Engine Warning (Check Engine Light)



Your check engine light may appear for a variety of reasons. Sometimes, it can indicate a serious issue and require you to pull over immediately. This could indicate low oil pressure or overheating. Other times, this light will appear if your gas cap is open, loose, or cracked, causing fuel to evaporate.
If this light appears, it's wise to pull over and check your gas cap and other systems in your vehicle. If it's flashing, you should definitely stop driving! In most vehicles, a flashing check engine light signals that you have a serious problem that could cause serious damage if ignored.

8. Battery Alert



This symbol indicates that there is an issue with the vehicle's charging system.
Interestingly enough, the culprit might not be your battery. While it might indicate that you have a loose or damaged battery cable, it can also signal that your alternator belt is broken.

If it is your battery, occasionally you'll notice that your clock is fading or your headlights are dimming. If you wait too long, your vehicle can completely conk out. This is what has happened when you see fellow drivers "jumping" each other's cars.

Not sure what the problem is? Our experts can help diagnose any battery-related or electrical issues, and if you need a new battery, we offer America's No. 1 battery replacement—Interstate Batteries.

9. Low Fuel Indicator

Most drivers are very familiar with this symbol. It simply means you're running low on gas. It's not a good idea to see if you can make it home if you have a ways to go. You never know how weather or traffic patterns will play out, so it's best to stop at the nearest gas station and fill up.

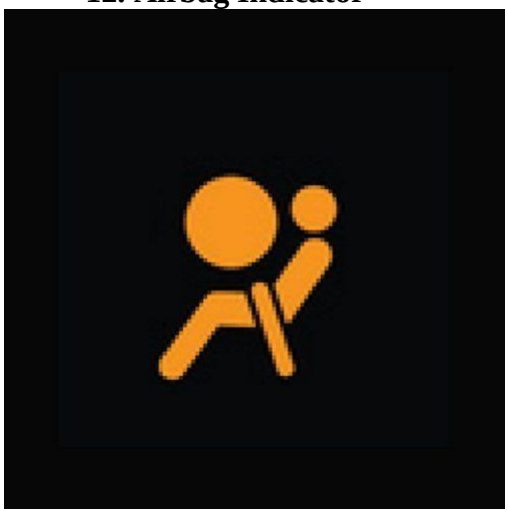
10. Automatic Shift Lock or Engine Start Indicator

If you see this symbol, you're most likely trying to shift gears or start your ignition without engaging the brake. The automatic shift lock will lock your vehicle in park or neutral until you engage the brake.

11. Seat Belt Reminder

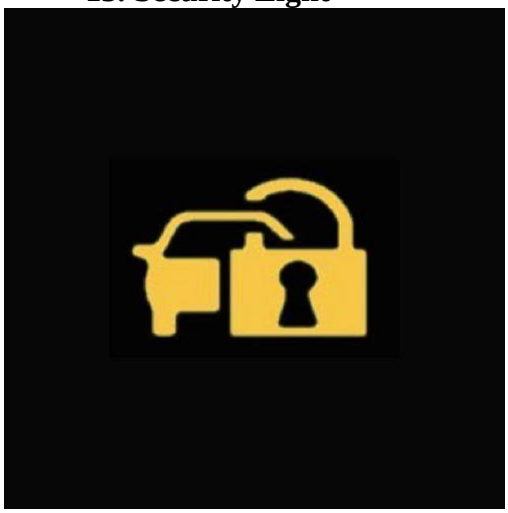
This symbol is simply reminding you or your passenger to buckle up! According to the CDC, seat belts decrease serious crash-related injuries by about 50%.

12. Airbag Indicator



The airbag indicator signals that something is wrong with one of your airbags or the system as a whole. Your car's airbags keep you safe during accidents, so it's important to address this issue immediately.

13. Security Light



If your vehicle has an anti-theft system, this image means that something could be malfunctioning. This symbol also briefly lights up when you turn your vehicle on, which isn't an indicator that something is wrong.

14. Fog Lamp Indicator

This symbol is telling you that your fog lights are on. Fog lights should only be used if your visibility is less than 100 meters. If you turn them on unnecessarily, this can be detrimental to other drivers on the road.

15. Washer Fluid Indicator

Imitating the motion of your windshield wipers, this symbol means that you're low on washer fluid. You'll want to fill up the reservoir with fluid as soon as you can.
Keep in mind that every car is different, so the symbols on your dashboard may vary slightly from the 15 we've mentioned. If in doubt, consult your vehicle's owners manual.

Safety

Car safety features

- Airbags.
- Anti-Lock Brakes.
- Convex rear view mirror.
- Laminated and high strength automotive glass.
- Vehicle over speed warning devices.
- Seatbelts.
- Stability Control Systems.
- Jack safety.

Precautions in Handling of Tools

- Inspect regularly. Regularly inspect your **tools** to make sure that they are in good condition.
- Wear gloves. Always wear appropriate personal protective **equipment**.
- Carry with care. Never carry **tools** up a ladder
- Don't pocket sharp objects.
- Be aware of your surroundings.
- Use the right **tools**.
- Follow instructions.
- Clean and return.

Safety precautions in Auto garage

- Never smoke in or near repair bays or garages.
- Keep work areas clean and organized.
- Never wear loose clothing or clothing that is ripped or torn.
- Wear protective gear at all times, as appropriate for the repair.
- Make sure fire extinguishers are easily acceptable and appropriate for all potential fire types.

General Safety Rules

- Be sure you know how to perform the job and perform it safely.
- Be sure you know its hazards and how to protect yourself. ...
- Report all near misses, incidents, injuries and illnesses immediately.
- Wear the required personal protective equipment necessary for the job. ...
- Always work clear of suspended loads.

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Short answer question

1. What is direct measuring equipment?
2. Write the angular measuring equipment.
3. Write the Instruments on the dash board.

Long answer questions

1. Explain direct and indirect measuring equipment.
2. Explain any five instruments on the dash board.
3. Explain safety precautions
   A).in handling tools
   B). in auto garage.

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7. Denting and painting

Common Dent causes

Six Common Causes of Car Dents

- Grocery Carts. People in grocery store parking lots can be careless or just don'tcare and you end up with a dent in your car as a result.
- Automobile Doors.
- Weather.
- Falling Tree Branches.Road
- Debris.
- Tight Parking or Other Spaces.

If a shopper leaves a cart in an unoccupied place, the cart might careen into and dent your car. Your car can also suffer dents when an adjacent motorist carelessly opens their car's door. Such accidents are common in parking lots with closely parked cars. The weather is also a common cause of car dents.

Denting Tools and materials

Denting & Painting

- EquipmentC Clamp.
- Engine Aligner. Hydraulic
- Trolley Jack. Vehicle Positioning
- Jack.Car Dolly.
- Polisher.
- Pneumatic Polisher. Bosch
- Drilling Machine.

Denting process

The Denting process removes visible deformities on the exterior body of the car. In case of accidents, collision of vehicle denting and painting of the parts are preferred as it helps save the additional cost of the new part used. The work also is carried out in such a manner that the part looks as good as new.

A depression in a surface made by pressure or a blow: a dent in the side of a car. Informal A significant, usually diminishing effect or impression: The loss put a dent in the team's confidence. 3. Informal Meaningful progress; headway: at least made a dent in the work.

Fender bender at low speed – a minor auto collision at a low speed will always result to car bumper dents. Miscellaneous reasons – other car dent causes include parking too closely to the curb, driver error, encountering road debris and even people riding bicycles.

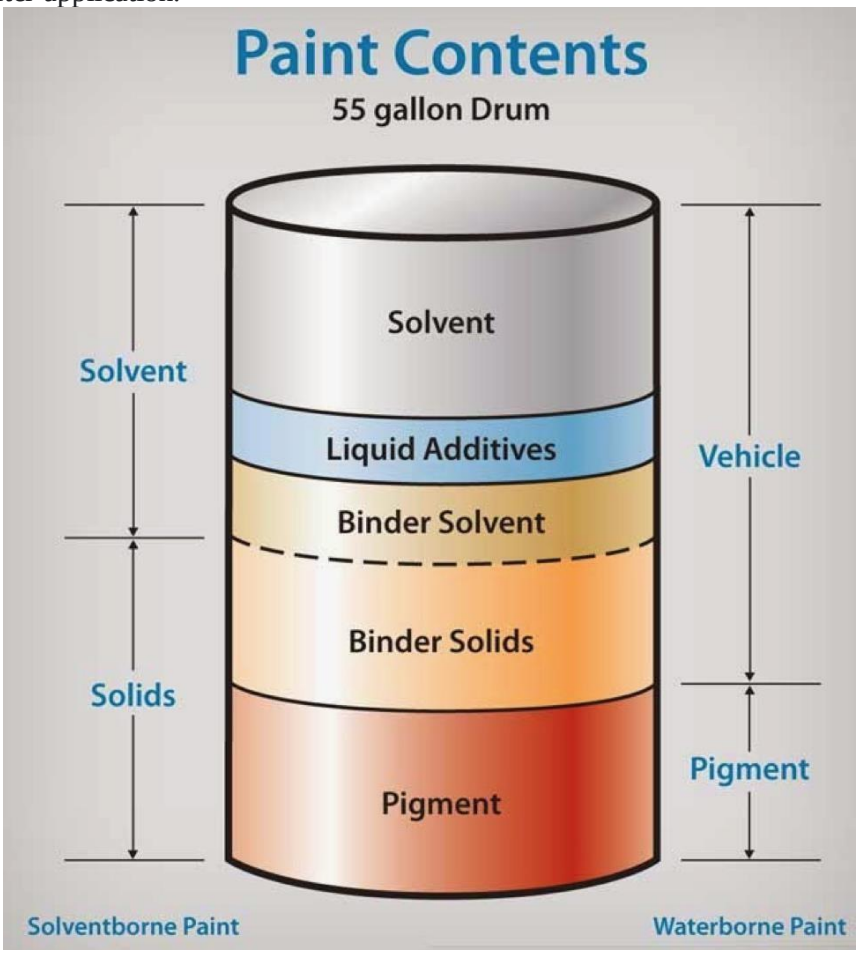
Painting

1. Choose Your Location Wisely. Before you begin any actual **painting**, you will need to find a suitable location for your DIY project.
2. Remove rust, dents, and trim.
3. Sand.
4. Clean.
5. Tape Surfaces.
6. Prime.
7. Allow primer to cure.
8. Sand once more.

A typical automotive coating system consists of four layers namely the e-coat, the primer or filler, the basecoat and the clear coat, and the latter two-layers are combined into the topcoat.

Main constituent of paints

Most paints consist of the same basic components: pigments, binders, liquids, and additives. Each component serves a role in determining the quality of the paint as well as its performance both during and after application.



Paints are variable combinations of:-
– Binder
– Pigment
– Filler/ Extender
– Volatile organic compound (Thinner)
– Driers
– Additives (Anti skinning agents, Anti settling agent, Plasticizers, fire retardants etc.

"Binders are usually resins or oils but can be inorganic compounds"
• the actual film forming component & absolutely required ingredient of any paint
• Consists of a resin and a solvent thinner
• It is the part which solidifies to form the dry paint film when the solvent evaporates
• Non-volatile & mainly polymers of various types. They are alkyd, epoxy, polyurethane resins etc
• Different resins form dry film on the substrate in different manners
• Alkyd resins (widely used binders) form dry film simply by volatilization as well as by oxidation in presence of air
• Epoxy & PU resin mainly dry through chemical reactions

Purpose: – Binds pigment, fillers & additives together – Imparts adhesion & strongly influences:
• Gloss • Durability • Flexibility • Toughness Binders include resins:- • Alkyds, Polyurethanes (PU), Epoxy, Polyesters Binder PIGMENTS "Pigments are finely ground inorganic or organic powders of higher RI (> 1.5) – Higher the RI, more the light is bent & greater the opacity – Good opacity has good lighting absorbing & /or scattering properties – Average diameter ranges from 0.01 to 5µ

PROPERTIES OF PIGMENT
• should be opaque so that it may have good covering power. – When a coating is opaque the pigment particles scatter &/or absorb light sufficiently to prevent it from reaching the substrate – Opacity depends on two characteristic properties:
• Refractive Index (RI) – If the particles do not have a high RI, less the bending of light travelling & thus insufficient hiding of the substrate.
• Particle size: – Particle size has also an effect on the effectiveness of the pigment. As the particle size decreases , opacifying ability increases.
• Should be non-toxic so that they have no bad effect on health of painter & inhabitants

PURPOSE OF PIGMENT Purpose: Pigment plays a major role to attain the following essential properties of paint system – provides colour, opacity, film cohesion and sometimes corrosion inhibition – provides aesthetic look to the paint – obliterates the substrate and previous colour on the substrate, if any – protects the film by reflecting the destructive UV light

PIGMENTS Widely used pigments: White Lead, Zinc Oxide, Titanium Dioxide, Red Oxide, Carbon Black, Prussian Blue, Chrome Yellow, Aluminum powder etc. * [Titanium dioxide is extensively used because it has good covering power). Titanium is an excellent reflector of infrared].

EXTENDER /FILLER Non -expensive commonly natural inorganic materials added to the paint in order to increase its volume.(RI<1.5)

Extenders are mainly inorganic substances & do not provide colour to the paint but added to improve adhesion, ease of sanding and film strength

• As they are cheap in comparison to prime pigments, they reduce overall cost of the paints
• Average dia: up to 50µ

EXTENDER/FILLER Properties:

• Do not provide colour
• Poor optical properties (reflectance, opacity, etc)
• It improves adhesion • If extender pigment added are of needle shaped or flaked shape, the settling may be very little Purpose: – thickens the film – Increases volume, paint film thickness – reduces cost of the paint – imparts toughness, abrasion resistance & texture – Control consistency Widely used fillers:- – Calcium carbonate, Gypsum, Ground silica, Barytes, Slate powder ,French chalk, china clay, asbestos, silica, mica, whiting etc.

VOC/THINNER "Liquid used for viscosity adjustment for correct application"
• Used to dissolve the binder and to facilitate application of paint.

Solvents are
• usually organic liquids or water.
• not a part of the paint film.
• Excessive thinner dulls the colour& gloss
• Most hazardous due to its toxicity & flammability
• Once the solvent gets evaporated, the remaining paint is fixed on to the surface
Purpose:-
• Control flow and application properties
• Act as carrier for binders & pigments
• Help penetration into porous surfaces
• Used to clean brushes & other painting tools

VOC/THINNER Widely used thinner:
• Turpentine oil (distilled pine tree sap): the most commonly used thinner
• Benzene & Naphtha: as substitute.
• Mineral spirit, acetone, carbon tetra chloride, ethyl alcohol

DRIERS
• Depending upon the nature of the solvent and film thickness, the drying process may take as long as several hours. – Thicker the film, longer the drying time. If the drying process is artificially accelerated, there may be problems with adhesion between the protective film and the metal surface.

• Metallic salts of Lead, Manganese, Cobalt, etc. of organic acids – Easily soluble at ordinary temp – Added in small quantity – One drier should be used at a time – Added to the paint just before use.
Purpose:- – to accelerate the drying process.
Examples:- • Lead acetate, Cobalt octate, Manganese octate, Litharge, Red lead, Lead octate, Manganese dioxide, Zinc sulphate, etc.

CORROSION INHIBITOR "A compound which prevents corrosion by forming a metal oxide layer"
• The surface becomes passivated.
Purpose:-
• To protect the substrate from corrosion Commonly used corrosion inhibitors:
• Sodium molybdate
• Zinc molybdate

ADDITIVES "Additives are small amounts of different chemical substances improving or modifying the paint properties.
• Added to a paint in amounts 0.001% & ≤ 5% & have a profound influence on physical & chemical properties of the paint
• Prevent clustering of pigments
• Surfactants such as polyoxyethylene ethers of dodecyl alcohol,
e.g. C12H25O (CH2 . CH2 .O)6H is added to attain compatibility of different material in the paint system

ADDITIVES
• Driers accelerate the paints drying (hardening) by catalyzing the oxidation of the binder.
• Plasticizers (liquids of mol wt higher than that of solids to limit volatility) increase the paints flexibility, durability, compatibility &minimize film cracking
• Fungicides, Biocides and Insecticides prevent growth and attack of fungi, bacteria and insects. (Protect the paint in storage from spoilage due to bacterial growth)
• Flow control agents improve flow properties.
• Deformers prevent formation of air bubbles entrapped in the coatings.
• Emulsifiers are wetting agents increasing the colloidal stability of the paints in liquid state.

ADDITIVES • UV stabilizers provide stability of the paints under ultra-violet light.
• Anti-skinning agents prevent formation of a skin in the can.
• Adhesion promoters improve the adhesion of the coating to the substrate.
• Corrosion inhibitors reduce the corrosion rate of the substrate.
• Texturizers impart textures to the coatings.
• Antifreezers helps to withstand exposure
• Pigment stabilizers improve pigment stability
• Fire retardant properties
• Anti settling

Methods of painting

- Oil Painting: The oil painting is the most widely known and common form of painting that has been in existence.
- Watercolor Painting:
- Pastel Painting:
- Acrylic Painting.
- Charcoal Drawing:
- Coloured Pencil:
- Pencil Sketch:
- Ink Painting:

Painting Procedure

- Oil Painting: The oil painting is the most widely known and common form of painting that has been in existence.
- Watercolor Painting:
- Pastel Painting:
- Acrylic Painting:

A typical automotive coating system consists of four layers namely the e-coat, the primer or filler, the basecoat and the clear coat, and the latter two-layers are combined into the topcoat.

- Painting a car requires a suitable environment with zero dust around and excessive moisture which means that you cannot paint your car in the open air. You need to have a closed room for this purpose; a room with no dust and extra moisture than required.
- In a suitable environment, suitable tools are also required. There are a number of tools that are necessary to paint a car; a tool to sand the vehicle, a tool to paint it, a tool to protect unwanted areas from being painted. All these tools help to entirely paint a vehicle and complete the process successfully with desired results.
- Additionally, we are going to be talking about the rust spots and the right way to deal with those rust spots. You cannot directly paint on those rust spots if you want your paint to stay there for a long time. Treatment of those rust spots is very important, and there is a proper way to treat them.
- It will be followed by discussing the way to get rid of dust particles if any because paining a car is a very detail based work and a minor dust particle might lead to an undesired result or untidy work. We will be looking for a smooth and dusk free body of the vehicle before we start painting the car.
- Once satisfied with the dust-free body of the car, the use of sprayers will be discussed to paint the car. This is the actual step that would leave the most visible impression on the viewer. But you will still have to execute one more step in order to complete the procedure of painting your car.

Reasons for Failure of paint

- Improper cleaning or preparation of substrate.
- Failure to remove sanding dust or other surface contaminants.
- Improper metal treatment.
- Use of incompatible materials or not properly mixed.
- Condensation on substrate due to temperature changes.
- Flash off/drying times too short.

Most often, it's caused by a poor paint job or prolonged exposure to the sun. Dings and damage to the clear coat that exposes the underlying paint can also cause peeling. To prevent it, protect your car from the elements and have any finish damage repaired right away.

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Short answer question

1. How the common Dent causes?
2. Write the tools used in Denting.
3. Write the main constituents of paint.
4. Write the methods of painting.
5. Write the reasons for failure of paint.

Long answer questions

1. Explain Denting process.
2. Explain main constituents of paint.
3. Explain painting procedure.

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Mechanical & Auto Mobile Technician

Paper – II

AUTO COMPONENTS AND OTHER SYSTEMS

INDEX

1. Chassis and body

Introduction

Chassis is a French term and was initially used to denote the frame parts or Basic Structure of the vehicle. It is the back bone of the vehicle. A vehicle without body is called Chassis. The components of the vehicle like Power plant, Transmission System, Axles, Wheels and Tyres, Suspension, Controlling Systems like Braking, Steering etc., and also electrical system parts are mounted on the Chassis frame. It is the main mounting for all the components including the body. So it is also called as Carrying Unit.

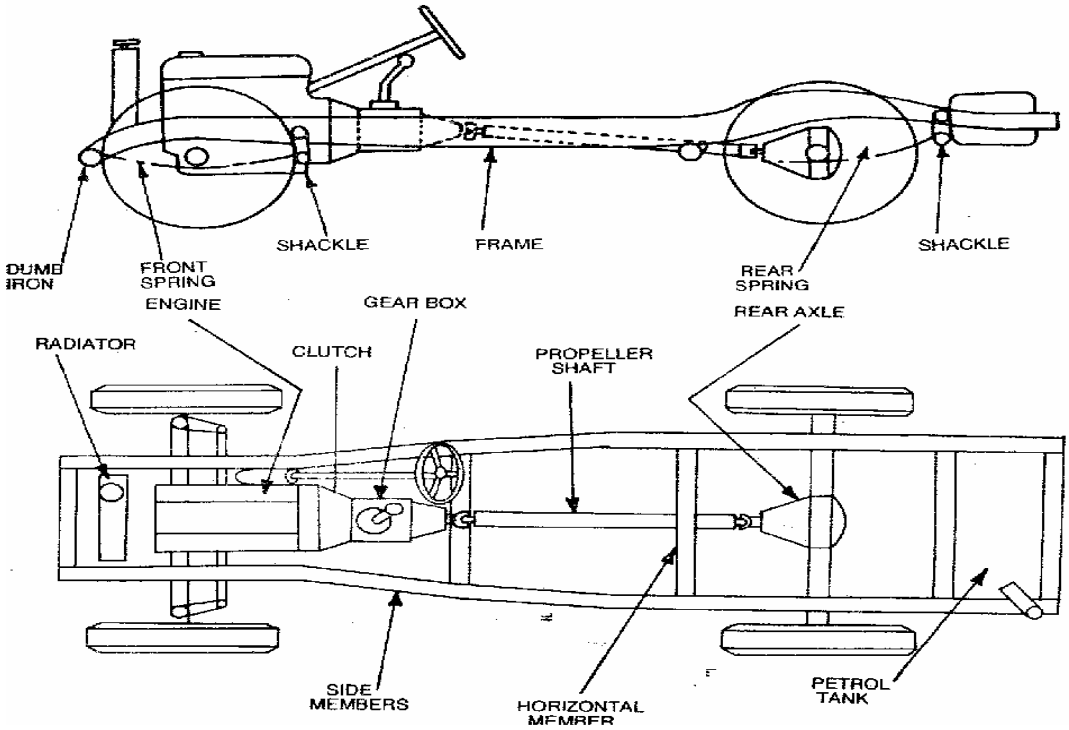
Chassis is the supporting frame of a structure (such as an automobile or television) Leaf springs are attached to the car's **chassis**. Also: the frame and working parts (as of an automobile or electronic device) exclusive of the body or housing.

What is An Automobile Chassis?

Chassis is the main support structure of the vehicle which is also known as 'Frame'. It bears all the stresses on the vehicle in both static and dynamic conditions. In a vehicle, it is analogous to the skeleton in living organisms. The origin of the word Chassis lies in the French language. Every vehicle whether it is a two-wheeler or a car or a truck has a chassis-frame. However, its form obviously varies with the vehicle type.

Chassis Major components

The chassis comprises the following components: wheels, wheel carrier, wheel bearing, brake, wheel suspension, axle support, suspension (including anti-roll bar).



The following main components of the Chassis are
1. Frame: it is made up of long two members called side members riveted together with the help of number of cross members.
2. Engine or Power plant: It provides the source of power
3. Clutch: It connects and disconnects the power from the engine fly wheel to the transmission system.
4. Gear Box: The gearbox provides different speeds according to load and speed of the vehicle.
5. U Joint: These are universal joints used to connect two shafts at any angle. The universal joint is used to joint the gearbox to the propeller joint. Also the propeller joint is joint to the differential joint by another universal joint.
6. Propeller Shaft: It is a long hollow shaft used to transmit power from the gearbox to the differential assembly.
7. Differential: The differential provides different speed to the rear wheels when the vehicle is making a turn.

Construction of Chassis:

The frame is designed to support the weight of the body and absorb all of the loads imposed by the terrain, suspension system, engine, drive train, and steering system. The body merely contains and, in some cases, protects the cargo. The body generally is bolted to the frame at a few points to allow for flexure of the frame and to distribute the loads to the intended load-carrying members. The components of this type of frame are the side members, the cross members, and the gusset plates

The side members, or rails, are the heaviest part of the frame. The side members are shaped to accommodate the body and support the weight. They are narrow toward the front of the vehicle to permit a shorter turning radius for the wheels, and then widen under the main part of the body where the body is secured to the frame. Trucks and trailers commonly have frames with straight side members to accommodate several designs of bodies and to give the vehicle added strength to withstand heavier loads. The cross members are fixed to the side members to prevent weaving and twisting of the frame. The number, size, and arrangement of the cross members depend on the type of vehicle for which the frame was designed. Usually, a front cross member supports the radiator and the front of the engine. The rear cross members furnish support for the fuel tanks and rear trunk on passenger cars and the tow bar connections for trucks.

Additional cross members are added to the frame to support the rear of the engine or power train components. The gusset plates are angular pieces of metal used for additional reinforcement on heavy-duty truck frames. With this type of frame construction, the body structure only needs to be strong and rigid enough to contain the weight of the cargo and resist any dynamic loads associated with cargo handling and cargo movement during vehicle operation and to absorb shocks and vibrations transferred from the frame. In some cases, particularly under severe operating conditions, the body structure may be subjected to some torsional loads that are not absorbed completely by the frame. This basically applies to heavy truck and not passenger vehicles.

In a typical passenger vehicle, the frame supplies approximately 37 percent of the torsional rigidity and approximately 34 percent of the bending rigidity; balance is supplied by the body structure. The most important advantages of the separate body and frame construction are as follows:

• Ease of mounting and dismounting the body structure.

• Versatility--various body types can be adapted to a standard truck chassis.

• Strong, rugged designs—these are easily achieved, though vehicle weight is increased.

• Isolation of noise generated by drive train components from the passenger compartment through the use of rubber mounts between the frame and the body.

• Simplistic design that yields a relatively inexpensive and easy manufacturing process.

Frame members serve as supports to which springs, independent suspensions, radiators, or transmissions may be attached. Additional brackets, outriggers, and engine supports are added for the mounting of running boards, longitudinal springs, bumpers, engines, towing blocks, shock absorbers, gas tanks, and spare tires.

Functions of Chassis Frame

1. Supports or bears the load of the vehicle **body**. To carry load of the passengers or goods carried in the body
2. Provide the space and mounting location for various **aggregates** of vehicle. To support the load of the body, engine, gear box etc.,
3. Supports the weight of various systems of the vehicle such as engine, transmission etc. To withstand the forces caused due to the sudden braking or acceleration
4. Supports a load of passengers as well as the luggage.
5. To withstand the stresses caused due to the bad road condition.
6. To withstand centrifugal force while cornering

The main functions of a frame in a motor vehicle are: To support the vehicle's mechanical components and body. To deal with static and dynamic loads, without undue deflection or distortion.

Main types of car chassis frames

1. Ladder Frame Chassis.
2. Backbone Chassis.
3. Monocoque Chassis.
4. Tubular chassis.

Loads acting on the chassis of the frame

1. Short duration Load – While crossing a broken patch.
2. Momentary duration Load – While taking a curve.
3. Impact Loads – Due to the collision of the vehicle.
4. Inertia Load – While applying brakes.
5. Static Loads – Loads due to chassis parts.
6. Over Loads – Beyond Design capacity.

Loads on the chassis frame are weight of the vehicle and the passengers, which causes vertical bending of the side members. Vertical loads when the vehicle comes across a bump or hollow, which results in longitudinal torsion due to one wheel lifted with other wheels at the usual road level. Loads are dynamic in nature.

Types of bodies in automobiles

The Vehicle Body of modern car consists of: engine section, saloon, trunk. Vehicle body is the main supporting structure of a vehicle, to which all other components are attached. Truck uses a separate frame as chassis.

Vehicle Types, Car Body Styles Explained

- SEDAN. A sedan has four doors and a traditional trunk. ...
- COUPE. Mercedes-Benz. ...
- SPORTS **CAR**. These are the sportiest, hottest, coolest-looking coupes and convertibles—low to the ground, sleek, and often expensive. ...
- STATION WAGON. Volvo. ...
- HATCHBACK. ...
- CONVERTIBLE. ...
- SPORT-UTILITY **VEHICLE** (SUV) ...
- MINIVAN.

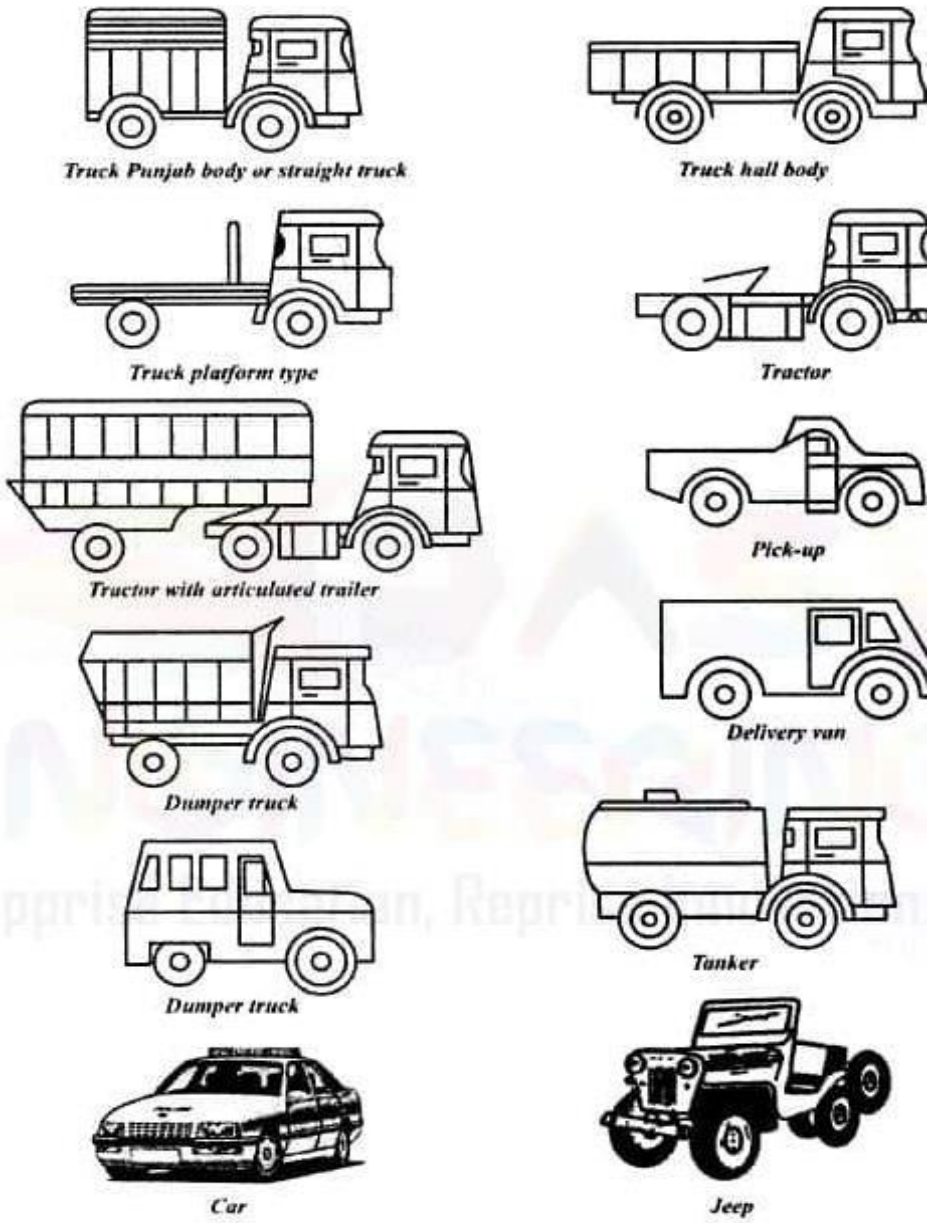


Figure showing the different types of bodies for different vehicles.

The car bodies have great resistance to wind. For high-speed vehicles, a special attention is given to streamline the body. The streamlining is the process for shaping the body to reduce resistance. It is mainly used for **racing cars.**

Straight truck vehicle bodies are constructed into two parts. One is driver cabin and other one is goods carriage. Goods carriage is a closed type with particular standard height. These vehicles are used to carry goods which are affected by weather conditions. Example. Vegetables, sugar, rice, sea foods etc.

Truck half body is having driver cabin as usual but the goods carriage has open at the top.

It is used to carry various goods which are not affected by weather. Truck platform type has also a separate driver cabin. Its goods carriage is a platform type. It usually carries goods such as iron billets, barrels, concrete slabs etc.

Tractor consists of small length body in addition to driven cabin. Usually, an articulated trailer is attached to the rear end of the trailer. This trailer has various cabins. Figure 1.25 shows different types of bodies normally designed for different vehicles. It may be an open type or a closed type depending on the purpose of use. It is used to carry passenger cars, mopeds, motor cycles etc. Most of these vehicles have six wheels.

Tanker is the vehicle which consists of a tank to carry fluids of various natures. The tank may be welded or bolted to the chassis frame behind the driver cabin. The tank has an opening at the top to pour fluid and a drain cock at the bottom to drain the fluid.

Dumper truck has heavy goods carrying panel with open top in the rear side. The rear side can be tilted up and down by hydraulic cylinders. It is used to carry brick, stones, marbles etc.

Requirements of bodies for various types of vehicles

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1. It must be strong enough to withstand all types of forces acting on the vehicle. The forces are including the weight of the car, inertia, luggage, braking and cornering forces.
2. Stresses induced in the body should be distributed evenly to all portions.
3. Weight of the body should be as minimum as possible.
4. It should be able to cope with impact loads of reasonable magnitude.
5. It should have reasonable fatigue life.
6. It must provide adequate space for both passengers and the luggage.
7. It should have minimum number of components.
8. It must have sufficient torsional stiffness i.e., ability to resist the twisting stresses produced by irregular road surface.
9. It should have good access to the engine and suspension elements.
10. It must ensure a quite ride, easy entry and exit.
11. It should create minimum vibration during running.
12. The shape of the body should be minimum drag.
13. It is easy to manufacture as well as cheap in cost.
14. It should be designed in such a way that passengers and luggage are protected from bad weather.
15. It should give appeal finish in shape and colour.

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Short answer question

1. What is an automobile chassis?
2. Write the components of chassis.
3. Write the functions of chassis frame.
4. Write the types of chassis frame.

Long answer questions

1. Explain the loads acting on the chassis frame.
2. Write the requirements of bodies for various types of vehicle.

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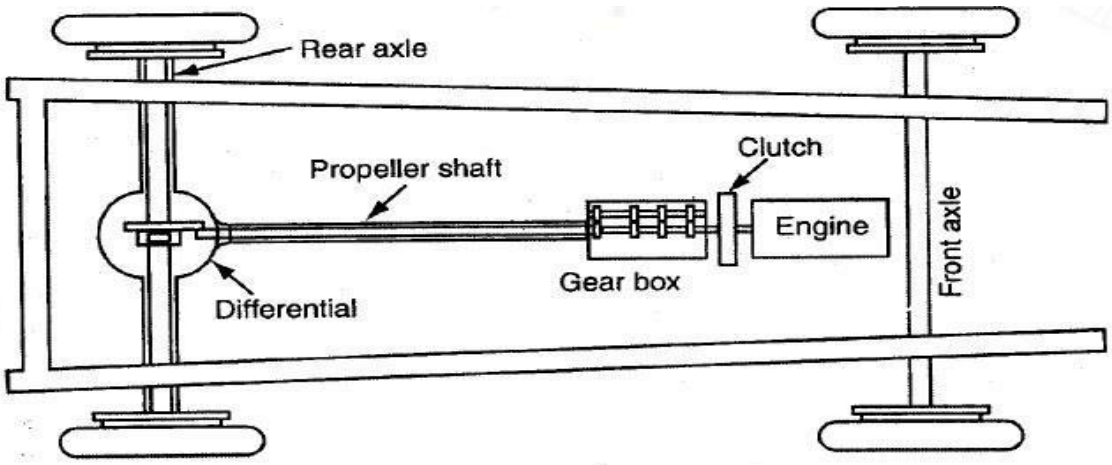
2. Transmission system – Clutch and Gearbox

Necessity of Transmission system

The transmission system is the system utilizing which power developed by the engine is transmitted to road wheels to propel the vehicle. In automobiles, the power is developed by the engine which is used to turn wheels. Therefore, the engine is to be connected to the transmission systems for transmitting power to wheels. Also, there should be a system utilizing which engine could be engaged and disengaged with the transmission system smoothly and without shock so that the vehicle mechanism is not damaged and passengers do not feel inconvenience. A clutch is employed in automobiles for this purpose.

A Clutch is an important element in power transmission. In this article, we will see brief information about what is transmission, function, and requirement of clutches, types of clutches, application, and their diagrams.

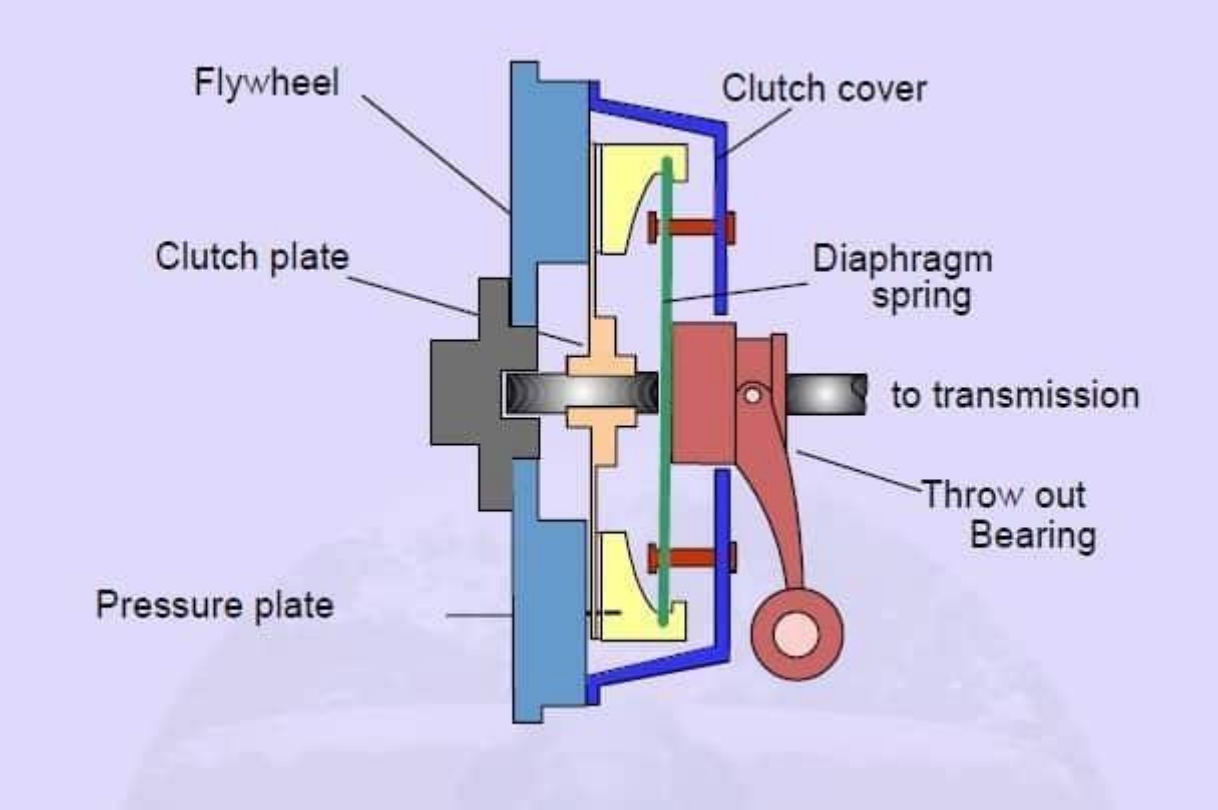
- The engines employed in automobiles are of very high speed. Hence, a speed reduction is necessary to reduce the speed to moderate level as well as to get the required high torque while moving from rest. For this purpose, a gearbox is employed in automobiles.
- The motion of the crankshaft is transmitted to the gearbox through the clutch. The gearbox consists of a set of gears to change the speed according to the requirement. The motion is then transmitted to the propeller shaft from the gearbox through a universal joint. The purpose of the universal joint is to connect two shafts at an angle for power transmission.
- The power is transmitted to the differential unit through another universal joint. Finally, the power is transmitted from the differential to wheels through the rear end. The differential unit is used to provide the relative motion between two-run wheels while the vehicle is taking a turn.



General arrangement of power transmission

Various components arrangement and function in manual transmission

- A Clutch is a mechanism used to connect or disconnect the engine from the rest of the transmission elements. It is located between the engine and gearbox.
- During normal running and stationary position, it is always in the engaged condition. The clutch is disengaged when the driver processes the clutch pedal. The clutch is disengaged for starting, changing gears, stopping and idling.
- When the clutch is engaged, the engine will be connected to the transmission, and power flows from engine to rear wheels through a transmission system.
- When 'the clutch is disengaged by pressing the clutch pedal, the engine will be disengaged from the transmission. Thus, the power does not flow to rear wheels while the engine is still running.



Clutch Parts

Main parts of Clutch

It consists of

(a) A driving member,

- The driving members consists of a flywheel which is mounted on the engine crankshaft
- The flywheel is bolted to a cover which carries pressure plate, pressure springs, and release levers.

- As the flywheel is bolted to the cover assembly, thus, the entire assembly of the flywheel and the cover rotate all the time.
- The clutch housing and cover provided with openings so that the heat produced during the function dissipates easily

(b) a driven member, and

- The driven members consist of a disc or plate called a clutch plate.
- The clutch is free to slide on the splines of the clutch shaft.
- It carries friction materials on both of its surfaces.
- When the clutch plate is gripped between the flywheel and the pressure plate, it rotates the clutch shaft through splines.

(c) an operating member.

The operating member consists of a pedal or lever which can be pressed to disengage the driving and driven plate.

. Functions of a Clutch:

The torque developed b the engine at the starting speed is very low. Therefore, it is not possible to start the engine under load. This requires that the transmission system should provide a means of connecting and disconnecting the engine from the rest of the transmission system. Such an operation must be smooth and without shock to the occupants of the vehicle.

Thus the two main functions of a clutch are:

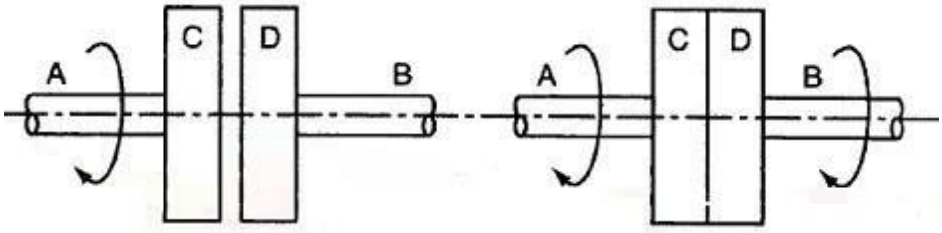
1. To engage and disengage the transmission from engine to the remaining parts of the transmission. (To allow the engine to be separated from rest of the transmission system) This is required when:

(a) Starting and running the engine at a sufficiently high speed lo generate sufficient power necessary for moving the vehicle from rest.

(b) Shifting the gears so that damage to gear teeth can be avoided.
(c) Stopping the vehicle after applying brakes.

2. The second function of the clutch is to allow the engine to take up the driving load of the vehicle gradually and without shock.

Principles of Operation of Friction Clutch



(a) Disengaged position *(b) Engaged position*

Figure Principle of friction clutch

Principle of The clutch works on the principle of friction. In Figure, the driving shaft A with flange C is rotating at 'N' rpm, and shaft B with the flange 0 is keyed to the driven shaft which is in stationary position when the clutch is not engaged.

- Now, an external force is applied to the flange D so that it comes in contact with flange C.
- As soon as the contact is made, they are united due to friction between them and the flange D starts rotating with flange C. The rotational speed of flange D depends on the friction between surfaces C and D which in turn proportional to the external force applied.

Requirements of clutch:

The main requirements of a clutch are as follows:

- It should be able to transmit the maximum torque of the engine.
- It should engage gradually to avoid sudden jerks.
- It should be able to dissipate a large amount of heat generated during clutch operation.
- It should be dynamically balanced, particularly in the case of high-speed engine clutches.
- It should have a suitable mechanism to damp vibrations and to eliminate noise produced during power transmission.
- It should be as small as possible so that it will occupy minimum space.
- It should be easy to operate requiring as little exertion as possible on the part of the driver.

- It should be made as light as possible so that it will continue to rotate for any length of time after the clutch has been disengaged.
- It must be trouble-free and have longer life.
- It must be easy to inspect, adjust, and repair.

Clutch Friction Lining material and their Necessity

The materials for clutch lining are:

1. Leather
2. Cork
3. Fabric
4. Asbestos
5. Ray bestos and Ferodo
6. Non- asbestos clutch lining material.

Necessity of clutch lining:

1. To transmit maximum power from engine flywheel transmission without jerk
2. To dissipate the heat and able to withstand higher heat generated
3. It should have a higher coefficient of friction
4. It should be cheap and easy to manufacture.

Types Of Clutch

Some types of clutches used in vehicles are given below

The classification of clutch

1) Positive clutch Dog clutch or spline clutch (In and Out clutch)

2) Gradual engagement Clutch

a) Electromagnetic clutch

b) Vacuum operated clutch

c)Hydraulic clutch

d) Fluid clutch or Fluid flywheel clutch

e) Friction clutch

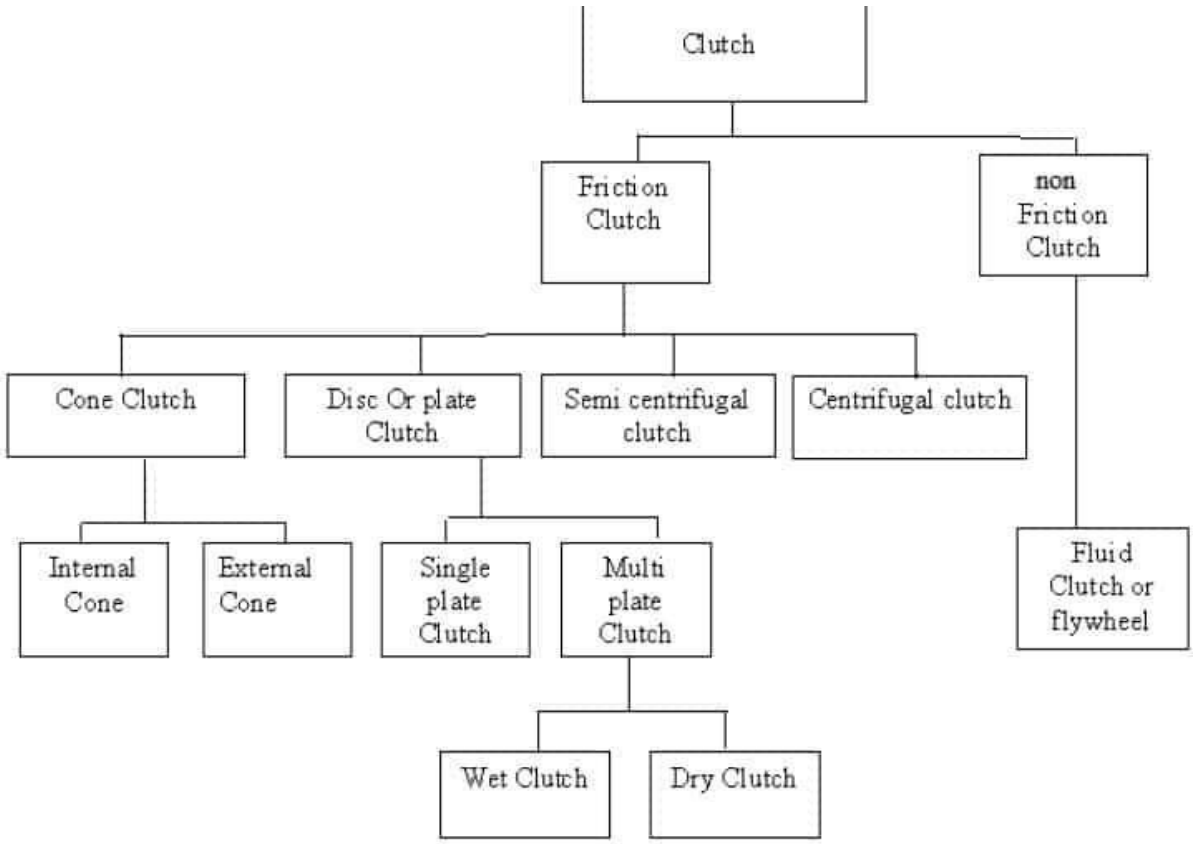
i) Cone clutch (Internal and External)

ii) Disc Plate clutch (Single plate and Multi-Plate)

iii) Semi centrifugal clutch

iv) Diaphragm or conical spring clutch (Taper finger and crown spring)

v) Centrifugal clutch



Clutch Mechanism:

Cable-operated clutch

Cable linkage is a popular and effective method of transferring movement from the pedal to the clutch. The cable assembly uses an inner multi-strand steel-wire core and an outer cable sheath of a spiral wound flexible sleeve normally with nylon end-pieces. A screw adjustment is incorporated at either the pedal or the bell-housing end to alter the length of the outer cable sleeve, for increasing or decreasing the free-play of the inner cable. From the cable the leverage is relayed through a pressed steel release-fork lever to the thrust bearing. A spherical headed bolt pivots the lever end. The outer end of the lever extends outside the bell-housing and is connected to the inner cable. When the clutch is disengaged, the inner cable is subjected to tension and the outer sleeve into compression. The fork-lever then tilts about its pivot forcing the release bearing against the release-fingers to disengage the drive.

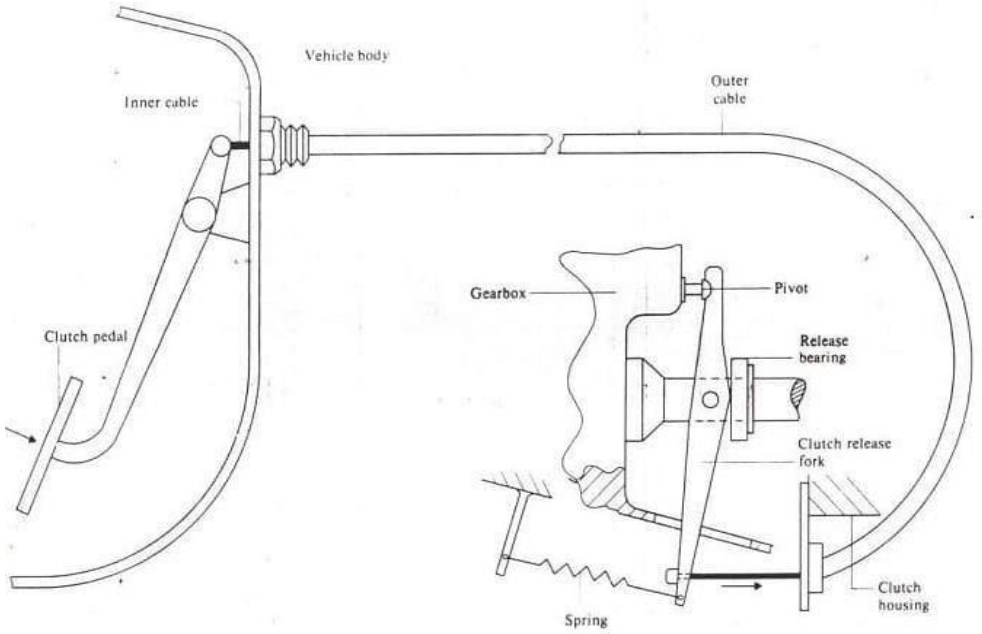


Figure showing the cable operated clutch mechanism

Hydraulic Operated Clutch Mechanism-

A hydraulically operated clutch mechanism is shown in the figure. The mechanism consists of master and slave cylinders. The cylinders are connected by hydraulic lines. When the clutch pedal is pressed the fluid under pressure from the master cylinder reaches the slave cylinder which is mounted on the clutch itself. The fluid under pressure actuates the slave cylinder push rod which further operates the clutch release fork to disengage the clutch. In India, this type of clutch has been used in Standard 20, Swaraj Mazda, and Eicher Mitsubishi's vehicles.

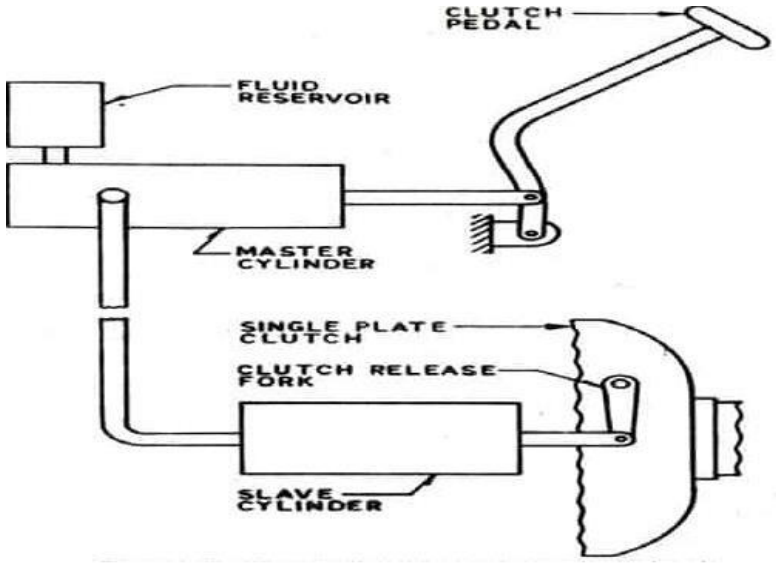


Figure showing the hydraulic operated single plate clutch

Mechanical Clutch Linkage

The mechanical clutch linkage is shown in the fig. when the clutch pedal is pressed it pivots on the pivot point and it moves the rod further. This rod turns the cross shaft, which moves the fork lever and actuates the release bearing. This movement is further conveyed to the clutch levers to disengage the clutch. Generally mechanical leverage from 10:1 to 12:1 is employed that would require a paddle force of about 100-120 N when using travel of 75mm.

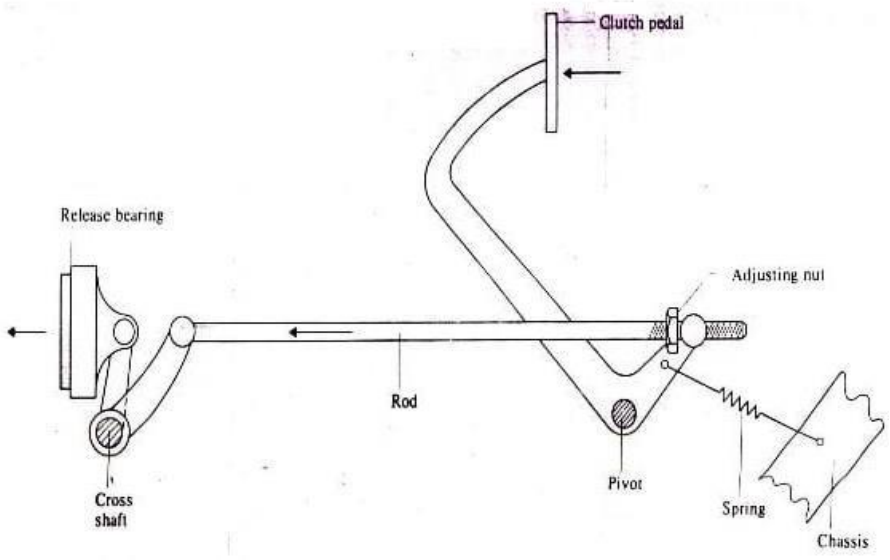


Figure showing the simple mechanical clutch operation

Single plate Clutch

A single disc or plate clutch as shown in the figure consists of a clutch plate whose sides are faced with the friction material (usually ferrodo). It is mounted on the hub which is free to move axially along the splines of the driven shaft. The pressure plate is mounted inside the clutch body which is bolted to the flywheel. Both the pressure plate and the flywheel rotate with the engine crankshaft or the driving shaft. The pressure plate pushes the clutch plate towards the flywheel by a set of strong spring which is arranged radially inside the body. The three levers (also known as release levers or fingers) are carried on the pivots suspended from the case of the body. These are arranged in such a manner so that the pressure plate moves away from the flywheel by the inward movement of a thrust bearing. The bearing is mounted upon the forked shaft and moves forward when the clutch pedal is pressed.

Necessity of Single plate clutch

1) To transmit a large amount of torque single plate clutch required
2) Response time to operate is very less compared to the multi-plate clutch.
3) It generates low heat so no need of cooling media required.
4) It should be dynamically balanced and easy to operate.

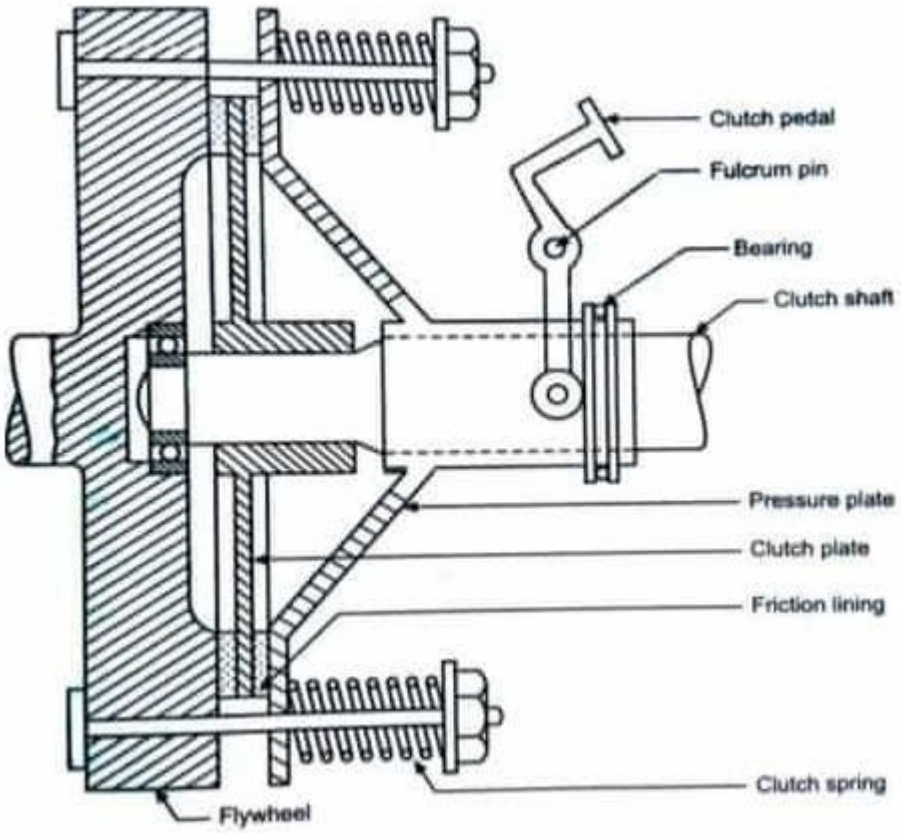


Figure showing the single plate clutch

Working:

Disengaging the clutch:

When the clutch pedal is pressed down, it's linkage forces the thrust bearing to move towards the flywheels and pressing the pressure plate away from the flywheel thereby the compression springs are compressed. This action removes the pressure from the clutch plate and the driving shaft comes to a stationary position.

Engaging the clutch:

On the other hand when the foot is taken off from the clutch pedal, the thrust bearing moves back by levers this action allows the springs to extend, and thus pressure plate pushes the clutch plate back towards the flywheel. The clutch is engaged and power is transmitted from engine to gearbox.

Application of Single plate clutch:

1. Most commonly used in cars.
2. Used in Light commercial vehicles and heavy transport vehicles.

Multi-Plate (Dry) Clutch

It is the extension of a single plate clutch. It consists of several clutch (friction) as well as pressure plates. As the number of plates increased, the friction surfaces also increase. The increase in the number of friction surfaces increases the capacity of the clutch to transmit torque. The plates are alternately fitted to the engine shaft and gearbox shaft. They are firmly pressed by strong coil springs and assembled in a cover assembly. Each alternate plate has inner and outer splines, this each of the alternate plate slides on the splines on the pressure plate.

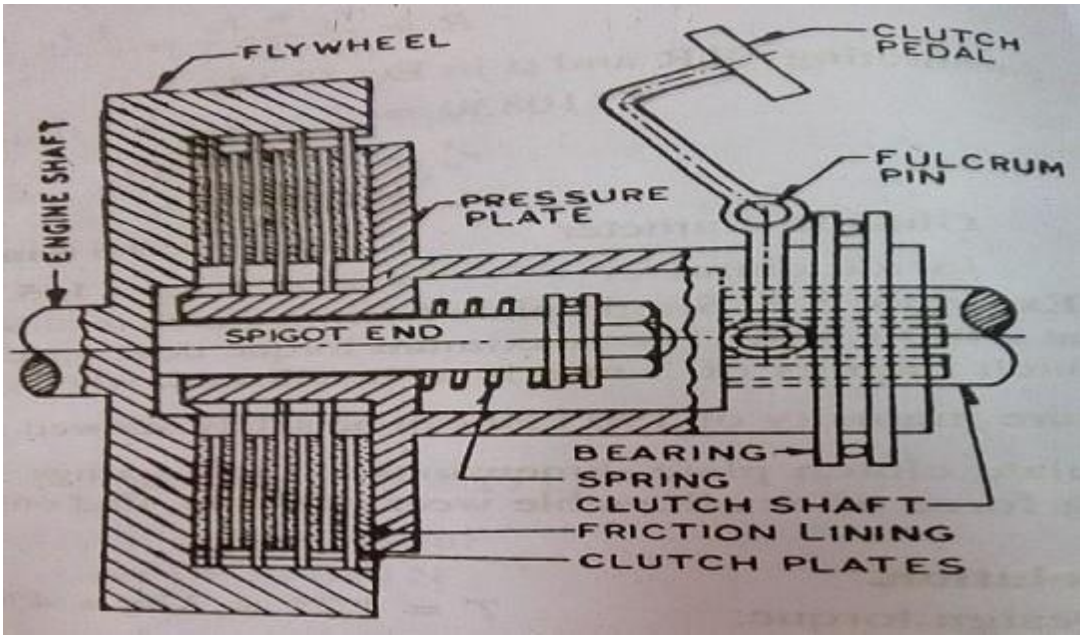


Figure showing the multi-plate dry clutch

Working of Multi-Plate Clutch: The pressure plates are used to apply the pressure on friction plates and the inside diameter of the pressure plate is splined while making the inside diameter splined, the rotating motion of the pressure plate is restricted. The pressure plate moves on the driven shaft axially. When we apply the pedal the pressure plates and the friction plates come in contact with each other and the speed or power is transmitted from the engine shaft to the transmission shaft.

Applications Of Multi-Plate Clutch :

This type of clutch is used in Scooters and Motor Cycles, where space availability is limited. Besides, this finds the application in some Heavy Transport Vehicles and Racing Cars where high torque is to be transmitted.

Centrifugal clutch

- When the engine is started, the speed of the driving shaft is less, so the centrifugal force is also less. Therefore, shoes (flyweights) do not move outwards and torque is not transmitted to the rear wheel. As the speed of the engine increases, the centrifugal force also increases.

- At certain engine speed, the shoes fly off outwards due to increased centrifugal force and they come in contact with the driven member.
- Now both the driving and driven members rotate together and the clutch is said to be engaged.
- Thus the engine torque is transmitted to the rear wheel.
- When the engine speed decreases, the centrifugal force also decreases. Now the shoes return to their original position due to spring force which results in a disengagement of the clutch and torque is not transmitted to the rear wheel.

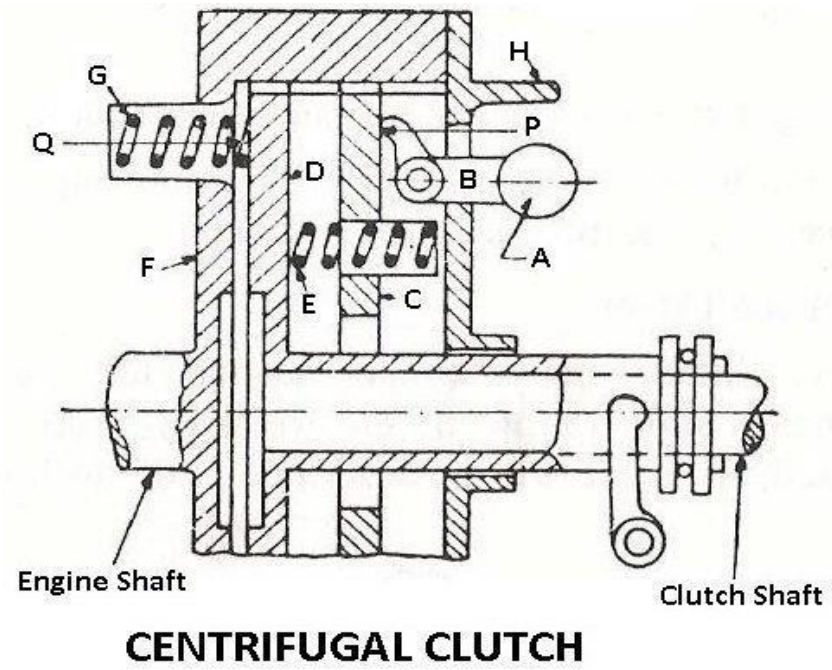


Figure showing the centrifugal clutch

Application of Centrifugal Clutch :

1. Used in Automatic transmission vehicles like mopeds and two-wheelers without gear.
2. Used in semi-automatic transmission vehicles like some modern cars.

Hydraulic clutch

The hydraulic clutch is the important category of a multi-plate clutch. It is mainly used in vehicles to disengage or engage the clutch plate from the engine. Apart from that, it can also be used as an alternative to the traditional mechanical clutch.

Usually, the hydraulic clutch is used to disengage or engage the clutch by forcing the hydraulic fluid to the disengagement clutch parts. In regards to this, the Hydraulic fluid needs to be highly pressurized.

Otherwise, it cannot push the clutch system forcefully. Therefore, the clutch does not disengage. Apart from that, this clutch has auto maintenance techniques.

Therefore, there is no need for manual maintenance system. This hydraulic clutch has some smaller parts as compared to the other clutches. It may be wrong sometimes, but for that, no maintenance is required.

It can maintain itself automatically. Such maintenance needed for the hydraulic fluid to check in the clutch reservoir as the fluid may be impure. Hence, the hydraulic fluid is needed to be replaced.

Components of a Hydraulic clutch

The Hydraulic clutch is made of different types of components. They are as follows:

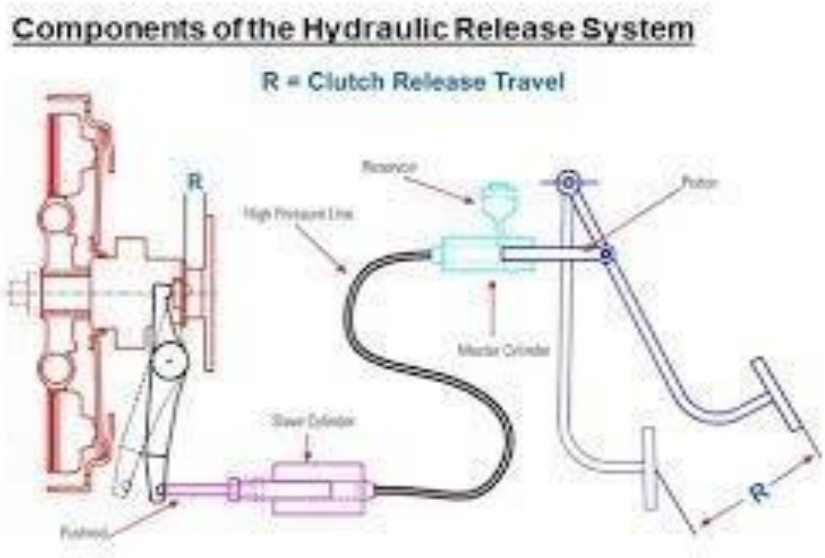
1. Clutch Pedal:

Most primary part that engages the clutch in vehicles is the Clutch Pedal. A driver has to press the clutch pedal to start the engagement process. At first, after pressing the clutch pedal, the clutch plate starts its rotation.

2. Diaphragm Clutch:

Diaphragm Clutch is usually an independent clutch, but in Hydraulic Clutch the Diaphragm Clutch can be used. The diaphragm Clutch is attached to the clutch pedal.

When the clutch pedal is pressed by the driver then at first, the clutch pedal pushes the Diaphragm Clutch then the other diaphragm Clutch presses the flywheel to do further processes.



3. Clutch Plate:

One of the most important parts of the Hydraulic clutch is the Clutch Plate. The clutch plate is made of thin metal plates. There is a friction lining present, which is attached to the clutch plate, on both sides.

Apart from that, this clutch plate is usually placed among the pressure plate and the flywheel. The friction lining of the thinner surface of the clutch plate makes its contact to the flywheel and the friction lining of the outer surface of the clutch plate and that makes contact to the pressure plate and makes the friction.

4. Friction Surface:

Friction surfaces are attached to the clutch plate on both sides. When the clutch plate starts its rotation then the friction surface makes contact to the pressure plate and also to the flywheel. Therefore, the friction force is generated. This friction force makes the high torque.

5. Pressure Plate:

Another useful part of the Hydraulic clutch is the Pressure plate. The pressure plate is placed on one side of the clutch plate. The pressure plate is attached with springs with the help of the bolts and along with the clutch pedals.

The friction surfaces of the clutch plate make contact with the pressure plate. The pressure plate's function mainly depends on weight. When weight is given to the pressure plate then it makes contact with the friction surface of the clutch plate and produces the friction.

6. Flywheel:

Another useful part of the Hydraulic clutch is Flywheel. The flywheel has placed on another side of the clutch plate. The flywheel is attached to the transmission shift. The friction surfaces of the clutch plate make contact with the flywheel. So, friction is produced.

7. Diaphragm Spring:

Diaphragm Spring is attached to the pressure plate. These springs mainly work, with the help of the pressure plate. This pressure is produced from the high weight, that is given to the pressure plate. Along with that, thrust spring makes contact with the friction surface of the clutch plate and produce high friction.

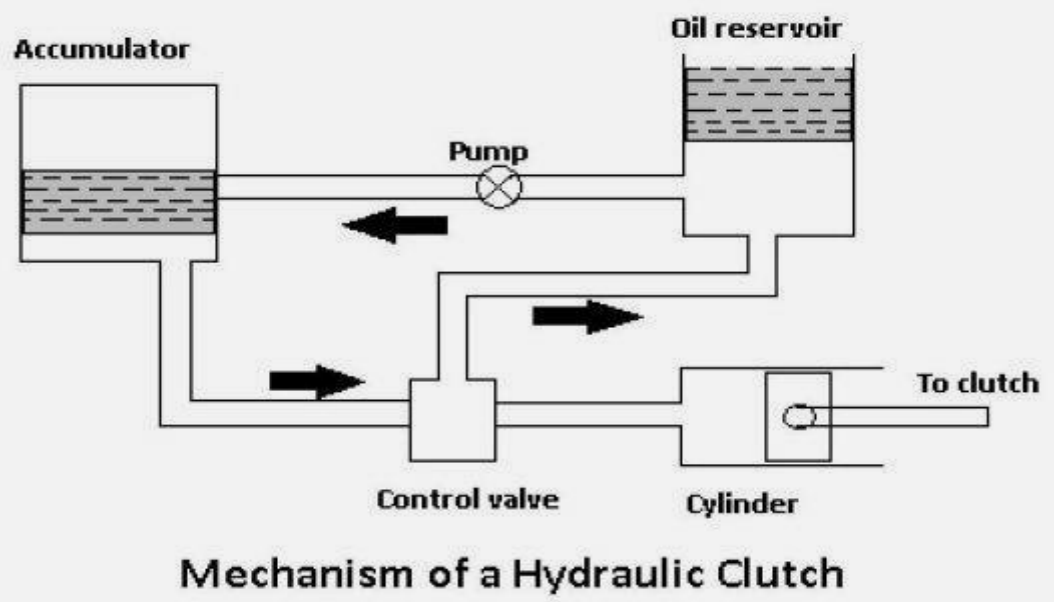
8. Splined Sleeves:

Splined sleeves are mainly used to make engagement and disengagement in the multi-plate clutch system or mainly in the Hydraulic clutch system. These Splined sleeves are placed between the friction lining of the clutch plate and the pressure plate.

When pressure plate gives pressure then the splined sleeves used to go forward to make the clutch engaged and when the pressure plate releases the pressure then the splined sleeves used to go back to make the clutch disengaged.

Working Principle of a Hydraulic Clutch:

The working procedure of the Hydraulic Clutch is usually divided into two parts. One is Engagement and another one is Disengagement. The following section discusses the same concisely.



Mechanism of a Hydraulic Clutch

Engagement:

- At first, the Clutch pedal has to be pressed by the driver of a vehicle to start the engagement process.
- When the clutch pedal is pressed then it starts the working process of the diaphragm Clutch.
- The clutch pedal is attached to the clutch plate. Therefore, the clutch plate starts its rotation.
- The friction surfaces of the clutch plate can be used to make contact with the pressure plate and also flywheel.
- The pressure plate gives pressure to the spring and spring makes contact with the splined sleeves.
- Then the attachment of pressure plate, splined sleeves, friction surfaces, clutch plate, and the flywheel is made and the engagement is done in this way.

Disengagement:

- At first, the Clutch pedal has to be released by the driver of a vehicle to start the disengagement process.
- The splined sleeves come backward and release the contact of the pressure plate and the clutch plate.
- Then the flywheel also released from the contact of the clutch plate.
- The rotation of the clutch plate becomes slow down and at last stops.
- Then the disengagement process is done in this way.

Advantages of a Hydraulic Clutch:

There are many advantages of the hydraulic clutch. Some of the advantages are stated below:

- The hydraulic clutch is self-lubricated so the hydraulic clutch needs no maintenance for lubricating the clutch.
- In the case of a hydraulic clutch, the height of the pedal is adjusted automatically.
- In comparison to the other clutch systems, the hydraulic clutch can give an easier feeling during pushing the clutch.
- There are many variations present of the hydraulic clutch so this clutch can be fitted at any place.
- Due to corrosion the, inner wires that used in the mechanical clutch may bend so mockingly the wires can get stuck. This incident can lead the damage to the clutch. But in the case of the hydraulic clutch, this type of damage is not possible. Because a replacement of a particular fluid in the hydraulic clutch is enough to prevent the above type of damage.
- Loosing of the cable after some time affects the disengagement process that may damage the clutch completely. But in the case of the hydraulic clutch, there is no cable required so this clutch is safe from damage caused by loosening the cable.
- So, using a hydraulic clutch instead of other clutch is safer and more reliable.
- It is better to use the hydraulic clutch because of quality. The quality of this hydraulic clutch is better than the mechanical clutch.

Disadvantages of a Hydraulic Clutch:

There are many disadvantages of the hydraulic clutch also present. Some of the disadvantages of the hydraulic clutch are stated below:

- The hydraulic clutch consists of some mechanisms such as the slave cylinder and cylinder are the two mechanisms of this clutch. So, there is a chance of outflow of fluid that can be used in the hydraulic clutch. This out flowing happens from the cylinder as well as from the slave cylinder due to the damage that results in the leakages. For repairing this damage, users have to spend extra money.

- This hydraulic clutch consists of plastic of metallic piping systems. This pipe is breakable or can be teared down. So, time to time checking is necessary. This is more expensive to maintain damage prevention.
- For proper functioning, standard and correct fluid is required otherwise seals may be damaged. So, maintaining the standard for proper fluid can be a little more expensive.
- Time to time checking the level of fluid of the hydraulic clutch is compulsory for users.
- The price of the hydraulic clutch is more expensive than the mechanical clutch. This is one of the most crucial disadvantages of this clutch.
-

Application or Use of the Hydraulic Clutch:

Most of the reputed car manufacturers are opting for the hydraulic clutch for their products for quality and simplicity in applications. Nowadays the use of the hydraulic clutch is highly observed in trucks and automotive industries also. Due to the features of self-oiling or lubrication, auto -adjustment, low effort to the actual adjustment, the hydraulic clutch is used in various systems.

Other types of clutches

Diaphragm clutch:

Clutch remains usually in the engaged condition. It is required to depress the clutch pedal to disengage the clutch. When a driver or an operator drives a vehicle he is required to engage clutch by depressing clutch pedal. As the driver depresses the clutch pedal, the effort applied gets transmitted either through level or cable to clutch release fork. The fork pushes clutch release bearing towards the engine side due to which clutch release levels shown in figure get displaced getting pressure plate in the backward direction. This action creates clearance between drive and driven members resulting in disengagement of the clutch. As the driver leaves the clutch pedal it returns to its original position due to which pressure plate put thrust on the clutch plate from one side and flywheel on the other. This is how the clutch gets engaged.

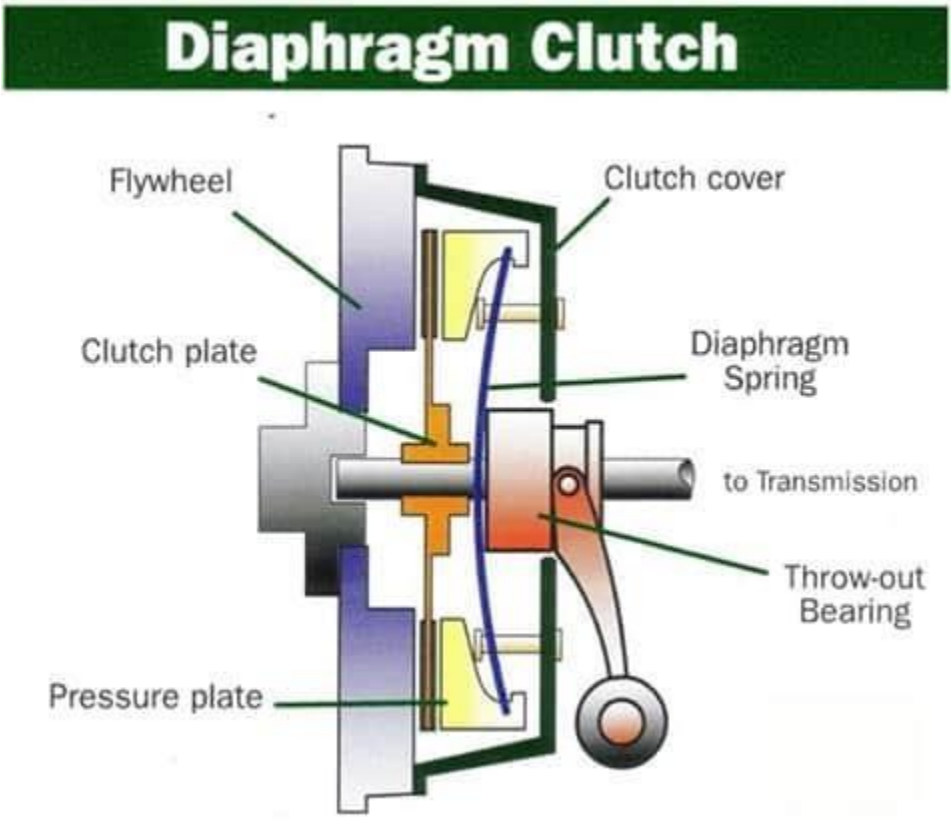


Figure showing the diaphragm clutch

Cone Clutch:

Cone clutch consists of friction surfaces in the form of a cone. The engine shaft consists of the female cone. The male cone is mounted on the splined clutch shaft. It has friction surfaces

on the conical portion. The male cone can slide on the clutch shaft. Hen the clutch is engaged the friction surfaces of the male cone are in contact with that of the female cone due to force of the spring. When the clutch pedal is pressed, the male cone slides against the spring force, and the clutch is disengaged.

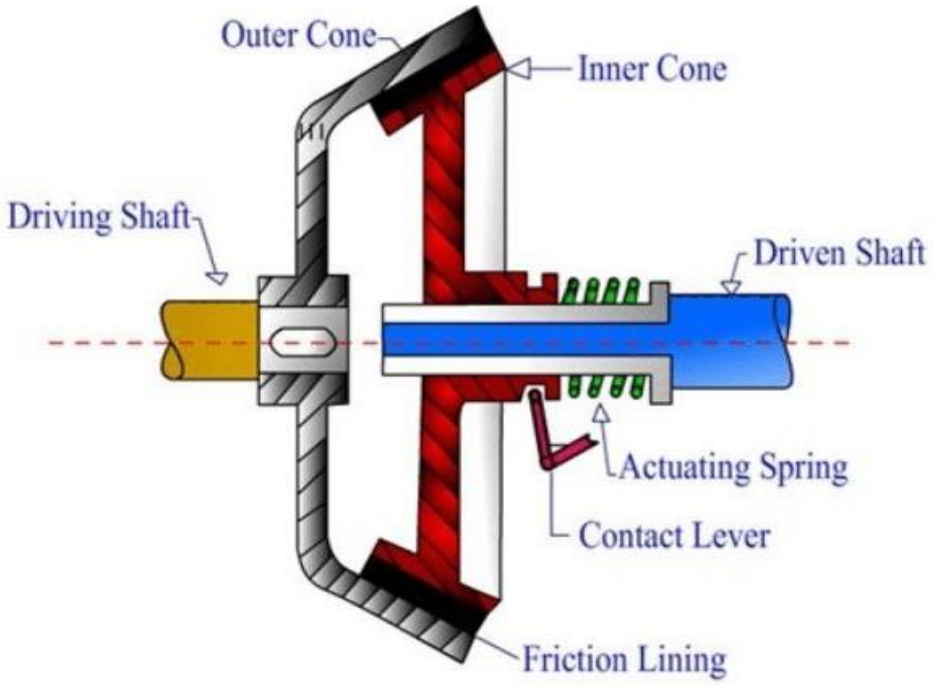
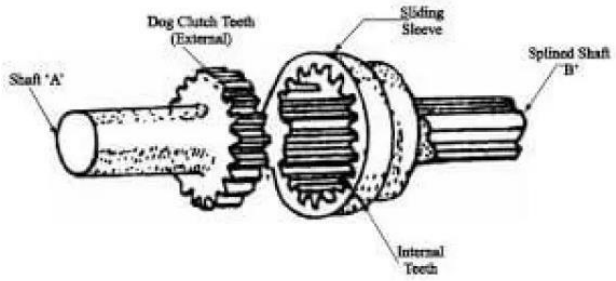


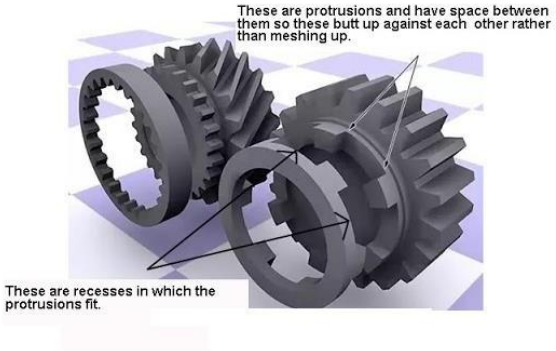
Figure showing the cone clutch types of clutches

The only advantage of the cone clutch is that the normal force acting on the friction surfaces is greater than the axial force, as compared to the single-plate clutch in which the normal force acting on the friction surfaces is equal to the axial force. The disadvantage in the cone clutch is that if the angle of the cone is made smaller than 200 the male cone tends to bind in the female cone and it becomes difficult to disengage the clutch. Cone clutches are generally now only used in low peripheral speed applications although they were once common in automobiles and other combustion engine transmissions. They are usually now confined to very specialist transmissions in racing, rallying, or in extreme off-road vehicles, although they are common in powerboats. Small cone clutches are used in synchronizer mechanisms in manual transmissions.

Dog & Spline Clutch

- This type of clutch is used to lock two shafts together or to lock a gear to a shaft. It consists of a sleeve having two sets of internal splines. It slides on a splined shaft with the smallest diameter splines. The bigger diameter splines match with the external dog clutch teeth on the driving shaft. When the sleeve is made to slide on the splined shaft, its teeth match with the dog clutch teeth of the driving shaft. Thus the sleeve turns the splined shaft with the driving shaft.
- The clutch is said to be engaged. To disengage the clutch, the sleeve is moved back on the splined shaft to have no contact with the driving shaft. This type of clutch does not tend to slip. The driven shaft revolves exactly at the same speed of the driving shaft, as soon as the clutch is engaged. This is also known as a positive clutch.





Objectives of the Gearbox

The purpose of a gearbox is to increase or reduce speed. As a result, torque output will be the inverse of the speed function. If the enclosed drive is a speed reducer (speed output is less than speed input), the torque output will increase; if the drive increases speed, the torque output will decrease.

The Gearbox (Transmission) is a mechanical device used to increase the output torque or to change the speed (RPM) of a motor. The shaft of the motor is connected to one end of the gearbox and through the internal configuration of gears of a gearbox, provides a given output torque and speed determined by the gear ratio.

High torque is required to start the vehicle from rest, accelerating, hill climbing, pulling a load and facing other resistances. But the IC engine operates over a limited effective speed range which produces a comparatively low torque. In such a situation, the engine is responsible for the stall and the vehicle rests if the speed falls below the limit.

The torque developed by the engine is increasing within limits with the increase of engine speed and reaches a maximum value at some predominant speed. If the engine directly connects to the driving axle, the engine speed may reduce.

Due to the variable nature of the vehicle resistance resulting in load and gradient changes, it require that the engine power should be available over a wide range of road speeds. Hence, for this reason, the engine speed maintain by using a reduction gear resulting in the road wheels rotating at a proper speed suited to the operating conditions of the vehicle.

Therefore, a single torque multiplication in the rear axle must be interposed and a variable multiplication factor in the gearbox is provided for this purpose.

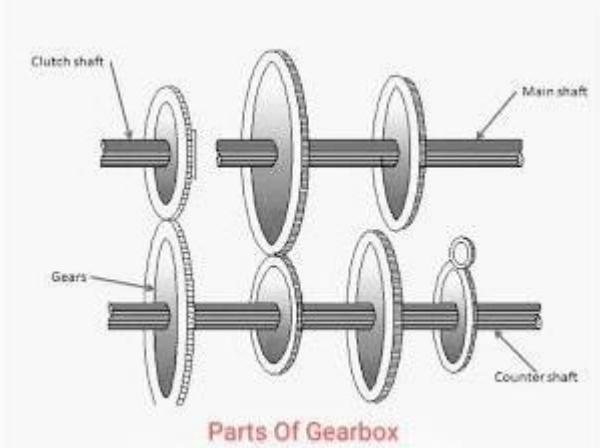
WHAT IS A GEARBOX?

The gearbox is a mechanical device used to increase the output torque or to change the speed (RPM) of a motor. The shaft of the motor is connected to one end of the gearbox and through the internal configuration of gears of a gearbox, provides a given output torque and speed determined by the gear ratio.

THE NECESSITY OF GEARBOX

To maintain engine speed on all conditions of load and vehicle speed, the gearbox uses a system to maintain engine speed, while sacrificing the same road speed. To enable the engine to run faster on-road wheels as well as to multiply the torque, a gearbox is required.

PARTS OF GEARBOX



1. Clutch Shaft / Driving Shaft / Input Shaft

A clutch shaft is a shaft that takes power from the engine to supply another shaft. The clutch shaft or driving shaft is connected through the clutch and when the clutch is engaged, the driving shaft also rotates. Only one gear is fixed on the clutch shaft and this engine rotates with the same speed as the crankshaft. In addition, the driving shaft and main shaft are in the same line.

2. Counter Shaft / Lay shaft

The counter shaft is a shaft that connects directly to the clutch shaft. It has gear which connects it to the clutch shaft as well as the main shaft. It can be run at engine speed or below engine speed according to gear ratio.

3. Main Shaft / Output Shaft

The main shaft or output shaft that rotates at different speeds and also provides the necessary torque to the vehicle. The output shaft is a splined shaft, so that the gear or synchronizer can be moved to engage or disengage.

4. Bearings

The bearings are required to support the rotating part and reduce friction. The gear box has both a counter and main shaft which is supported by the bearing.

5. Gears

Gears are used to transmitting the power from one shaft to another shaft. The amount of torque transmitted through the gears depends on the number of teeth and the size of the gears. Higher the gear ratio, higher the torque / acceleration and lower the speed. All gears except those on the main shaft are fixed to their respective shafts; They can slide in any of the directions along the shaft.

6. Gear Selector Fork

Gear selectors are simple devices that use a lever that selects gears to engage in disengage mechanisms. The motion of the lever slides the engaging part on the shaft. It depends on the type of gearbox whether the lever slides the gear or synchronizer that are already forged along the main shaft.

Types of Gearboxes

1.Manual Transmission
(a) Sliding Mesh Gearbox
(b) Constant Mesh Gearbox

(c) Synchromesh Gearbox

2. Epicyclical Gearbox

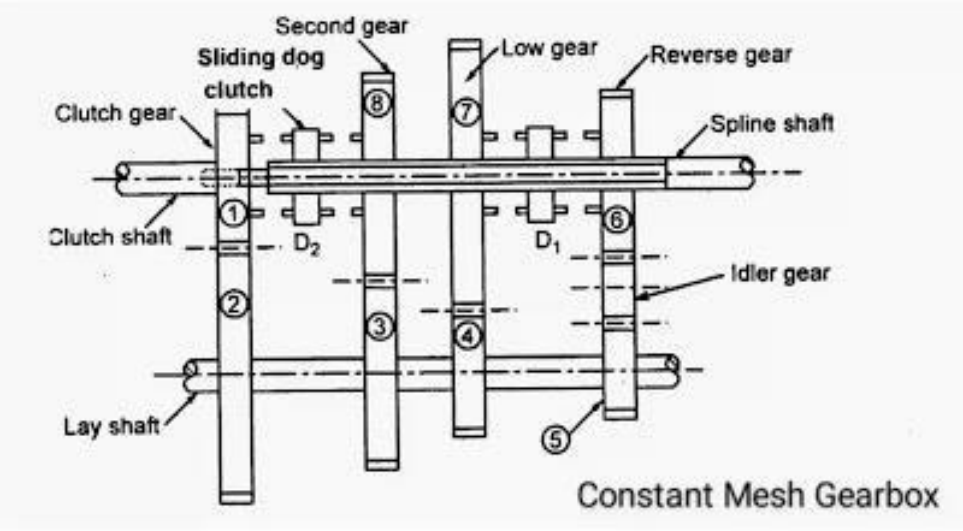
3. Automatic Transmission
(a) Hydromantic Gearbox
(b) Torque Converter Gearbox.

Constant mesh gearbox, sliding mesh gearbox

Working of Constant Mesh Gearbox

Figure shows the construction of a constant mesh type gearbox having three forward and one reverse speeds. In this type of gearbox, all gears are constantly in mesh and dog clutches are used for engaging and disengaging the gears. The dog clutches (D) and D2) are mounted on the main shaft. One (D2) is connected between clutch gear and reverse gear whereas the other (D)) is placed between low speed gear and reverse gear. The splines are provided on the main shaft for the linear movement of dogs. Dog clutch can slide on

the shaft and rotate along with it. All gears are rigidly fixed on the counter shaft.



All main shaft and lay shaft gears, and idler gears are engaged by dog clutch to obtain opposite and slow speed. Only reverse gears are spur gear type and all others are helical gears.

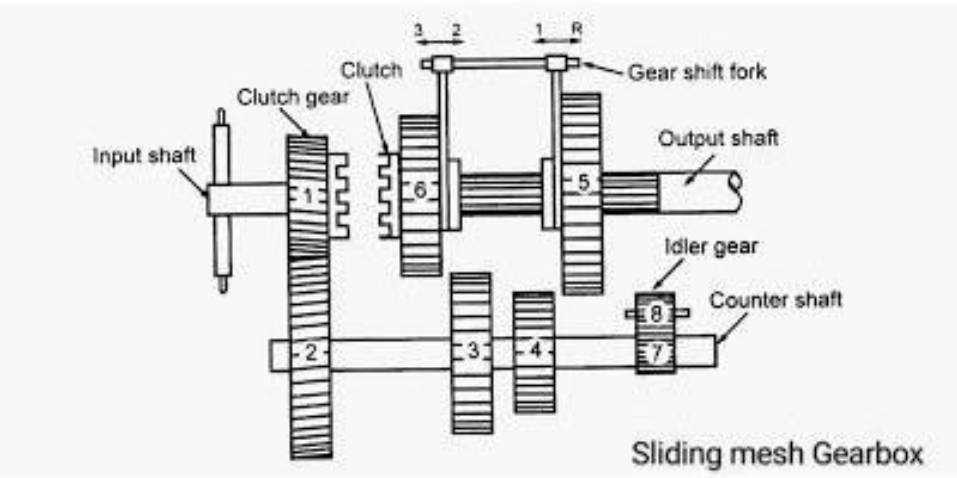
As compared with the sliding mesh type, the constant mesh type gearbox meshes more readily with the gears having less danger of damaging during meshing because the gear diameters are smaller with few numbers of teeth.

So, this type has more defects when compared to a synchromesh type. The necessity of double clutching is needed so that it is not used to any large extent.

Working of Sliding Mesh Gearbox

It is the simplest type of gearbox. In this gearbox, spur gears are used. The Figure shows the construction of a sliding mesh type transmission having three forward and one reverse speeds.

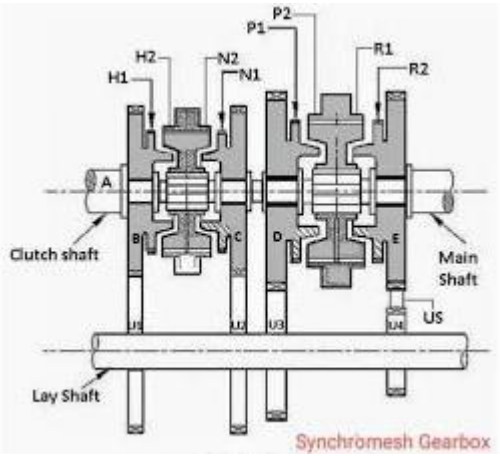
There are three gears (1, 6 and 5) attached on the main shaft and four gears (2, 3,4 and 7) on the lay shaft.



The two gears on the main shaft (6 and 5) can be slided by a shafting yoke and mesh with the gears (3 and 4) on a lay shaft. Therefore, it is called a sliding mesh gearbox. A separate idler gear (8) is mounted on the idler shaft.

Synchromesh gearbox

Synchromesh gearbox uses synchronizer instead of sliding dog clutches to affect the ratio change. The synchromesh gearbox is similar to the constant-mesh gearbox, but the synchromesh gearbox is provided with a synchronizer, the device by which two gears to be engaged are first brought into frictional contact which equalizes their speed, afterward they are engaged smoothly.



To engage, when the gear lever is moved the synchronizer cone meets with a similar cone on the pinion. Due to friction, the rotating pinion is made to rotate at the same speed as the synchromesh

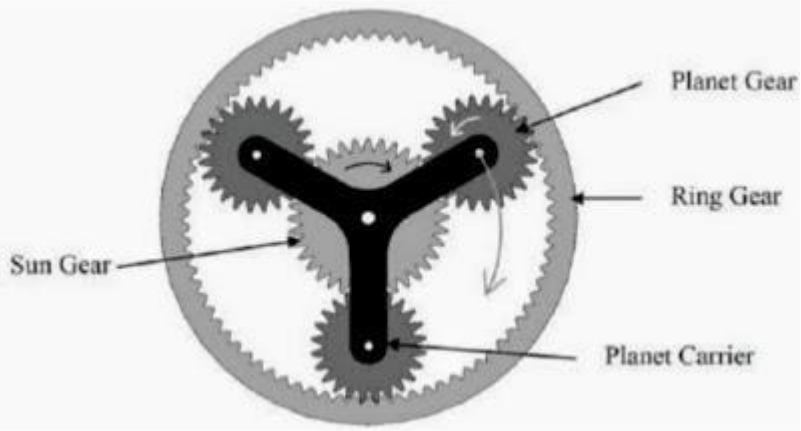
unit. To give a positive drive further, movement of the gear lever enables the coupling to override several spring load balls and the coupling engages with the dogs on the side of the pinion.

Since both pinions and synchromesh units are moving at the same speed, this engagement is done without noise or damage to the dogs.

A slight delay is necessary before engaging the dog teeth so that the cones have a chance to bring the synchronizer and pinion to the same speed.

Epicyclic gearbox

An epicyclic gear train (also known as planetary gear) consists of two gears so that the center of one gear rotates around the center of the other. A carrier connects the centers of two gears and rotates to carry one gear, called planet gear or planet pinion, around the other, called sun gear or sun wheel. The rays of the planet and the sun form traps so that their pitch circles are rolled without slip. A point on the pitch circle of the planetary gear traces an epicyclic curve. In this simplified case, the sun gear is fixed and there is planetary gear rolled around the sun gear.

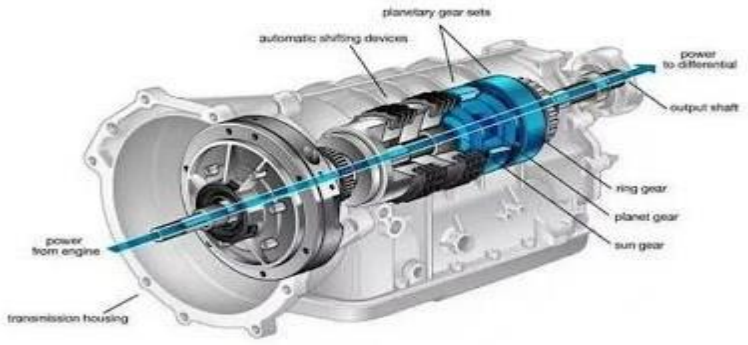


An epicyclic gear train can be assembled so the planetary gear is rolled onto a fixed, external gear ring or inside the pitch circle of the ring gear, sometimes called the annular gear. In this case, the

curve detected by a point on the planet pitch circle is a hypocycloid.

The combination of epicyclic gear trains with a planet engaging both a sun gear and a ring gear is called planetary gear train. In this case, the ring gear is usually fixed and the sun gear is operated.

Automatic Transmission



Various speeds are obtained automatically in gearboxes known as automatic gearboxes. Generally, the driver selects the car condition such as neutral, forward or reverse. The gear selection, timing, and engagement of gear for the required gear speed select automatically when the accelerator press or depress.. The Automatic gearbox does not require a gear change lever and a clutch pedal. Since, both clutch and transmission are a combined unit

which works automatically. The automatic gearbox operates in two ways namely.

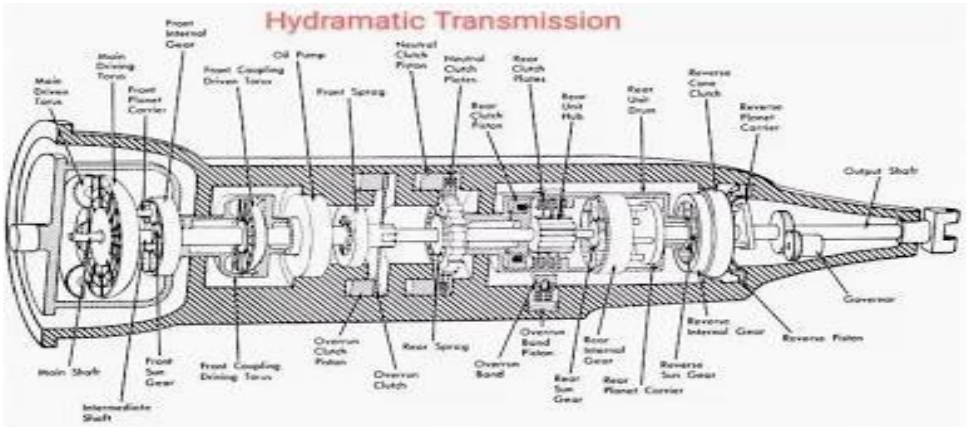
1. Hydromatic transmission, and

2. Torque converter transmission

Nowadays, automatic transmissions are popular with various names prescribe by the manufacturers. They may differ in construction slightly. Somebody employs only fluid coupling with the planetary transmission. But others may include a torque converter with fluid coupling and planetary transmission as per their requirements.

- Hydromantic Transmission

In the case of a dramatic transmission gearbox, the planetary gear sets connect in such a way that power may transmit through them. A centrifugal governor in the transmission chooses the proper gear according to the speed and throttle position.



The gear shifting from one gear to another gear is done through hydraulically operated pistons by actuating springs. These springs control the brake bands on the planetary gear sets and clutches

within the planetary unit. The various shifts achieves by the throttle and centrifugal governor.

- Torque Converter Transmission

A torque converter is a type of fluid coupling that transmits rotational power from a prime mover, such as an internal combustion engine, to a rotating driven load. In a vehicle with an automatic transmission, the torque converter connects to the power source to the load. It is usually located between the engine's flex plate and transmission. The manual transmission will have an equal space mechanical clutch.

The main feature of a torque converter is its ability to increase torque when the output rotational speed is so low that it allows the fluid from the winding vanes of the turbine to separate from the stator while it close against its one-way clutch, thus providing the equivalent of a reduction gear. This is a feature beyond simple fluid coupling, which can match rotational speed, but does not

multiply torque, thus reducing power.

Torque converter transmission system employs fluid coupling, torque converter and epicyclic gear arrangement. If all different devices are combines into one unit, they will do their duties jointly without any interruptions.

PURPOSE OF GEARBOX

1. It helps the engine to disconnect from driving wheels.
2. It helps the running engine connect to the driving wheel smoothly and without shock.
3. It provides the leverage between engine and driving wheels to be varied.
4. This helps in reducing the engine speed in the ratio of 4 : 1 in case of passenger cars and in a greater ratio in case of heavy vehicles like trucks and lorries.
5. It helps the driving wheels to drive at different speeds.
6. It gives the relative movement between engine and driving wheels due to flexing of the road spring

FUNCTION OF GEARBOX

1. Torque ratio between the engine and wheels should be varied for fast acceleration and for climbing gradients.
2. It provides means of reversal of vehicle motion.
3. Transmission can disconnect from the engine by the neutral position of the gearbox.

Gear Ratio

Gear ratios are gear reduction steps in the gearbox. A gear reduction multiplies the engine torque by gear ratio amount. Torque requirement at the wheel depends on operating conditions.

For example :

Moving a vehicle from a standstill requires much more torque than the peak torque of the engine. Therefore the torque multiplies by the first gear ratio.

Once starting the vehicle and moving using first gear, it requires less torque at the wheels to keep it moving. Hence it requires no multiplication or very less multiplication.

If the vehicle suddenly encounters a gradient , it will require more torque on the wheels to keep the vehicle moving. Hence an intermediate ratio requires.

More Blogs - Single Plate Clutch

Advantages And Disadvantages Of Manual Transmission

Manual Transmission

Advantages

- The vehicle is more attractive to the driver.
- The driver has complete control over the gears and when to shift the gears.
- The cost of a manual vehicle is lower than that of an automatic vehicle.
- Transmission cost is less for repair.
- It provides better mileage.

Disadvantages

- Manual transmission can be annoying in heavy traffic.
- There may be some problems in learning the new driver.
- Precise control over hills is necessary to avoid stalling or rolling back.
- Hands and feet can hurt when using gears and clutch.

Advantages and Disadvantages Automatic Transmission

Advantages

- It is easy to drive in stop-and-go traffic.
- This transmission is fast and smooth.
- Current automated vehicles offer the same mileage as manual transmission.
- The automatic transmission is very comfortable for the driver when driving.

Disadvantages

- Buying an automatic transmission vehicle is more expensive than a manual transmission vehicle.
- There are more moving parts in the automatic transmission, which increases the cost of repair.
- The gear change takes a little time and the gear shifting detects, and at times a slight shock is also failing.
- You cannot make the automatic gear more or less at your own will, suddenly there is a problem in overtaking the car.

_*_*_*_*_*_*_

Short answer question

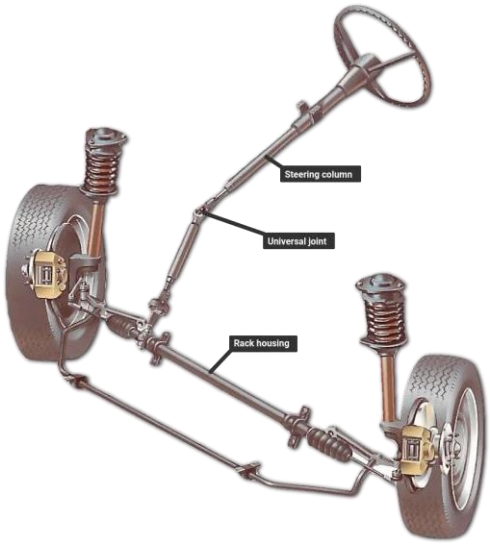
1. Write the necessity of transmission system.
2. Write the components in power transmission system.
3. Write the main parts of clutch.
4. Write the functions of clutch.
5. Write the materials required for clutch lining.
6. Write the types of clutch.
7. Write the necessity of gear box in an automobile.
8. Write the parts of gear box.

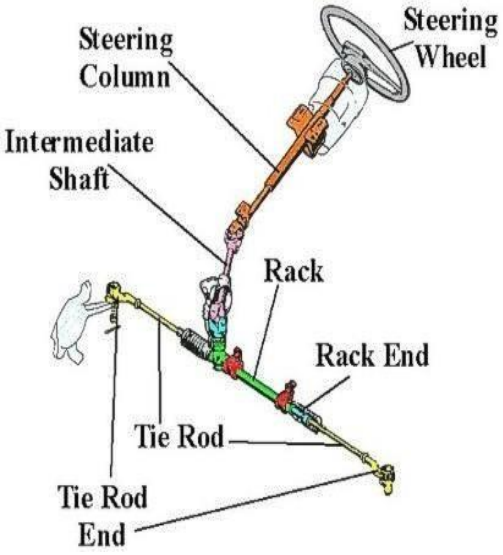
Long answer questions

1. Explain types of clutch mechanisms.
2. Explain single plate clutch with neat sketch.
3. Explain the components of hydraulic clutch with sketch.
4. Explain the parts of gear box.
5. Explain the constant mesh type of gear box.
6. Explain the sliding mesh type of gear box.

_*_*_*_*_*_

3. Steering System





In most cars, small trucks and SUVs on the road today, there is a rack and pinion steering system. This converts the rotational motion of the steering wheel into the linear motion that turns the wheels and guides your path. The system involves a circular gear (the steering pinion) which locks teeth on a bar (the rack).

The steering system converts the rotation of the steering wheel into a swiveling movement of the road wheels in such a way that the steering-wheel rim turns a long way to move the road wheels a short way. The system allows a driver to use only light forces to steer a heavy car.

Functions of steering system

a) It helps in swinging the wheels to the left or right.

b) It helps in turning the vehicle at the will of the driver.

c) It provides directional stability.

d) It helps in controlling wear and tear of tyres.

e) It helps in achieving the self-rightening effect.

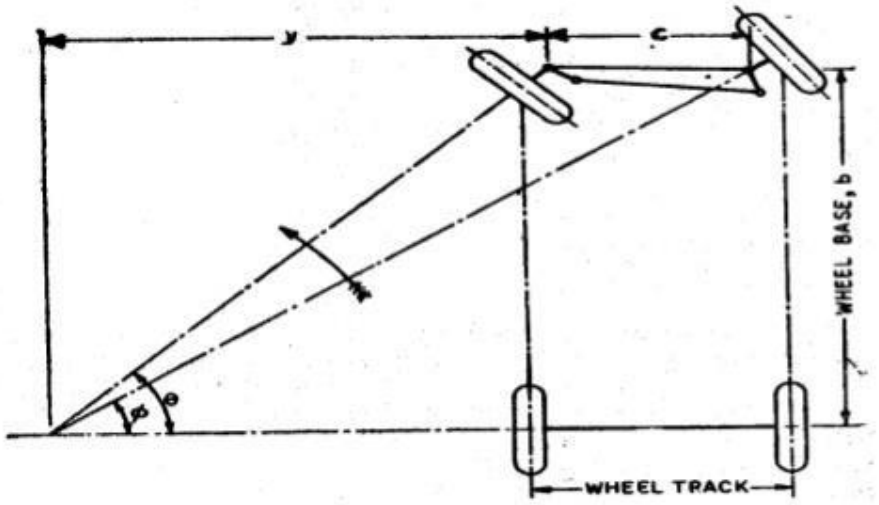
f) It converts the rotary movement of the steering wheel into an angular turn of the front wheels.

g) It multiplies the effort of the driver by leverage in order to make it fairly easy to turn the wheels.

h) It absorbs a major part of the road shocks thereby preventing them to get transmitted to the hands of the driver.

The complete steering system which performs the above functions, can be divided into two portions, namely, steering gear provided at the end of the steering column and the linkage between the steering gear and the wheels.

Steering Geometry:



for correct steering,

$$\cot\phi = \frac{y+c}{b}$$

$$= \frac{y}{b} + \frac{c}{b} = \cot\theta + \frac{c}{b}$$

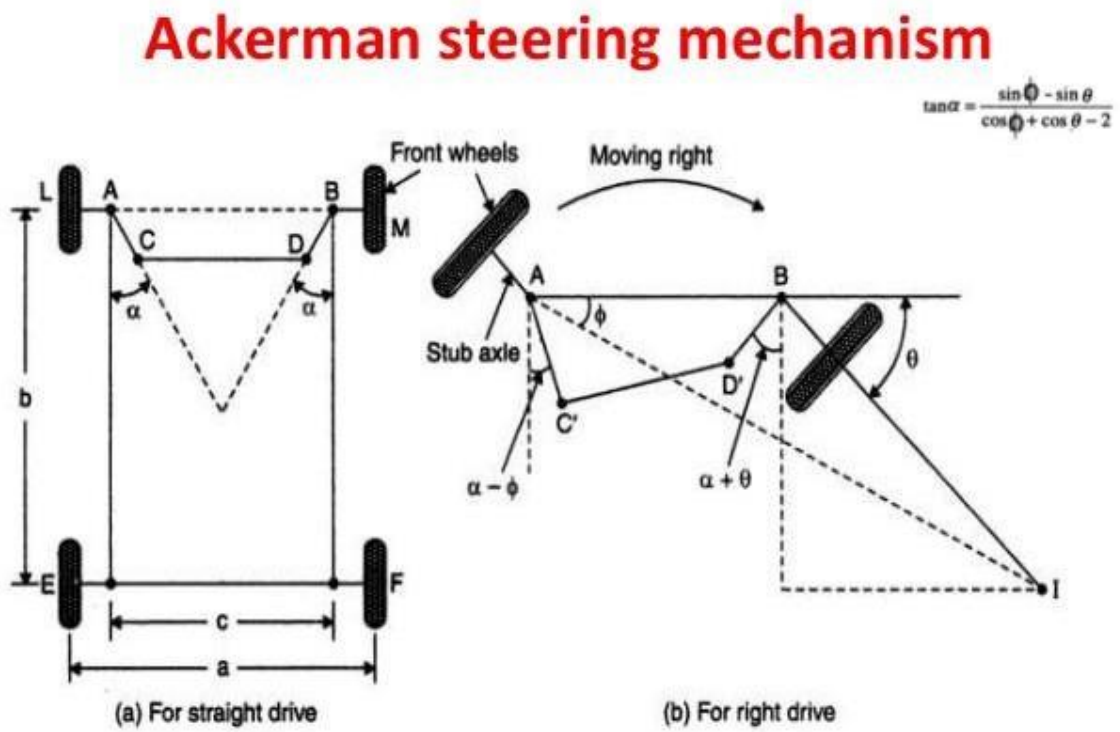
$$\therefore \quad \cot\phi - \cot\theta = \frac{c}{b}$$

where

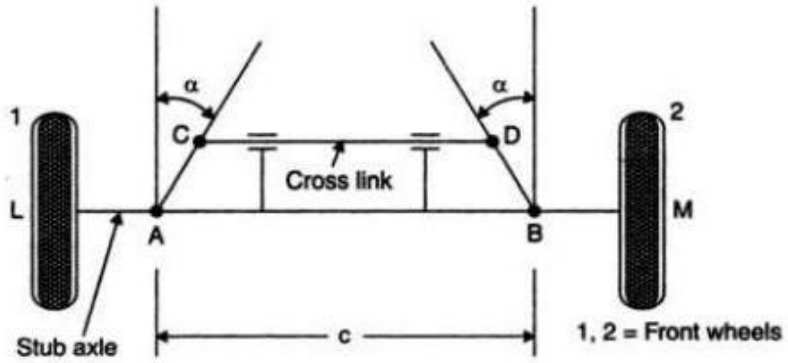
- c = lateral wheel separation
- b = longitudinal wheel separation
- θ = relative angle of inside wheel
- ϕ = relative angle of outside wheel

Equation represents the basic condition for the steering mechanism for perfect rolling of all wheels.

Ackermann steering diagram



Ackermann steering gear mechanism.



Davis steering gear mechanism.

3.1.2 Requirements of steering system

For proper and smooth operation and performance of the system, the steering system of any vehicle should ful fil the following requirements:

- The steering mechanism should be very accurate and easy to handle.
- The effort required to steer should be minimum and must not be tiresome to the driver.
- The steering mechanism should also provide the directional stability. This implies that the vehicle should have tendency to return to its straight ahead position after turning.
- It should provide pure rolling motion to wheel.
- It should be designed in such a manner that road shocks are not transmitted to driver.

Steering components and layout

The following are the main components of steering system are

1. Steering Wheel
2. Steering column or shaft
3. Steering Gear
4. Drop Arm or Pitman Arm
5. Drag Link
6. Steering Arm
7. Track-Arms
8. Track Rod or Tie-Rod
9. Adjusting Screws

Functions and types of steering gearbox

The basic function of the steering system is to allow the driver to safely and precisely steer the vehicle. Beyond this, the steering system also provides a way to reduce driver effort by making the act of steering the vehicle easier.

The different types of steering gears are as follows:

- Worm and sector steering gear.
- Worm and roller steering gear.
- Cam and double **lever** steering gear.
- Worm and **ball bearing nut** steering gear.
- Cam and roller steering gear.
- Cam and peg steering gear.
- Recirculating ball nut steering gear.
- Rack and pinion steering gear.

Worm and wheel

A worm drive is a gear arrangement in which a worm (which is a gear in the form of a screw) meshes with a worm gear (which is similar in appearance to a spur gear). The two elements are also called the worm screw and worm wheel.

The terminology is often confused by imprecise use of the term *worm gear* to refer to the worm, the worm gear, or the worm drive as a unit.

The worm gear or "endless screw" was invented by either Archytas of Terentum, Apollonius of Perge, or Archimedes, the last one the most probable author The worm gear later appeared in the Indian subcontinent, for use in roller cotton gins, during the Delhi Sultanate in the thirteenth or fourteenth centuries.

Like other gear arrangements, a worm drive can reduce rotational speed or transmit higher torque. A worm is an example of a screw, one of the six simple machines. One of the major advantages of worm gear drive units are that they can transfer motion in 90 degrees. The worm in the worm gear drive may have single or multiple starts. Each full 360 degree turn of a single start worm advances the gear by one tooth. For a multi start worm the gear reduction equals the number of teeth on the gear divided by the number of starts on the worm. Both the sliding and the rolling actions of the worm and the gear come into play during the meshing of the gears. The sliding contact dominates at high reduction ratios. Much heat is produced due to friction while sliding, which limits the efficiency of worm gears to 30 to 90 percent. The worm and the gear are made of dissimilar metals in order to minimize the friction and loss in efficiency.

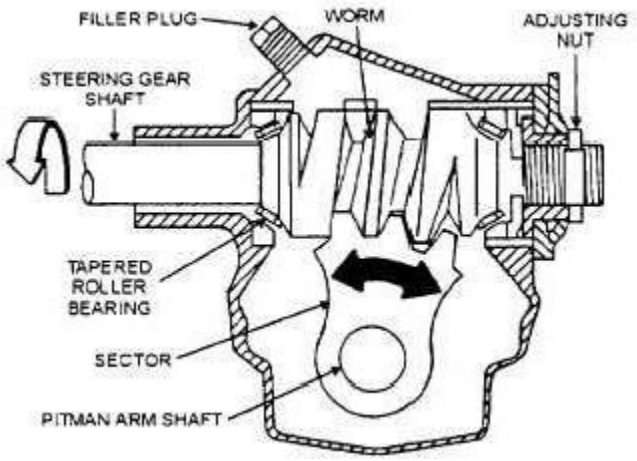
A gearbox designed using a worm and worm-wheel is considerably smaller than one made from plain spur gears, and has its drive axes at 90° to each other. With a *single start* worm, for each 360° turn of the worm, the worm-wheel advances only one tooth of the gear wheel. Therefore, regardless of the worm's size (sensible engineering limits notwithstanding), the gear ratio is the *"size of the worm wheel - to - 1"*. Given a single start worm, a 20 tooth worm wheel reduces the speed by the ratio of 20:1. With spur gears, a gear of 12 teeth must match with a 240 tooth gear to achieve the same 20:1 ratio. Therefore, if the diametrical pitch (DP) of each gear is the same, then, in terms of the physical size of the 240 tooth gear to that of the 20 tooth gear, the worm arrangement is considerably smaller in volume.

Worm and sector

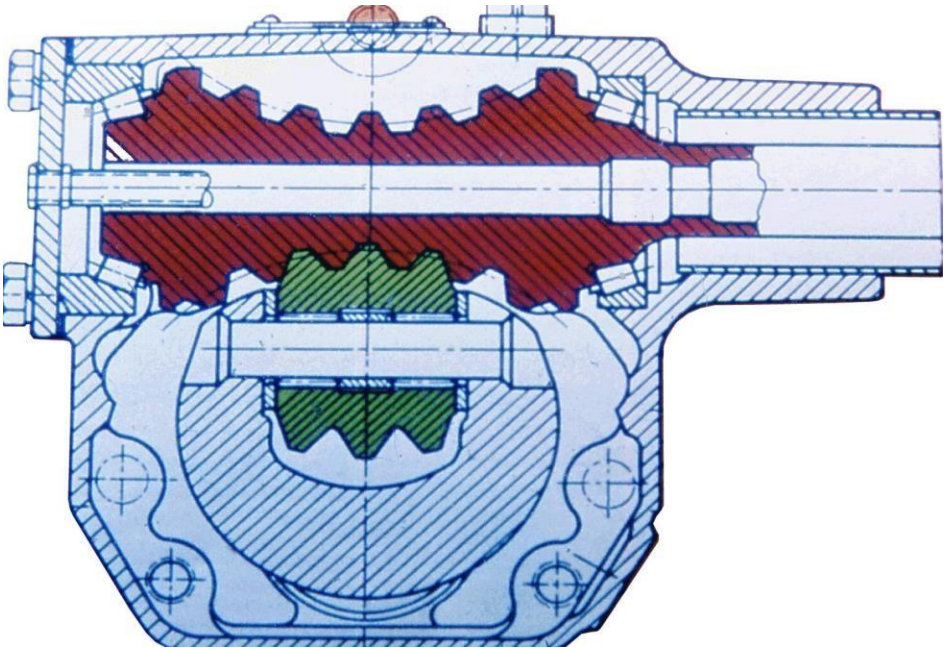
This steering gear consists of case-hardened steel worm and sector; both supported by bearings. Its casting is made from malleable iron or light alloy. The worm connects to the steering shaft while the sector forms a part of the rocker shaft.

In this type of steering mechanism, the steering shaft has a worm gear attached to it at its end. It meshes directly with a sector gear. It is called ‘sector’ gear because it's only a section of the full gear. When you turn the steering wheel, the steering shaft turns the worm gear. The sector gear rotates around its axis as its teeth move along the worm gear and moves the Pitman arm.

In worm and sector design, the bearings support the worm at both ends. Besides, the manufacturers provide some mechanism for adjusting the bearings to control the end play. The Pitman arm shaft fits into the steering gear housing supported by bushings. However, sometimes the manufacturers also use roller bearings. They also provide a screw for backlash adjustment to move the sector closer or away from the worm gear. This controls the backlash between the sector and worm threads or teeth.



Worm and rotor



The steering shaft coming in from the top left ends in the worm gear with the ball-bearings. This is known as a globoid-worm, because the diameter of the trapezoidal thread decreases towards the middle. It meshes into the cog segment lying below it. To reduce the friction as well, this is able to swivel in the roller bearings and is called the cog-roller. When steering, the fork in which the cog-roller is carried, swivels and transfers this movement further to the tie-rods.

Reversible and irreversible steering systems

A steering gear, esp. for an automobile, not affected by the road wheels, as when they strike an obstacle sideways, but easily controlled by the hand wheel or steering lever.

Reversible steering: When the deflection of road wheels is transmitted through the steering wheel to road surface, the system is called Reversible. If every imperfection of road surface causes the steering to rotate, it causes much strain on the part of the driver to

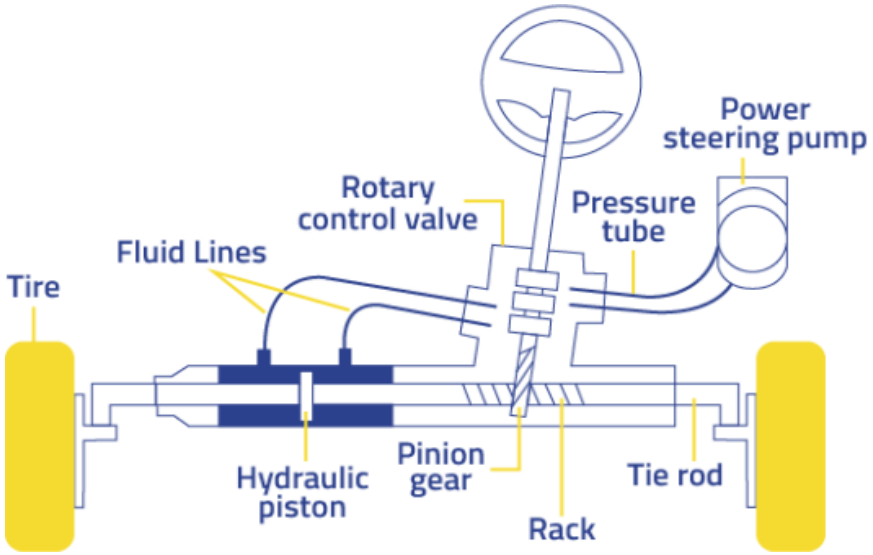
control the vehicle.

Reversible steering: When the deflection of road wheels is transmitted through the steering wheel to road surface, the system is called Reversible. If every imperfection of road surface causes the steering to rotate, it causes much strain on the part of the driver to control the vehicle. It causes much strain on the part of the driver to control the vehicle. Therefore such of the reversibility is not desired. But, some degree of reversibility desired, so that the wheel becomes straight after taking a curve.

Irreversible steering: If the front road wheels does not transfer any deflection to the steering which is called irreversible steering. After negotiating a curve and the steering wheel not returned easily, there causes the production ofun due stresses on the steering mechanism, therefore some degree of irreversible also desired.

Power steering

This system has single-handedly made steering of a vehicle a cakewalk. We will discuss the power steering employed by the rack and pinion steering system in brief.



Power-assisted rack and pinion

The power steering adds some more parts to the rack and pinion system which makes it easier to use. Mainly the pump, pressure tubes, rotary control valve, fluid lines and a hydraulic piston.

The job of the pump is to as you might have guessed, pump the fluid around when needed. The rotary control valve ensures that the movement of fluid is only performed when the driver is actually steering the car. The hydraulic piston moves around depending on which fluid line brings the high-pressure fluid. This piston movement on the rack makes it easier for the driver as it is applying most of the force necessary to steer the car. This concludes the brief discussion on how a hydraulic power steering system works.

Steering Linkage

The steering linkage is composed of all the parts of the steering system that connect the steering wheel to the front wheels. When you turn your steering wheel, the steering linkage causes your front wheels to respond by moving in the proper direction.

Steering linkage is a series or arms, rods, and ball sockets that connect the steering mechanism to the steering knuckles. The steering linkage used with most manual and power steering mechanisms typically includes a pitman arm, center link, idler arm, and two tie-rod assemblies. This configuration of linkage is known as parallelogram steering linkage and is used on many passenger vehicles.

Pitman Arm

The pitman arm transfers steering mechanism motion to the steering linkage. The pitman arm is splined to the steering mechanisms output shaft (pitman arm shaft). A large nut and lock washer secure the pitman arm to the output shaft. The outer end of the pitman arm normally uses a ball-and-socket joint to connect to the center link.

Center Link

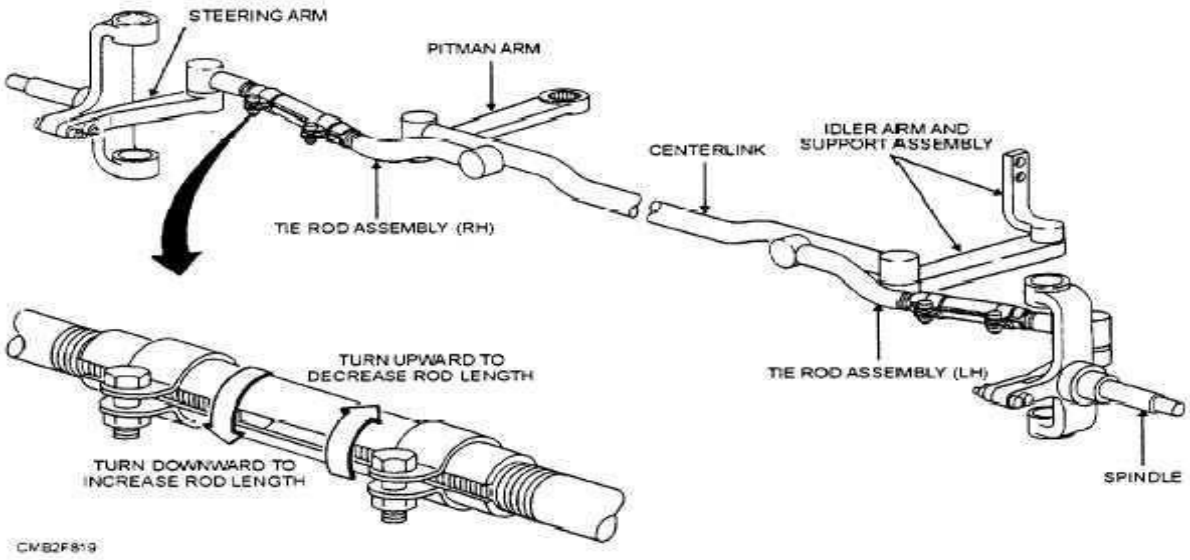
The parallelogram steering linkage uses a center link, otherwise known as an intermediate rod, track rod, or relay rod, which is simply a steel bar that connects the steering arms (pitman arm, tie-rod ends, and idler arm) together. The turning action of the steering mechanism is transmitted to the center link through the pitman arm.

Idler Arm

The center link is hinged on the opposite end of the pitman arm by means of an idler arm. The idler arm supports the free end of the center link and allows it to move left and right with ease. The idler arm bolts to the frame or sub frame.

Ball Sockets

Ball sockets are like small ball joints; they provide for motion in all directions between two connected components. Ball sockets are needed so the steering linkage is NOT damaged or bent when the wheels turn or move up and down over rough roads. Ball sockets are filled with grease to reduce friction and wear. Some have a grease fitting that allows chassis grease to be inserted with a grease gun. Others are sealed by the manufacturer and cannot be serviced.



Parallelogram steering linkage.

The main parts of Conventional system are:

- Steering Gear Box.
- Center Link.
- Pitman Arm.
- Idler Arm.
- Tie Rods. The main components of a Rack and Pinion steering system are:
- Rack and Pinion Assembly.
- Bellows Boots.
- Tie Rods.

Types of steering linkages

There are three basic types of steering linkage used in passenger cars and light trucks. These are Rack and Pinion, Parallel Linkages and Haltenberger Linkages. There are other variations on those designs described in this section, but these are the three fundamental types.

Types of steering Linkages:

1. Conventional steering Linkage.
2. Direct cross type steering linkage

3. Three piece steering linkage
4. center arm steering linkage
5. Relay type steering linkage.

Slip Angle: The angle between direction of the motion of the vehicle and the center plane of the tyre is known as Slip Angle. It ranges from 8º to 10º.

Under steer: When the front slip angle is greater than that of rear, the vehicle tends to steer in the direction of side force. Then it is known as under steer. This provides greater driving stability, especially when there is a side wind.

Over Steer: When the rear slip angle is greater than that of front slip angle, the vehicle tends to mover away from the direction of center path. This is known as over steer. This is advantageous when the vehicle moving on the road having many bends curves.

Steering Gear Ratio or Reduction Ratio: It has been defined as the " number of turns on the steering wheel required to produce on turn of steering gear cross shaft to which the pitman arm is attached. Generally it varies between14′.1 and 24′.1.

Turning radius

Turning Radius: It is the radius of the circle on which the outside front wheels moves when the front wheels are turned to their extreme outer position. This radius is 5 to 7.5 m for buses and trucks.

Wheel Alignment: It returns to the positioning of the front wheels and steering mechanism that gives the vehicle directional stability, reduce the tyre wear to a minimum.

Factors effects the wheel alignment:

1. Factors pertaining to wheel:- a. Balance of wheels(Static and Dynamic)
2. Inflation of tyre.
3. Brake adjustments.
4. Steering Linkages.
5. Suspension System
6. Steering Geometry –a. caster b. camber c. king pin inclination d. toe-in and toe-out etc.,

Steering geometry

Steering Geometry: It refers to the angular relationship between the front wheels and parts attached to it and car frame. The steering Geometry includes

1. Caster angle
2. Camber angle
3. King-pin inclination
4. toe-in
5. toe-out etc.,

Caster Angle: This is the angle between backward or forward tilting of the king pin from the vertical axis at the top. This is about 2º to 4º. The backward tilt is called as positive caster. The forward tilt is called negative caster.

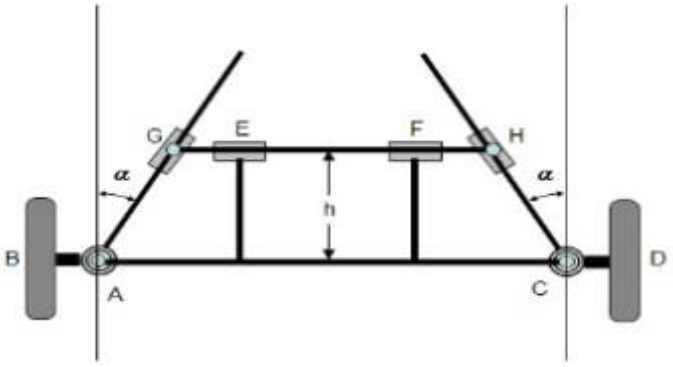
Camber: The angle between wheel axis to the vertical line at the top is called camber angle. It is approximately ½º to 2º.

King-pin inclination: It is the angle between vertical line to the king pin axis. The inclination tends to keep wheels straight ahead and make the wheels to get return to the straight position after completion of a turn. The inclination is normally kept 7º to 8º.

Toe-in: It is the amount in minimum at the front part of the wheel points inwards approximately 3 to 5 mm. It prevents side slipping excessive tyre wear, proper rolling of front wheels and steering stability.

Toe-out: It is the difference in angles between two front wheels and vehicle frame during turning. It is used to prevent dragging of tyre during turn.

Davis steering gear mechanism



Davis Steering Gear The Davis steering gear is shown in Fig. It is an exact steering gear mechanism. The slotted links AMand BHare attached to the front wheel axle, which turn on pivots A and B respectively. The rod CD is constrained to move in the direction of its length, by the sliding members at P and Q. These constraints are connected to the slotted link AM and BH by a sliding and a turning pair at each end. The steering is affected by moving CD to the right or left of its normal position. C′D′ shows the position of CD for turning to the left.

Let a= Vertical distance between AB and CD,

b= Wheel base, d= Horizontal distance between AC and BD,

c= Distance between the pivots A and B of the front axle.

x= Distance moved by AC to AC′= CC′= DD′,

And α= Angle of inclination of the links AC and BD, to the vertical.

Steering defects

- Fluid leaks.
- Contaminated fluid.
- Temperature **problems**.
- Bushing **defects**.
- Jammed **steering** wheel lock.
- Faulty hydraulics.

- Linkage damage.
- Faulty pump.

Symptoms of a bad or failing steering rack/gearbox

- Very tight steering **wheel**. Today's rack and pinion steering systems are supported by a **power steering** unit that utilizes hydraulic pressure to allow easy and quick steering **wheel** handling. ...
- Leaking **power steering** fluid. ...
- Grinding noise when steering. ...
- Burning oil smell.

Causes of steering problems can include:

- Defective wheel assembly.
- Worn **steering** or suspension components.
- Fluid leaks.
- Electrical shorts or malfunctions.
- Damages rims.
- Damaged tires.
- Suspension **problems**.
- Out of calibration **steering** system.

Steering systems in various vehicles

Land vehicle steering

- **Basic** geometry.
- Rack and pinion, recirculating ball, worm and sector.
- Power steering.
- Speed sensitive steering.
- Four-wheel steering.
- Articulated steering.
- Rear wheel steering.
- Steer-by-wire.

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Short answer question

1. Write the functions of steering system.
2. Write the components of steering system.
3. Write the types of steering linkages.
4. What is the use of steering linkage?
5. Write the steering defects.

Long answer questions

1. Draw the main components of steering system.
2. Explain worm and sector steering gear with sketch
3. Explain power steering with neat sketch.
4. Explain steering linkage with neat sketch.
5. Explain steering geometry.

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4. Front and Rear Axle

Introduction

An axle on your vehicle is a rod or shaft that rotates the wheels and supports the car's weight. Car and Driver explains that axles are essential components of any vehicle. Since axles conduct the power that turns the wheels, every vehicle needs axles in order to operate properly.

In most cases, four wheelers have two axles to rotate the wheels. Larger vehicles that carry more passengers and have more wheels may have more axles. It's easy to identify the number of axles that your car or any other vehicle has.

Front Axle and types of front axles

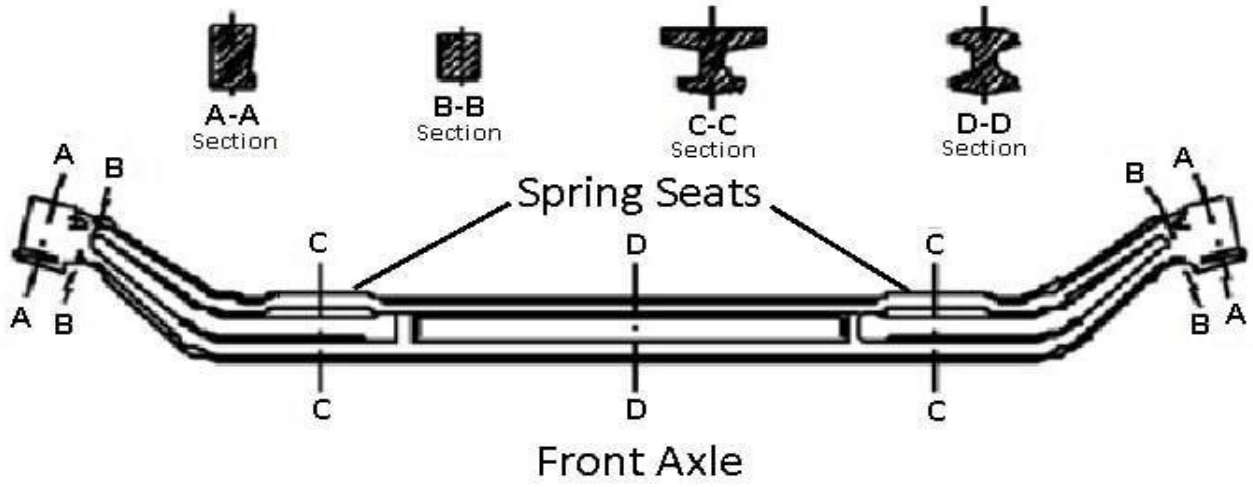
Front wheels of the automobile are mounted on front axles and the functions of the front axle are:

- Supporting the weight of the front part of the automobile.
- Absorbing shocks transmitted due to the uneven surface of the road.
- Facilitating Steering mechanism etc.
- To transmit the weight of the vehicle through the springs to the front wheels.
- To take the braking torque of the wheels.

The front axle facilitates steering, absorbs shocks from driving on uneven road surfaces and carries the weight of the front part of the vehicle.

There are two types of front axles: (a) Dead front axle, and (b) Live front axle.

Dead axles are those axles, which do not rotate. These axles have sufficient rigidity and strength to take the weight only. The ends of the front axle are designed to accommodate the stub axles.



Live front axle's function is to carry the load coming onto it and rotate by giving power transmission.

Necessity of front Axle

The front axle is made up of a circular or elliptical section at the ends and I-section in the middle portion.

This cross-section of the axle withstands bending loads due to the weight of the vehicle and torque applied due to braking.

Front axle carries the weight of the front part of the automobile as well as facilitates steering and absorbs shocks due to road surface variations. The front axles are generally dead axles, but are live axles in small cars of compact designs and also in case of four-wheel drive

Live axle and dead axles

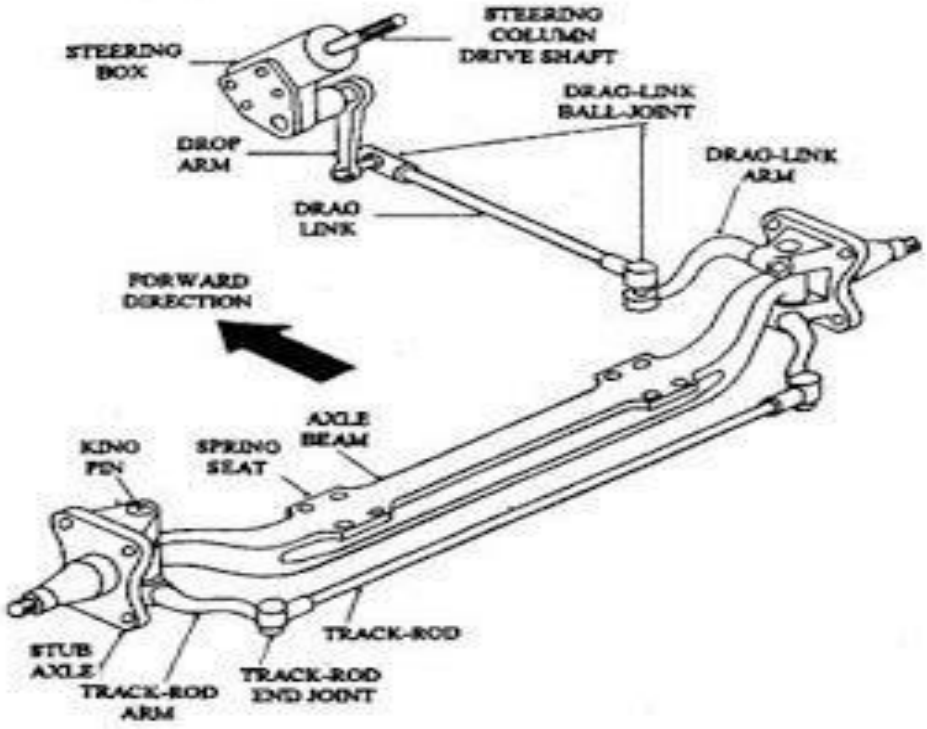
There are two types of front axles : (a) Dead front axle, and (b) Live front axle.

Dead axles are those axles, which do not rotate. These axles have sufficient rigidity and strength to take the weight only. The ends of the front axle are designed to accommodate the stub axles.

Components of front axle assembly

The front axle is designed to transmit the weight of the automobile from the springs to the front wheels, turning right or left as required.

- To prevent interference due to front engine location, and for providing greater stability and safety at high speeds by lowering the centre of gravity of the road vehicles, the entire centre portion of the axle is dropped.
- The front axle includes the axle-beam, stub-axles, ack-rod and stub-axle arm.
- The front axles are generally dead axles, which does not transmit power.
- The front wheel hubs rotate on anti-friction bearings of tapered-roller type on the steering spindles, which are an integral part of steering knuckles.
- To permit the wheels to be turned by the steering gear, the steering spindle and steering knuckle assemblies are hinged on the end of axle. The pin that forms the pivot of this hinge is known as king pin or steering knuckle pin.



Stub axle and types of stub axles

- Stub axles are connected to the front axle by king pins. Front wheels are mounted on stub axles arrangement for steering is connected to stub axles.
- Stub axle turns on kind pins. King pins is fitted in the front axle beam eye and is located and locked there by a taper cotter pin

Types of Stub Axle:

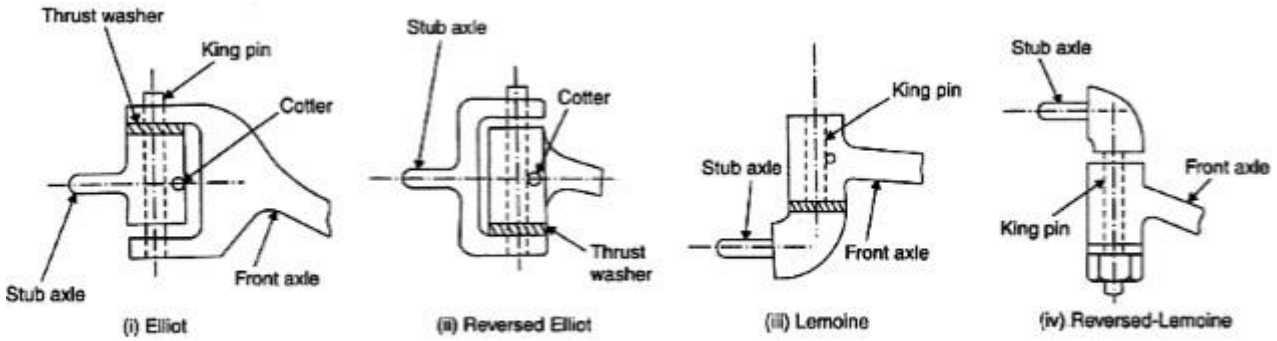
1. Elliot
2. Reversed Elliot
3. Lamoine
4. Reversed lamoine

Elliot: This type uses a kingpin, a yoke, and a cotter to connect to the front axle.

Reverse Elliot: This type has the opposite arrangement of a standard Elliot stub axle.

Lamoine: This stub axle type has an L-shaped spindle instead of a yoke-type hinge.

Reversed Lamoine: The stub axle has an L-shaped spindle and is fitted below the front axle.



Types of Stub Axles

Rear Axle and types

In between the differential and the driving wheels is the rear axle to transmit power from the differential to the driving wheels. It is clear from the construction of the differential, that the rear axle is not a single piece, but it is in two halves connected by the differential, one part is known as the half shaft.

The inner end of the half shaft is connected to the sun gear of the differential. and the outer end of the driving wheel. In rear-wheel-drive vehicles, the rear wheels are the driving wheels. Whereas, in front-wheel drive vehicles, the front wheels are the driving wheels. Almost all rear axles on modern passenger cars are live axles, that is, they revolve with the wheels.

Dead axles simply remain stationary; do not move with the wheels. Housing completely encloses the rear axles and the differential, protecting them from water, dust and injury, in addition to mounting their inner bearings and providing a container of the lubricant.

Function of Rear Axle

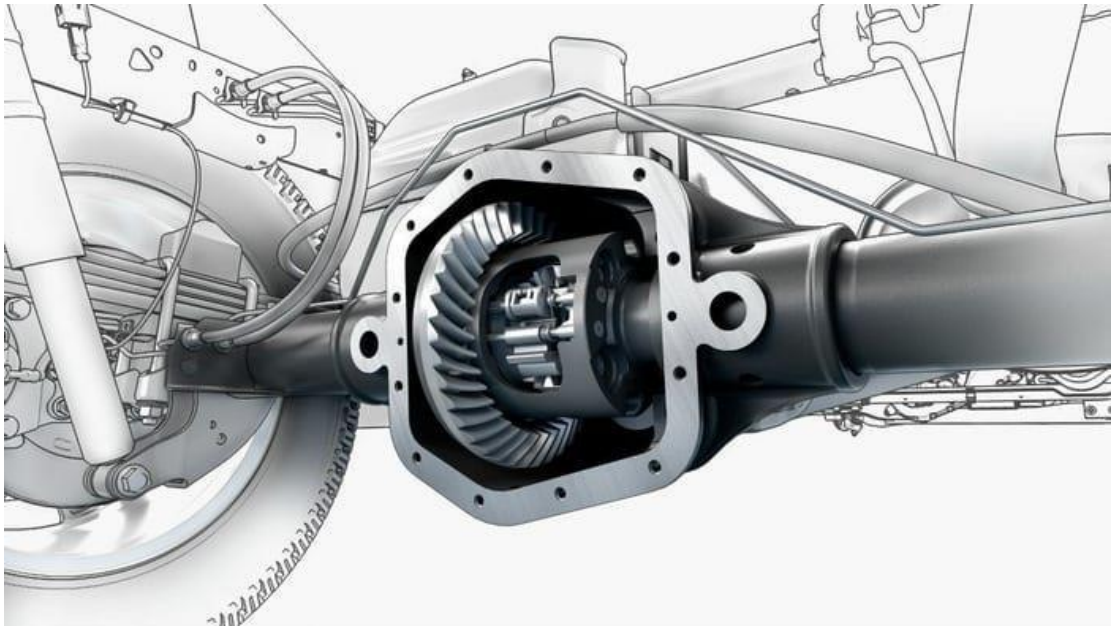
- Torque transmission. Differential rear axle increases torque due to downshift. Also, the bridge can change the plane of rotation of the drive wheels, allowing you to rotate the wheels perpendicular to the body when the crankshaft rotates along the axis of the car;

- Rotation of driving wheels with different angular speeds. This effect is achieved through the use of a differential (auxiliary satellites), which redistributes the torque depending on the load on the wheel. This makes it possible to safely take turns, especially at high speeds, and the presence of a differential lock allows you to overcome difficult areas when slipping one wheel;

- Support for wheels and body. For example, for VAZ 2101-2123 and GAZ Volga cars, the rear axle is of a closed type, in the body of which (stocking) there is a axle and axle gearbox, as well as brake drums. In this case, the suspension is dependent.

Elements of the rear axle

- a crankcase (stocking), usually one-piece, having a lid in the middle for access to the differential at the rear. On UAZ vehicles, the housing consists of two parts;
- drive and driven gear of the main pair;
- differential case (axle gearbox is assembled in it);
- semi axial gears (satellites);
- a set of bearings (pinion gear and differential) with a spacer;
- set of shims and gaskets.



Loads on the rear axle

Rear axle behaves like a beam supported at the ends and loaded at two points. The load coming on the axle is due to the weight of the body being transmitted through the suspension springs.

Weight causes shear force and bending on the wheels.

The various loads acting on the rear axle are

(1) Driving Thrust - Driving torque produced in the engine causes the thrust to be produced in the road wheels, which has to be transmitted from the axle casing to the chassis frame and the body of the vehicle.

(2) Torque Reaction - If the rear axle is held rigidly when the road wheels are prevented from rotation, (due to driving needs or road conditions) the bevel pinion of the final drive tends to rotate around the crown wheel. It produces a tendency in the whole vehicle to rotate about the rear axle, or to lift off the front of the vehicle. This effect is known as torque–reaction.

(3) Braking torque or thrust - The axle casing experiences the brake torque when the brakes are applied to the vehicle.

(4) Side Thrust - When the vehicle is taking the turn, the rear axle subjected to the side thrust or pulls due to any side load on the wheel.

(5) Weight of the body - The rear axle may be considered a beam supported at ends loaded. This weight causes bending and shears force in the axle shaft.

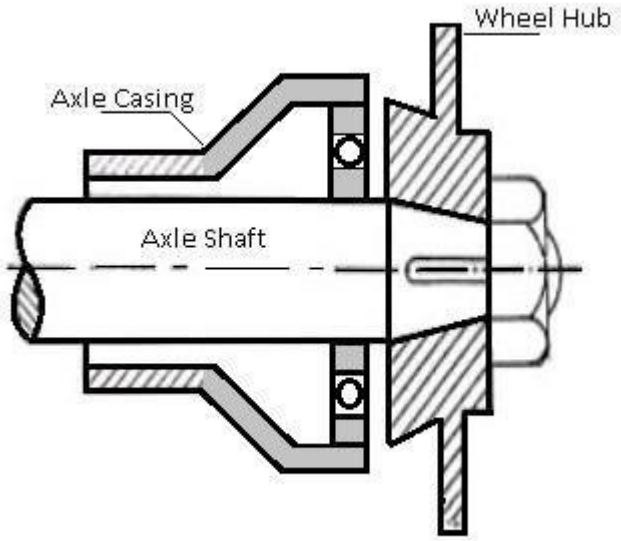
Types of axle housing

Depending upon the methods of supporting the rear axles and mounting the rear wheels, the three types of rear axle housing are as follows:

1. Semi-floating axle
2. Full-floating axle
3. Three quarter floating axle

Semi-Floating Axle

A semi-floating axle has a bearing located on the axle and inside the axle casing. It has to support all the loads as listed above. Therefore, it needs to be of a larger size, for the same torque output, than any other type. The inner end of the axle is supported by the differential side gear.



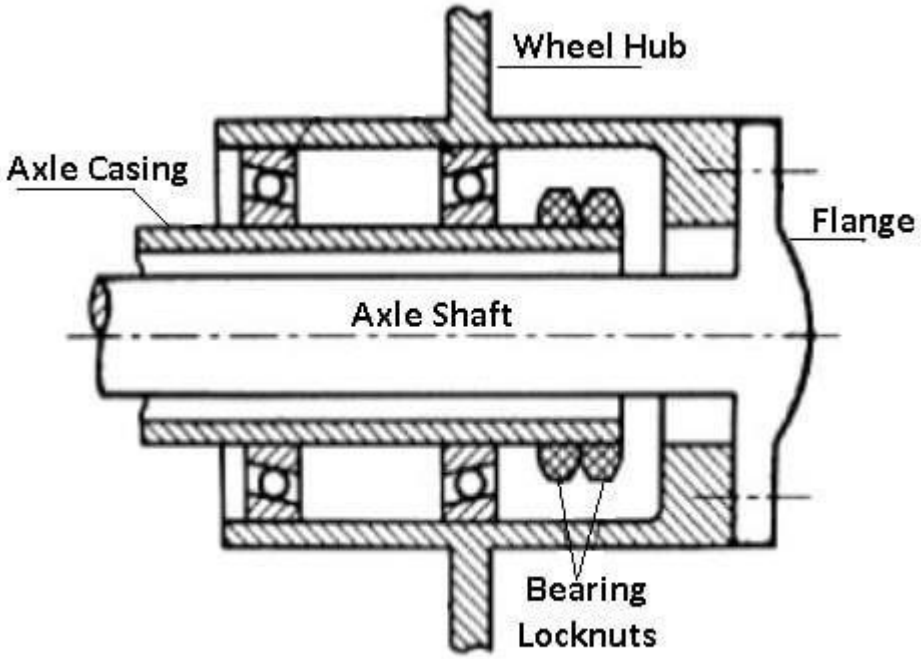
Semi-Floating Axle

It is thus relieved of the job of carrying the weight of the car by the axle housing. The outer end has to support the weight of the car and take end thrust. The inner end of the axle is splined to the differential side gear.

The outer end is flanged so that the wheel can be bolted directly to it. In some design, the hub of the wheel is keyed to the outer end of the axle. The vehicle load is transmitted to the axle through the casing and the bearing, which causes the bending or shearing of the axle. The semi-floating axle is the simplest and cheapest of all other types and widely used on cars.

Full-Floating Axle

A full floating axle has two deep groove ball or taper roller bearings, located between the axle casing and wheel hub. The outer of an axle is made flanged to which the wheel hub is bolted. The axle is not supported by bearing at either end, and its position is maintained by the way that it is supported at both ends.



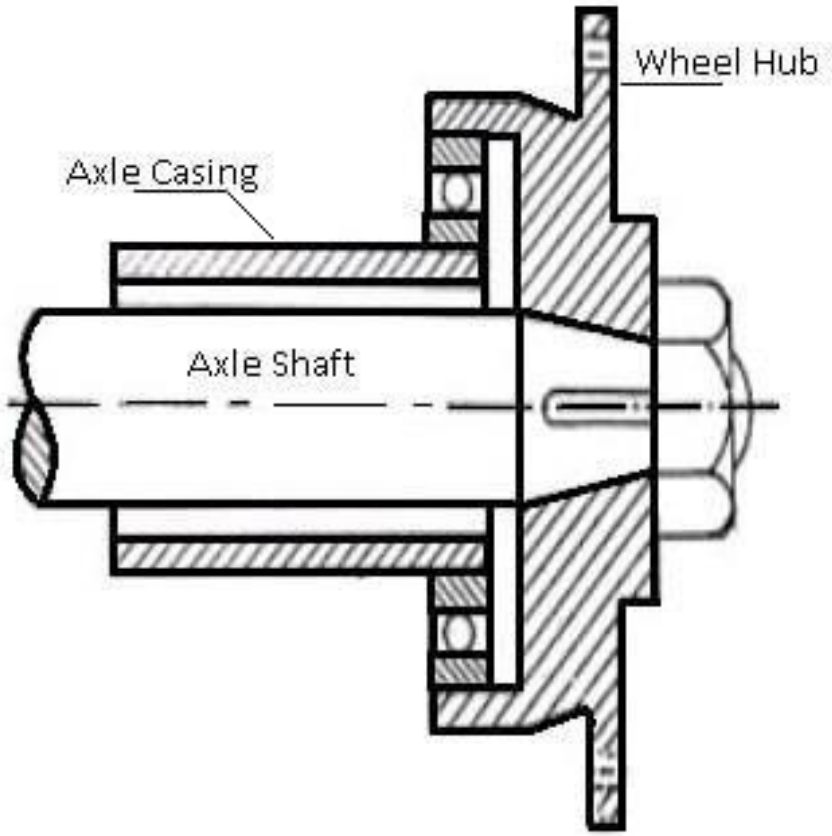
Full Floating Axle

Thus the axle is relieved of all strain caused by the weight of the vehicle on the end thrust. It transmits only the driving torque. For this reason, it is called full floating. The axle may be removed from the housing without distributing the wheel by removing the nuts.

An additional advantage of this design is the ability to the vehicle even if it has a broken axle. This type of axle is more, expensive and heavier than the other axle. It is usually fitted on commercial vehicles.

Three-Quarter Floating Axle

This type of axle has a bearing placed between the hub and the axle casing. Thus, the weight of the vehicle is transferred to the axle casing, and only the side thrust and driving torque are taken by the axle.

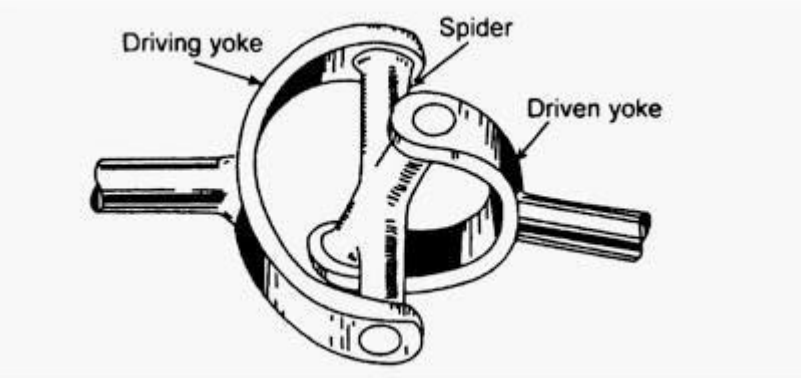


Three Quarter Floating Axle

The axle is keyed rigidly to the hub, thus proving the driving connection and maintaining the alignment of the wheel. The inner end of this axle has the same construction as that of the semi-floating axle. Although the three-quarter floating axle is more reliable it is not as simple as the semi-floating axle.

Universal joint types

Universal joints allow drive shafts to move up and down with the suspension while the shaft is moving so power can be transmitted when the drive shaft isn't in a straight line between the transmission and drive wheels. Rear-wheel-drive vehicles have universal joints (or U-joints) at both ends of the drive shaft.



WORKING OF UNIVERSAL JOINT

In case of an automobile, the gearbox is rigidly mounted. Due to the action of the road springs, the position of the rear axle is constantly varied and the allowance is provided if the gearbox is mounted to the rear axle by a propeller shaft.

A universal joint consists of two yokes. These yokes are attached to each end of the shaft. The two yokes are joined by a central or connecting cross piece. The connecting cross piece will turn bearings of the yoke with the change in angularity between shafts. They do not transmit motion uniformly if the shafts are operating at an angle.

TYPES OF UNIVERSAL JOINT

1. Variable Velocity Joints

- Cross or Spider Type
- Ring Type
- Ball And Trunnion Type

2. Constant Velocity (CV) Joints

- Rzeppa
- Bendix Weiss
- Tracta

1. Variable Velocity Joints

In this case, both the driven and driving shafts do not rotate at the same speed even though each part of a revolution is at the same rpm. The driven and driving shafts should be placed in a straight line to turn at the same speed through each part of a revolution. But in actual practice, it will not be feasible in any automobiles. The drive shaft is always inclined.

If there is an angle between driven and driving shafts, the driven shaft will be less than the driving shaft by half revolution and faster than the driving shaft by the other half revolution. Hence, the average speed of the driven shaft is equal to the driving shaft. The speed variation in the driven shaft increases with increase in flex angle of the universal joint.

If two variable speed universal pairs are used in two drive lines, the yoke on the shaft connected to the universal pairs should not be indifferent planes. It provides the balancing to the speed variations.

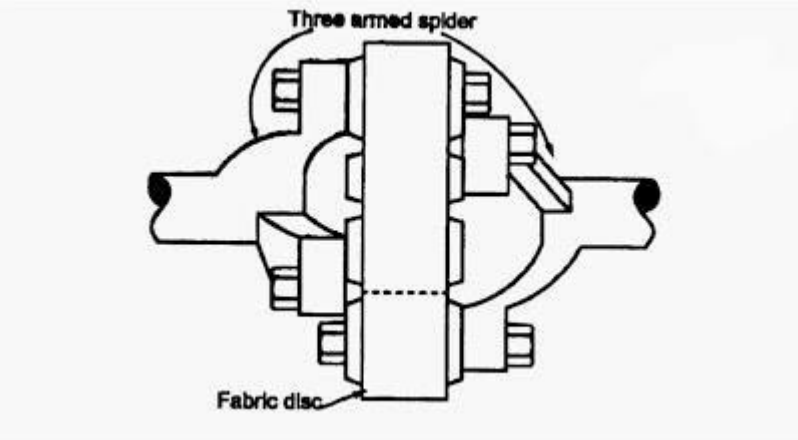
Variable Velocity Joints are following These Types.

- Cross or spider type
- Ring type
- Ball and Trunnion type

Cross or Spider Type:

In universal joints, the two yokes in which one is connected to the driving shaft and the other one is connected to the driven shaft at right angles to each other by a cross or spider. Needle type bearings are mounted between yokes and cross ends. These types of joints are generally used in driving shafts.

Ring Type :



This type of joint uses a flexible ring. The shaft has two or three armed spiders. The arms are bolted to opposite faces of the flexible ring. The arms of one spider are placed midway between the arms of the other. The flexible ring is made of one or more rings of rubber to provide enough strength. A number of thin steel discs are used instead of the fabric rings. This joint itself provides a sufficient amount of axial movement of the shaft. It smoothens the

torque fluctuations and it does not require lubrication. The main drawback is that the ring does not withstand for a longer period.

Ball and Trunnion Type:

A combination of both universal and slip joints in one assembly is used in this type. A pin or cross shaft is connected crosswise in 'T' fashion in the end of a universal joint shaft. A ball is mounted on the needle bearings at each end of the cross shaft. The complete assembly freely slides in grooves machined in the outer body of the joint. The heavy spring resists excessive longitudinal movement of the shaft. The power is transmitted through the Trunnion, balls and cross shaft. The bending moment occurs by rolling the ball in one direction. It is also in the other direction by moving balls lengthwise in Trunnion grooves. The open end of the shaft is covered by the leather or rubber boot covers.

2. Constant Velocity Joints

In this type of joint, the driven shaft is turned at the same speed as the driving shaft turns through each part of revolution at any degree of flex. These joints are mainly used in front drive axles to transmit power over large angles. Cadillac cars use ball and socket type constant velocity joints in their propeller shafts.

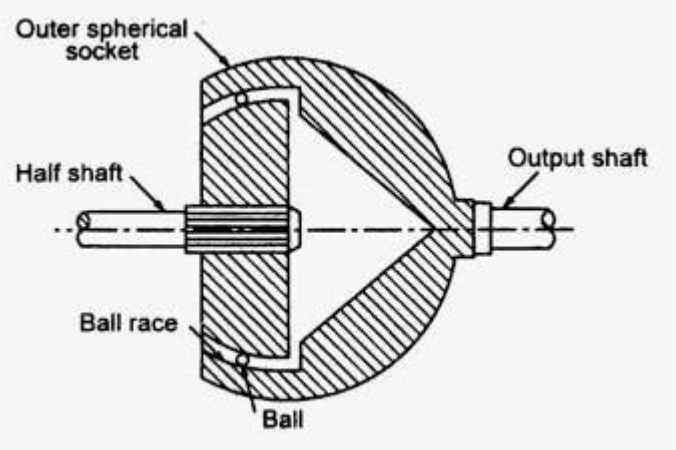
Constant Velocity Joints are following These Types.

- Rzeppa
- Bendix Weiss
- Tracta

Rzeppa :

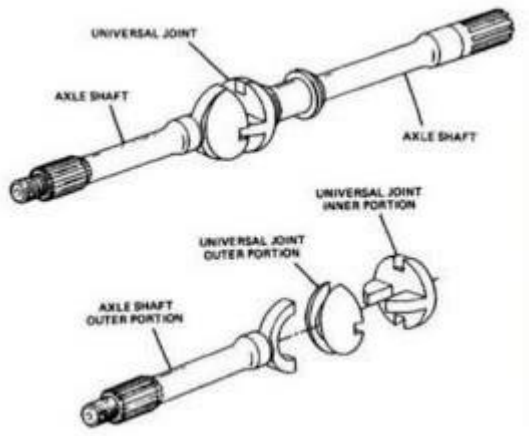
It consists of spherical internal and external ball races in which the grooves are cut parallel to the shaft. The Steel balls are placed in grooves on the spherical races. The torque transmission is done from one race to another ball. The circular pattern of balls causes shafts to turn at the same velocity.

Bendix Weiss :



The principle of driving through balls placed in a circle around a sphere is used in this type of joint. Four numbers of driving balls are placed into machined races in close fitting yokes. A fifth or centre ball is held between two yokes as an inner race. The driving balls are arranged themselves in a circle in the same manner as the Rzeppa joint. The aligning action of the balls gives a constant velocity joint.

Tracta :



This joint differs from the above two joints. Four yokes are used in this joint in which two yokes are fastened to shafts and the other two are floating at the centre of the joint. The mating parts of the yokes are made into segments of a circle. Both circular segments and floating action of the two yokes provide a constant velocity joint.

FUNCTION OF UNIVERSAL JOINT

Universal joints are used for connecting two shafts inclined to one another at angle and also for transmitting the rotary motion from engine to road wheels throughout the variations in rear axle position with respect to gearbox and chassis.

So the universal joints are used at the front and rear end of the propeller shaft which transmit the power to the wheels even if the heights of transmission and rear axle are different. Also whenever the axle moves up and down due to road irregularities, the angle of drive changes continuously and the universal joint allows

Materials Used For Universal Joints

Universal joints can be made from almost any material depending on the application.

Common materials used include stainless steel, steel, naval brass and other similar alloys to handle greater torque and temperature.

Plastics and thermoplastics are also used to create universal joints as they have greater rust and corrosion resistance as well as electrical and magnetic insulation in applications where this is required.

APPLICATIONS OF UNIVERSAL JOINT

- Universal joints vary based on their material composition, hub type and the applications for which they are designed, it is a positive mechanical joint that is used for connecting shafts.
- Universal Joint is most commonly found in the propeller shaft of rear wheel drive cars.
- Specific applications of universal joints include aircraft, appliances, control systems, electronics, Instrumentation, textile machinery, medical and optical equipment, radios, weapons, sewing machines and tool drives.

Advantages And Disadvantages Of Universal Joint

Advantages

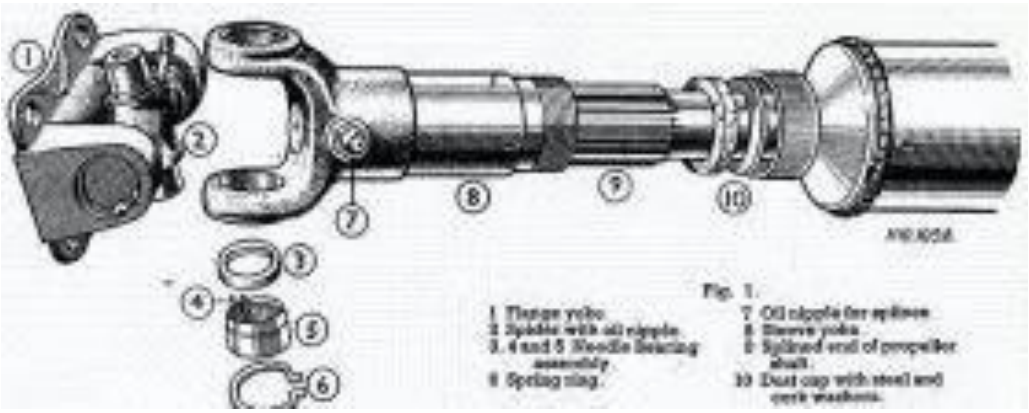
1. Universal coupling is more flexible than knuckle joint.
2. It facilitates torque transmission between shafts which have angular misalignment.
3. It is cheap and cost-effective.
4. It is simple to be assembled and dismantled.
5. Torque transmission efficiency is high.
6. The joint permits angular displacement.

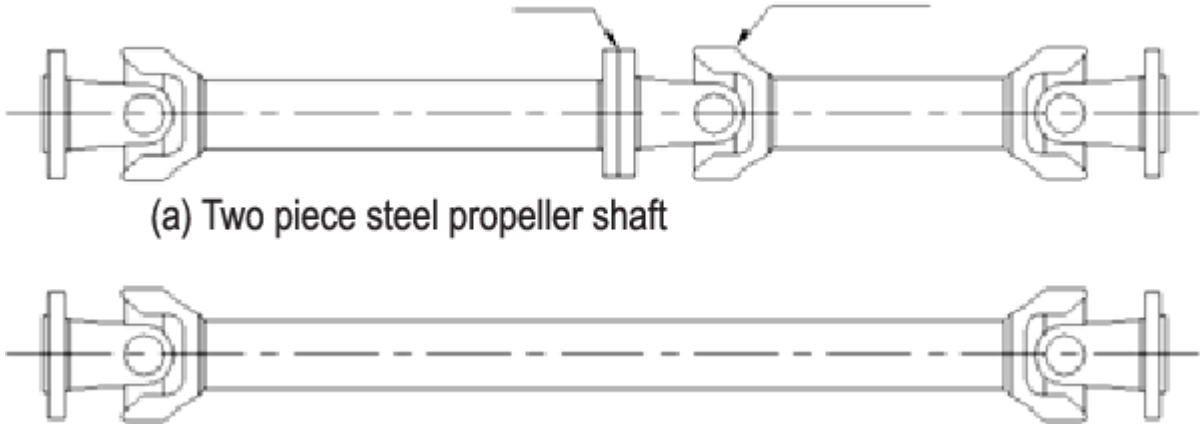
Disadvantages

1. Wear may occur if the joint is not properly lubricated.
2. Maintenance is often necessary to avoid wear.
3. Universal joint produces fluctuating motion
4. It does not support axial misalignment.

Propeller shaft types

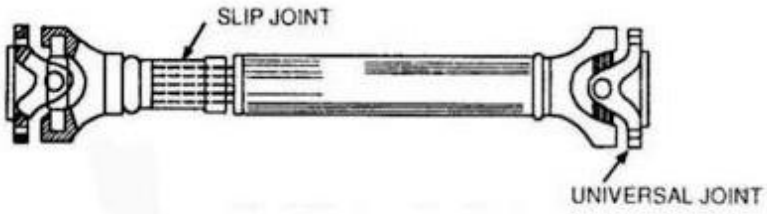
Propeller shaft is a hollow circular shaft which is used to transmit the power or rotational motion from the gear box to the final drive. It also includes the U- joints and slip or slider joint to adjust the length of a shaft when the vehicle is on bump. The propeller shaft is inclined at an particular angle for the length adjustment with the help of U-joints and slip joint.





(a) Two piece steel propeller shaft

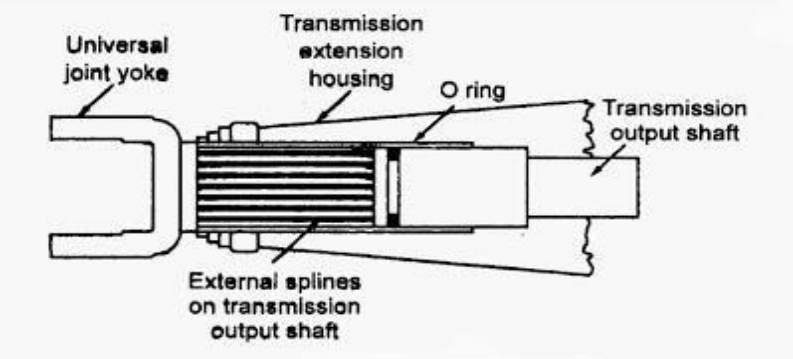
SLIP JOINT



A Slip Joint or Sliding Joint is used between propeller shaft and universal joint connecting the propeller shaft to compensate for this change of length and it helps to transmit the power from engine to rear axle at the same time. In cars having a torque-tube drive, a slip joint is not necessary.

The propeller shaft is inclined towards down from the transmission main shaft to the rear axle as stated earlier. The propeller shaft will also be shortened and lengthened again when the axle rises as the rear springs are compressed and at the time the axle returns to its original position.

The joint consists of a male splined end of the main shaft which slides into the corresponding grooves with the female member of the joint. The female part is integral with the universal joint hub. The splines enable the slip joint to transmit power for compensating any change of length in the propeller shaft when sliding.



FUNCTION OF SLIP JOINT

If the rear wheel comes in front of the bump, then the spring compresses or expands as the differential with the rear axle housing and the wheel moves up and down. This not only changes the angle but also varies the length of the propeller shaft.

The slip joint therefore allows an effective length of propeller shaft depending on the road conditions. If there is no slip joint, the propeller shaft will buckle or brake

Differential unit

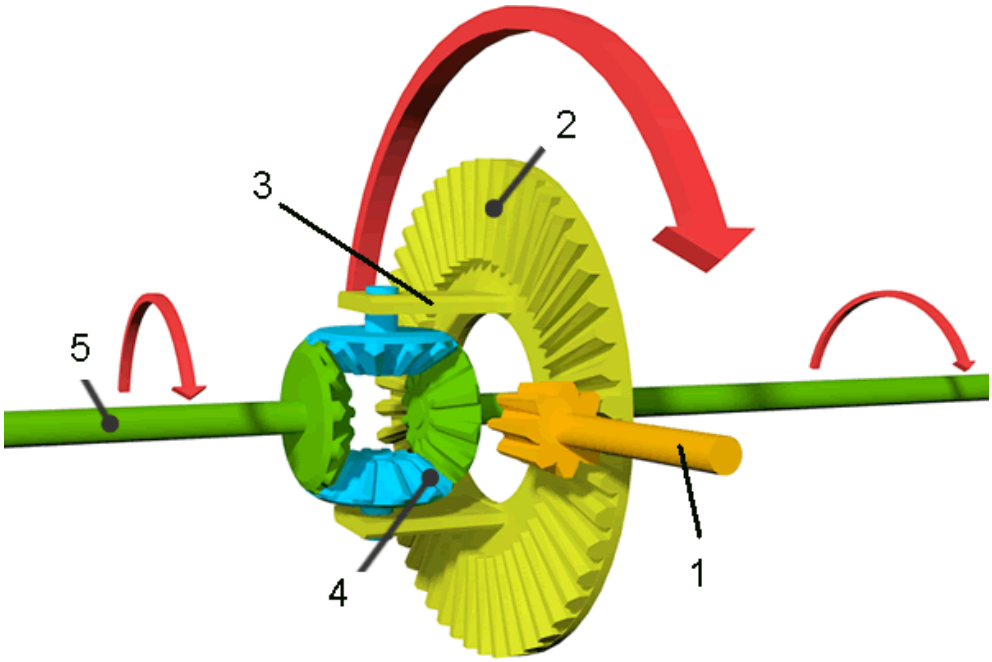
Differential gear in automotive mechanics is a gear arrangement that permits power from the engine to be transmitted to a pair of driving wheels, dividing the force equally between them but permitting them to follow paths of different lengths, as when turning a corner or traversing an uneven road. On a straight road the wheels rotate at the same speed; when turning a corner the outside wheel has farther to go and will turn faster than the inner wheel if unrestrained.

The conventional automobile differential was invented in 1827 by a Frenchman, Onésiphore Pecqueur. It was used first on steam-driven vehicles and was a well-known device when internal-combustion engines appeared at the end of the 19th century.

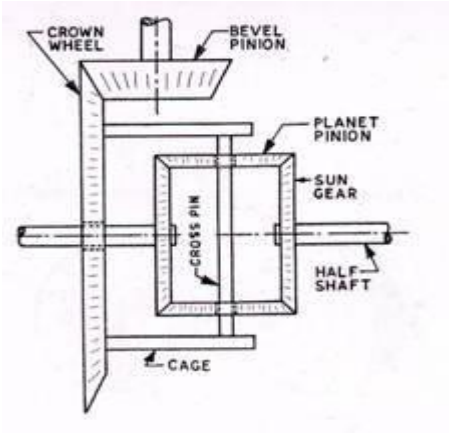
The elements of the Pecqueur differential are shown in the Figure. The power from the transmission is delivered to the bevel ring gear by the drive-shaft pinion, both of which are held in bearings (not shown) in the rear-axle housing. The case is an open boxlike structure that is bolted to the ring gear and contains bearings to support one or two pairs of diametrically opposite differential bevel pinions. Each wheel axle is attached to a differential side gear, which meshes with the differential pinions. On a straight road the wheels and the side gears rotate at the same speed, there is no relative motion between the differential side gears and pinions, and they all rotate as a unit with the case and ring gear. If the vehicle turns to the left, the right-hand wheel will be forced to rotate faster than the left-hand wheel, and the side gears and the pinions will rotate relative to one another. The ring gear rotates at a speed that is equal to the mean speed of the left and right wheels. If the wheels are jacked up with the transmission in neutral and one of the wheels is turned, the opposite wheel will turn in the opposite direction at the same speed.

The main components of the differential are:

1. Input pinion gear
2. Crown wheel gear
3. Differential cage
4. Differential star
5. Differential axle (sun) gear



The torque (turning moment) transmitted to the two wheels with the Pecqueur differential is the same. Consequently, if one wheel slips, as in ice or mud, the torque to the other wheel is reduced. This disadvantage can be overcome somewhat by the use of a limited-slip differential. In one version a clutch connects one of the axles and the ring gear. When one wheel encounters low traction, its tendency to spin is resisted by the clutch, thus providing greater torque for the other wheel.



Working of differential

The main components of the differential mechanism are as follows.
1. Crown wheel
2. Cage
3. Sun gears
4. Planet pinions

The power from the propeller shaft bevel pinion goes to the crown wheel. Along with the crown, rotates the assembly of four bevel pinions (planet pinions and sun gears). Two bevel gears are carried on individual half axles which are connected to the rear wheels. When stationary, if one wheel is made to rotate in anticlockwise direction then the other wheel through the bevel gear assembly rotates in the clockwise direction.
If on a straight road the both the wheels are rotating at N rpm, and now if negotiating a curved path, if the inner wheel rotates at N-a rpm the outer wheel will rotate at N+a rpm.

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Short answer question

1. Write the functions of the front axle.
2. Write the types of stub axles
3. Write the functions of rear axle.
4. Write the applications of universal joints.
5. Write the types of universal joints.

Long answer questions

1. Explain any one type of rear axle with neat sketch.
2. Explain types of axle housings.
3. Explain constant velocity type Universal joint.
4. Explain propeller shaft with neat sketch
5. Write the components and explain the working of Differential.

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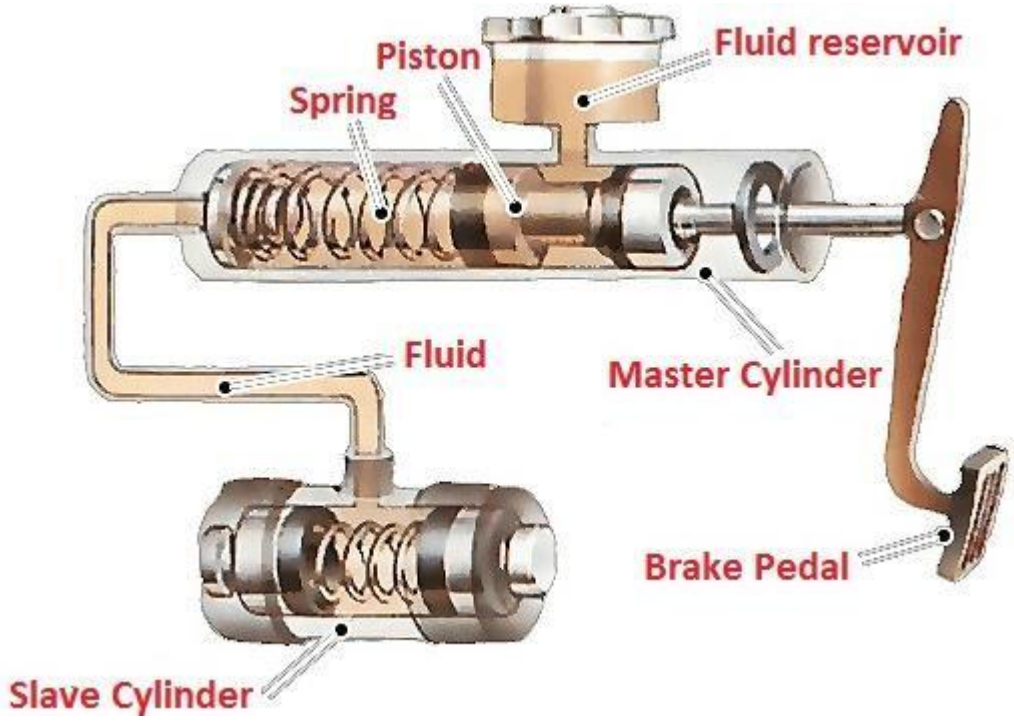
5. Braking system

Introduction

A Braking System is designed to control and halt the moving automobile vehicle, to pull off this, various components within the Brake system should convert the moving object from kinetic energy into heat energy, this conversation of force is carried by friction, which reduces the speed and also helps in de-accelerate the vehicle.

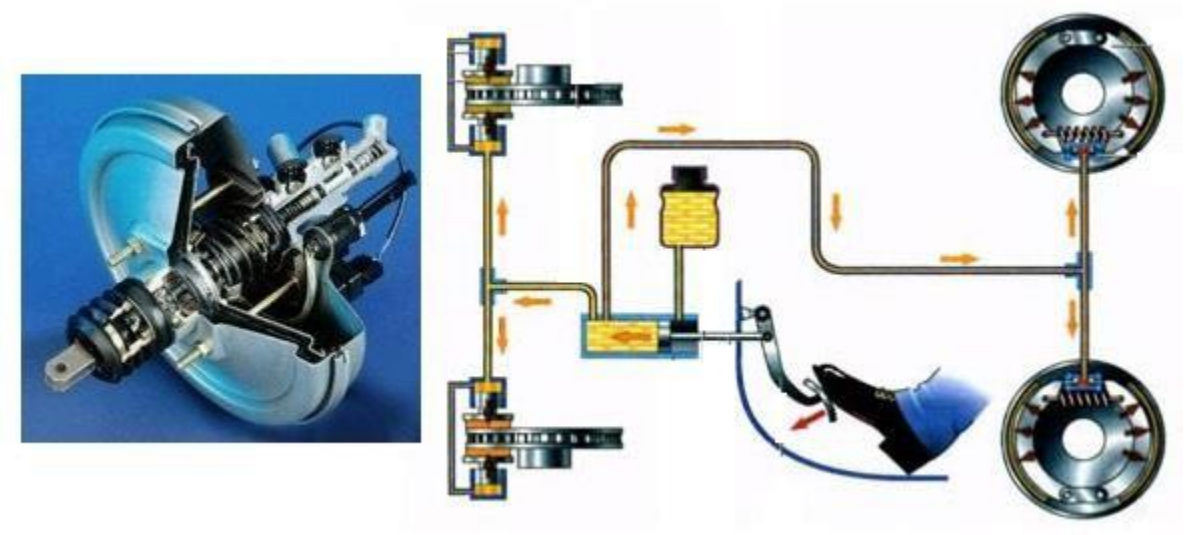
This Frictional force generated by the Frictional contact of bodies between the shoe and moving drum or disc of an automobile braking system.



Friction opposes the body that is in contact with each other by relative motion, so when you use energy to counter the friction it produces heat and components such as pads, liners, drums, and disc gets heated during the process and acts to slow down the moving body.

The Frictional force depends upon the surface nature materials, to achieve the braking effect of a moving body it depends on the speed of relative motion.

Hence to experience higher friction the bodies should be pressed comparatively more together, and also the faster the relative body moves in relation to each other lesser friction would be experienced between them.



Functions

- The function of vehicle brake system is to stop or slow down the moving motor vehicle or prevent it from moving when in stationary position.
- All the braking systems use the force of friction for their operation. Friction opposes the relative motion of the bodies that are in contact with each other.
- It always acts opposite to the force of motion. When you use energy to overcome the friction, it creates heat. So, the components such as brake liners, pads, drums and discs get heated while in operation.

Stopping distance

If a driver uses the brakes of a car, the car will not come to a stop immediately. The stopping distance is the distance the car covers before it comes to a stop. It is based on the speed of the car and the coefficient of friction between the wheels and the road. This stopping distance formula does not comprise the effect of anti-lock brakes or brake pumping. This lesson will explore the physics behind the distance it takes to stop a moving car. You'll learn stopping distance formula with example.

Stopping Distance Formula

Concept of Stopping Distance:

When the body is moving with a certain velocity and suddenly one applies brakes. You will observe that the body stops entirely after covering a certain distance. This is stopping distance. The stopping distance is the distance covered between the time when the body decides to stop a moving vehicle and the time when the vehicle stops entirely. The stopping distance relates to factors containing road surface, and reflexes of the car's driver and it is denoted by d. The SI unit for stopping distance meters.

The Formula for Stopping Distance:

Stopping Distance formula is given by, $\boldsymbol{d = \frac{v^2}{2\mu g}}$

Where V = Velocity in m/sec,

μ = Friction coefficient

g= Acceleration due to gravity in m/sec^2.

D = Distance in meter.

Stopping time

The measure of velocity is distance divided by time (fps), stated as feet per second. The measure of acceleration (or deceleration in this case) is feet per second per second. That assumes a reasonably good co-efficient of friction of about .75; better is .8 or higher while conditions or tire quality might yield a worse factor of .7 or lower.

No matter the velocity, that velocity is reduced 15 fps every second. If the initial velocity is 60 mph, 88 fps, after 1 second elapsed, the vehicle velocity would be 73 fps, after 2 seconds it would be 58 fps decreasing progressively thereafter. For the true mathematical perfectionist (one who carries PI to 1000 decimal places), it would have been technically correct to indicated the formula is 'fpsps' rather than 'fps', but far less understandable to most drivers. Since at speeds of 200 mph or less, the difference from one method to the other is in thousanths of seconds, our calculations in these examples are based on the simple fps calculations.

To determine how long it will take a driver to stop a vehicle, assuming a constant rate of deceleration, the process is to divide the initial velocity (in fps) by the rate of deceleration. You may want to use our Vehicle Stopping Distance Calculator to do actual model calculations.

60 MPH = 88 fps. (fps=1.467 * MPH). If the vehicle deceleration rate is 20 fpsps (rather than the previously calculated 15 fps), then stopping time = 88/20 = 4.4 seconds. Since there is a 1 second delay (driver reaction time) in hitting your brakes (both recognition and reaction time is often 2 seconds), the total time to stop is 5.4 seconds to 6.4 seconds.

To determine how far the vehicle will travel while braking, use the formula of 1/2 the initial velocity multiplied by the time required to stop. In this case, this works out to be .5 * 88 * 4.4 = 193.6 feet, plus a reaction time of either 88 feet for a second delay in reaction time, or 176 feet for two seconds reaction time. That yields 281.6 feet or 369.6 when added to the base stopping distance of 193.6 feet. If the driver is very responsive and takes only a half a second to react, the distance is reduced to 237.6 feet. Notice that the reaction time is a huge factor since it is at initial velocity.

Based on pure math, it is evident that there is a very large difference in the reported performance tests and reality. Assuming a deceleration rate of 32 fpsps (1g), calculations indicate a braking stop time of 2.75 seconds (88/32). Distance traveled now is calculated to be 121 feet, which is for all practical purposed, the published performance figures, excluding reaction times.

The intelligent driver will error on the safe side and leave room for reaction time and less than perfect conditions. That driver will also hone the braking skills to give more of a margin of safety. That margin can save lives. Pay attention to the need to react quickly.

Factors affect stopping distances

As we've already mentioned, stopping distances can be influenced by a number of factors.

1. Weather: In poor weather conditions, a car's total stopping distance is likely to be longer for a number of reasons. Research suggests that the braking distances may be doubled in wet conditions – and multiplied by 10 on snow or ice. That means, in the snow, it could take you further than the length of seven football pitches to stop from 70mph.

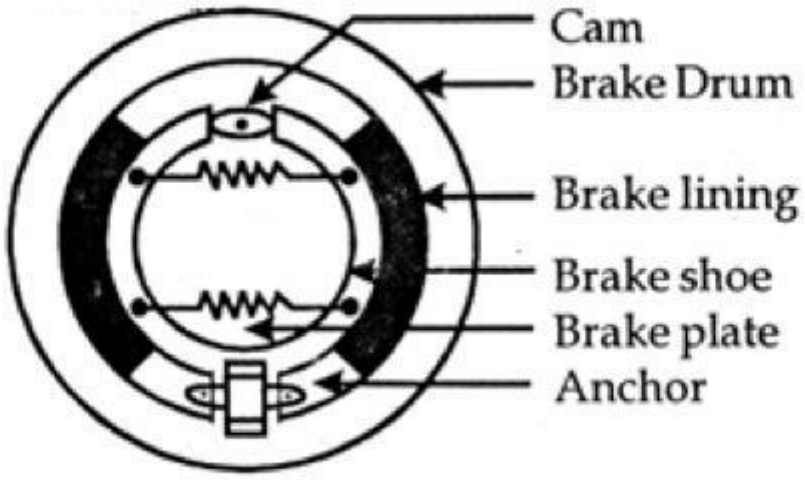
2. Road condition: It's not always as clear as 'bad weather equals long stopping distances', either. A road might be particularly greasy if there has been raining after a period of hot weather, or if the oil has been spilt on it.

3. Driver condition: A driver's age, how awake they are and if they've consumed any drugs or alcohol can all influence how quickly it takes them to react.

4. Car condition: While many modern cars may indeed be able to stop in shorter distances than the official Highway Code states, a car's condition can also have an impact.

Working of Mechanical Break

Mechanical brakes all act by generating frictional forces as two surfaces rub against each other. The stopping power or capacity of a brake depends largely on the surface area of frictional surfaces as well as on the actuation force applied. The friction and wear encountered by the working surfaces



Mechanical Brake

are
severe.

Types of braking

Most of the Brakes use friction on both sides of the wheel, the collective wheel pressing converts kinetic energy into heat energy.

For eg: (A regeneration braking system helps in the transformation of the energy into electrical energy, which also can be stored and used later. Eddy current brakes used magnetic fields to process kinetic energy into electrical current and The brake disc, which is then converted into heat).

It's always good to know which of these braking systems fits your modern car's needs for easy troubleshooting and servicing. So let's have a look at the different types of Braking system.

- **Mechanical Braking System**
- **Hydraulic Braking System**
- **Pneumatic Braking System**
- **Electromagnetic Braking System**
- **Servo Braking System**

- **Electrical braking system**
- **Disc Brake System**
- **Drum Brake System**
- **Emergency Brake**
- **Anti-lock Braking system**
- **Service Brakes or Foot oriented Brakes and**
- **Hand Brake System**

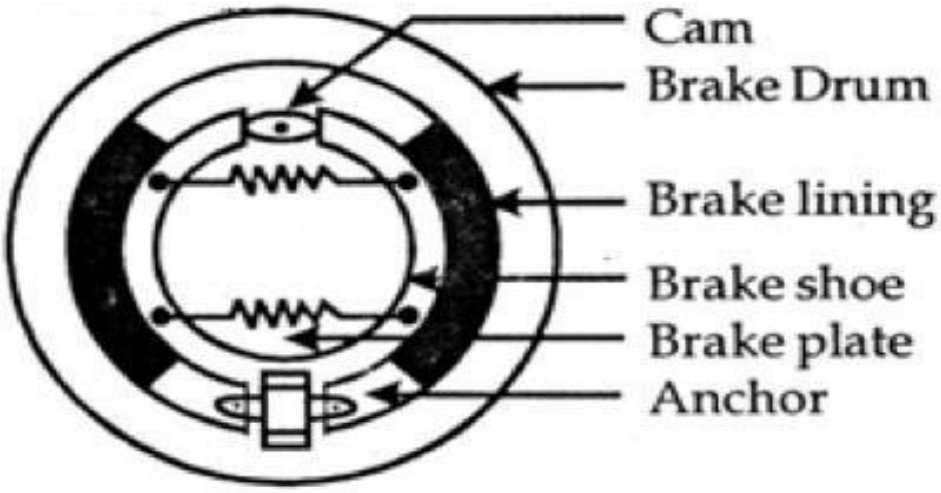
Now we will study one by one in detail. So let's start,

1. Mechanical Braking System:

This mechanical braking system is the hand brake or the emergency brake, it generates friction between two surfaces as they rub against each other.

In this braking system, a particular force is applied to the pedal and it's carried to the final drum by mechanical components such as a fulcrum, springs, and that are used as linkages to transmit force from one point to another, for slowing down the vehicle.

The slowing down of the speed or capacity of a brake depends on the surface friction as well the actuation force applied to it.



Mechanical Brake

Advantages of Mechanical Braking System:

- Mechanical brakes are simpler and easy to be maintained.
- It is less expensive than a hydraulic brake system.
- It provides great uses for emergency and parking brakes.

2. Hydraulic Braking System:

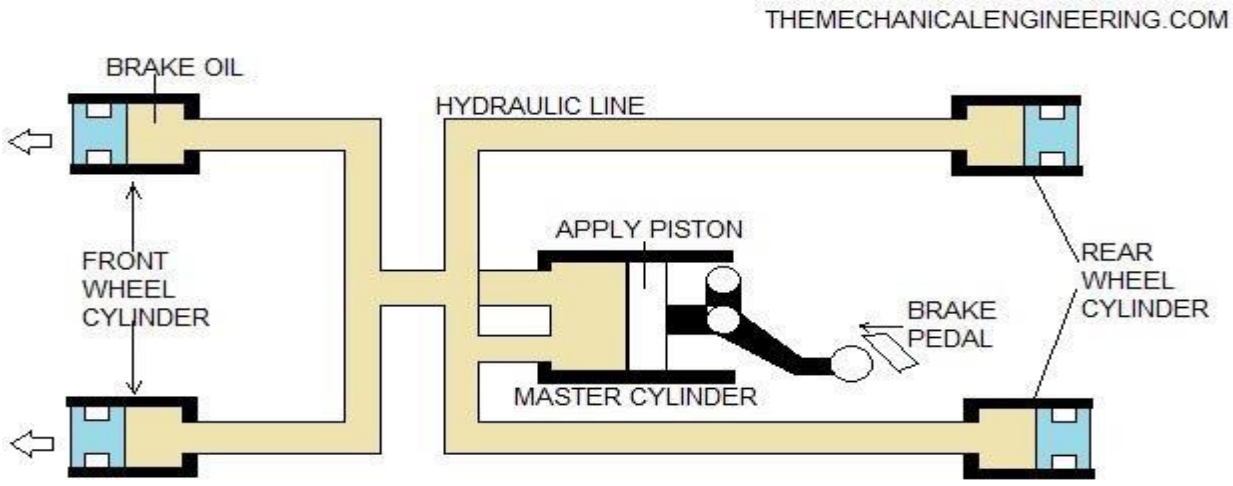
A magnetic flux is passed in a direction perpendicular to the rotating direction of the particular wheel, a rapid current flowing in a direction opposite to the rotation of the wheel creating an opposing force to the wheel rotation thus, gradually slowing down the wheel speed.

It transmits the brake system to the wheels of the brake through the pressure of fluids, converting the pressure into useful work of wheel brakes.

The Brake pedal relays the driver foot effort to the master cylinder piston, which compresses the brake fluid.

The fluid pressure is the same as it's transmitted to the front disc-caliper pistons and the rear disc caliper pistons. As per the process, a different mechanical parking brake must be included with at least two wheels.

This also allows the driver to be in control of the vehicle in the cause of a failure with the Hydraulic Brake system.



HYDRAULIC BRAKE SYSTEM LINE DIAGRAM

Advantages of Hydraulic brake system

The Hydraulics offers the following advantages over the mechanical layout:

- It provides equal braking effort on all wheels.
- Relative brake effort is less to deliver the same output.
- It is full compensated thus each brake receive a full share of pedal effort
- It is more efficient than mechanical.
- Suitable for all types of vehicles having independent suspension.

3. Pneumatic Braking System:

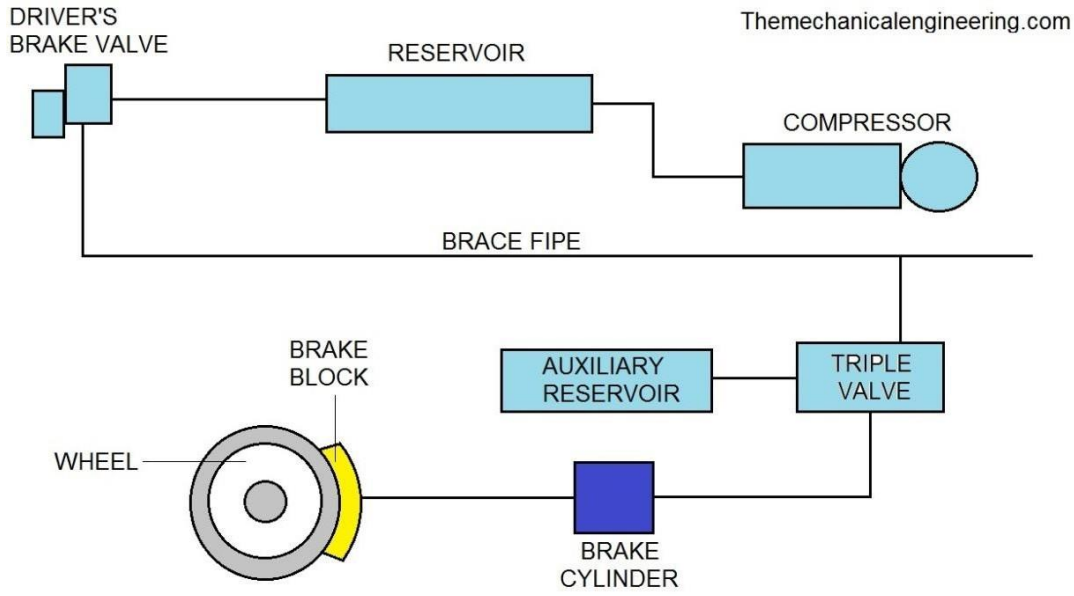
It maintains a higher level of pressure inside it, and the pressure in line starts dropping the moment when the driver applies the brake causing result in slowing down the vehicle trucks buses and trains use this type of braking system.

It operates on compressed air helps in charging up the entire braking system to maintain optimum pressure.

The charged-up lines make sure for the brakes to be dis-engaged, the very moment the driver applies the force on to the pedal the air pressure drops.

Due to this sudden drop of pressure, the control reservoir, and gets disconnected causing the auxiliary cylinder to be connected to the brake cylinder.

Compressed air from the auxiliary cylinder gets to the brake cylinder causing it to be more engaged. This is how the pneumatic brake works.



Advantages of a pneumatic brake system:

- Pneumatic brake equipment is much more reliable than hydraulic brakes
- If there is a leakage in the pneumatic brake system, there is less wastage as compared to leakage in the hydraulic brake system.
- It is very powerful with a single pedal that can work the entire pneumatic brake equipment which makes everything easy to control and there are fewer chances of mistakes.
- Their systems are clean as the compressed air used in the operation can be directly dumped into the atmosphere.

Why the pneumatic system is not utilized in cars or light-duty vehicles?

Even though the air system got a lot of benefits over the hydraulic braking system, as well as its efficiency but it requires much more space to fit in the air braking system which has got several components in it.

Where another hydraulic system is lightweight and does not require much more space than an air braking system.

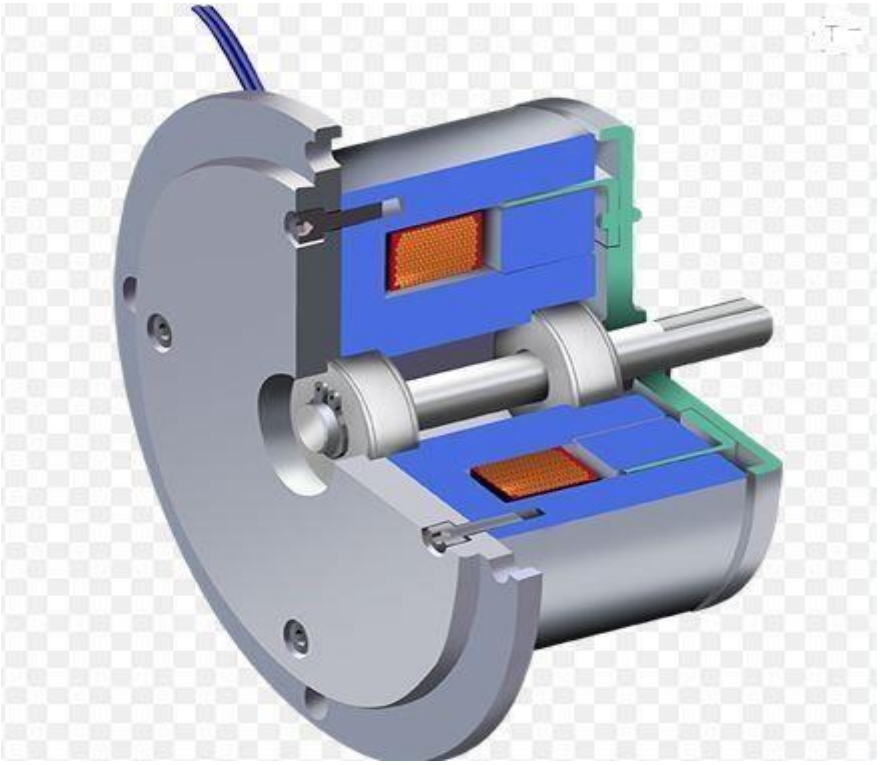
Also, the hydraulic system is much cheaper than the air braking system which does its job efficiently and effectively for the vehicle or cars.

4. Electromagnetic Break System:

The electromagnetic system can be used in both modern and hybrid vehicles. The principles of electromagnetism are to achieve frictionless braking.

It increases the lifespan and reliability of the brakes also it's backed by quick magnetic brakes so without the use of friction or any lubrication this technology is preferred in hybrids as they are moderate in size compared to the normal braking. It mostly used in trams and rails.

A magnetic flux is passed in a direction perpendicular to the direction of the rotating particular wheel, a rapid current flowing in a direction opposite to the rotation of the wheel creating an opposing force to the wheel rotation which hence reduces and slows down the speed.



Advantages of an electromagnetic field:

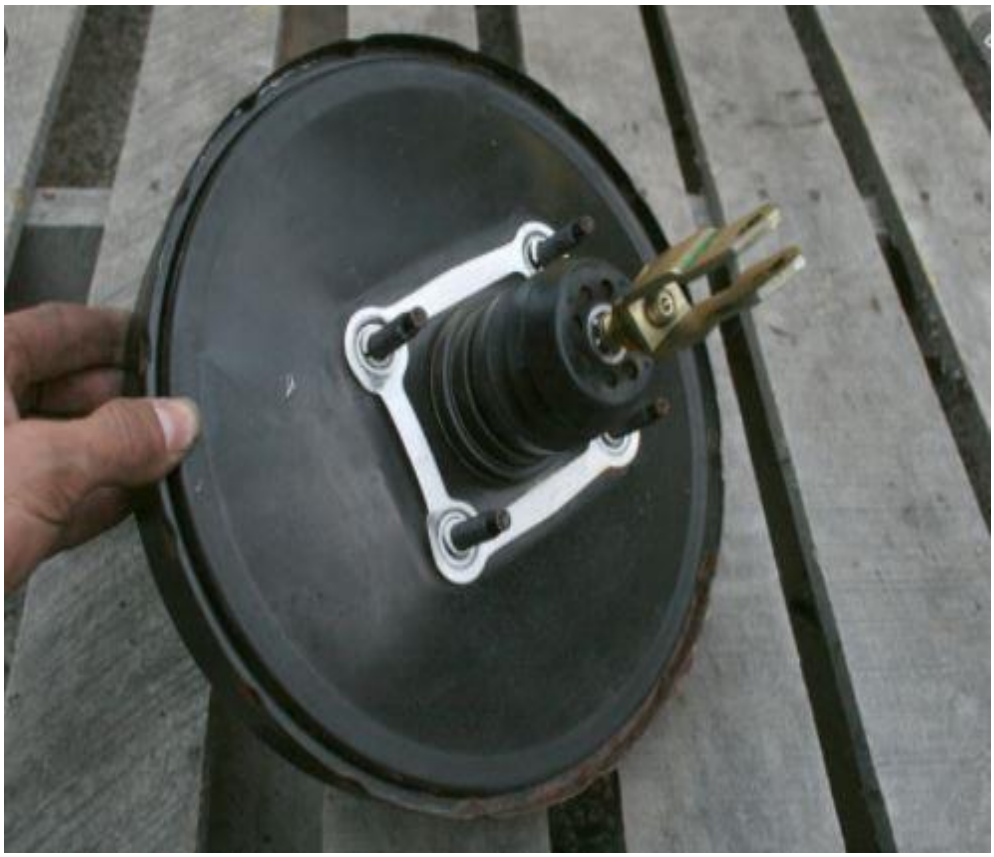
- Brake is faster and cheaper.
- There is no replaceable cost for brake shoes periodically.
- This breaking helps in increasing the capacity of the system.
- In this braking, a small amount of heat is generated wherein in mechanical braking an enormous amount of heat is generated.
- A part of the energy is delivered to the supply consequently the running cost is reduced.

5. Servo Braking System:

It is also known as vacuum-assisted braking. In this process, the pressure applied to the pedal by the driver is increased.

It uses the vacuum that is produced inside the petrol engines by the air intake system also it uses the power assistance to reduce the manpower effort.

Servo braking system boosters used with the hydraulic brake system increase the braking force applied on the surface, pushing the brake pedal to release the vacuum on the side of the booster the difference in the air pressure makes the diaphragm in slowing down.



Advantages of Servo Braking:

- It is Simpler in design.
- It provides greater level of safety because a loss in volume result in the breaking of the vehicle.
- More reliable in rail wagons.
- It's simpler to control as it permits the automatic process of the brake down the entire length of the train by applying a decent force.
- It is more effective as its ability to get partial release it's something that the pneumatic brake could not do without adding an additional equipment.

6. Electrical braking system:

It is mainly used in electric vehicles in which braking is produced using electric motors, and it's the main power source in electric vehicles. It basically categorized into three types.

Plugging or Counter current Braking:

It is the simpler form of braking runs when gets connected to motor windings for reverse direction of rotation at a particular time when the armature still rotates in the forward direction under control of the action of an external torque or due to inertia. Plugging reconnects the power source with the motor, so it moves to drive in the opposite direction. It is generally obvious for the system to come at rest as it's mostly required and then to accelerate in the reverse direction.

It is important to introduce a special device and to cut-off the supply exactly at the time when the motor stops.

This method produces a greater braking torque. It's beneficial to get a quick reversal or to get a more rapid stop in an event of control.

It is mostly used in rolling mills, elevators, machine tools, etc. This method can be used in both direct current and alternating current and also in induction and synchronous motors.

Dynamic Braking system:

In this particular method, the motor power is cut from the supply and it operates as a generator carried by the kinetic energy of the rotating parts of the motor and its driven machines.

Thus, the kinetic energy gets converted into electrical energy of the rotation.

Which is then dissipated and connected at the breaking instant. Using this method, the exact amount of energy required for the power supply to break the motor has been removed as compared to the plugging method.

And this is one of the advantages of dynamic Braking: It applies to direct current motors, synchronous motors, and induction motors.

Regenerative Braking:

In this method, the mechanical energy is converted into electrical energy. Some parts of energy are returned to the supply and the rest of the energy is lost as heat in the windings and bearings

of the electrical machines. It did not involve any switching method unless a change of speed is required at which it becomes more efficient.

Most of the widely electrical machines pass smoothly from motoring to operations generating, when getting overdriven by the load.

Necessities for Regenerative Brake System:

- Lesser Supply voltage.
- The motor to be a little more excited.
- The motor to be running at a higher speed than no-load speed.

In all of this process, the retarding torque is produced and the armature current is reversed, decreasing the speed of the motor until the armature back emf becomes same to voltage source.

Regenerative braking does not stop the motor. It is only efficient for handing braking hauling loads, they also vehicle increased the motor due to the work of lowering load or in the motor of an electric locomotive moving downgrade.

Advantages of Electric Braking:

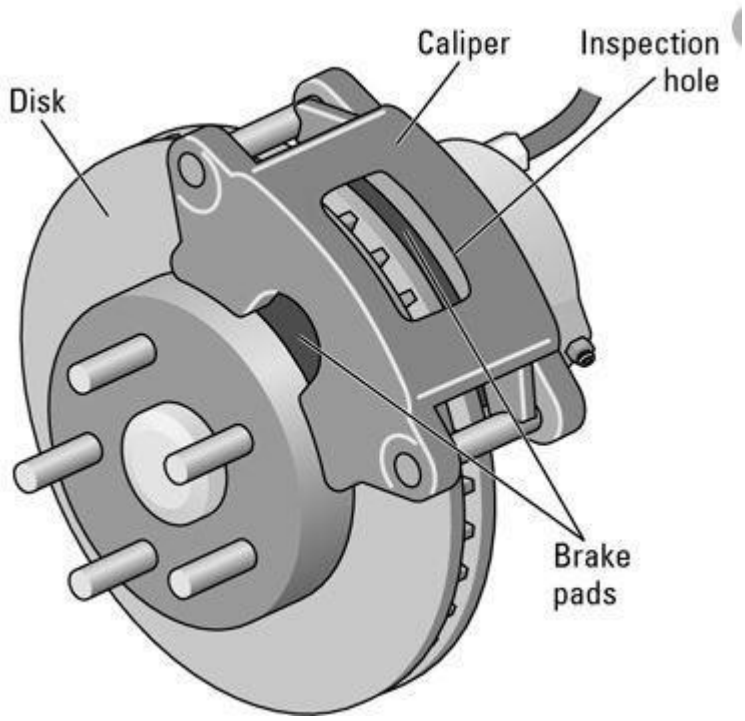
- It's more efficient than the mechanical braking system which needs costly and frequent replacement but no such replacement is required in electric braking hence it's cheaper and works efficiently.
- By using of electric braking, speed capacity of the system increases way higher with haulage of heavy loads.
- It helps in saving energy, as a small amount of energy returns to supply offering a considerable saving in the operating cost.
- Metal dust is produced in mechanical braking, but no such dust is produced in electric placement of the mechanical brakes may result in harsh effects in the discomfort to occupants. On the other side electric braking is way more safer, smoother and without shock.

7. Disc Brake System:

Brake Fluid is compressed by a piston inside the master cylinder located at the base of the vehicle hood beside the engine, thus creating a huge amount of hydraulic pressure, also producing a large amount of force just by pressing the pedal down.

The pressure gets passed via the brake fluid and then to brake horses that connect a linkage with the brake assembled at each wheel.

The conversion of wheel pressure takes place with the hydraulic force to be converted to the mechanical force causing the brake friction to push against the disc, and the drum helps to decrease the speed and stopping it completely.



Credit to Learn Engineering

The floating caliper:

It is the most common type used with one or two pistons, when the brakes are applied, the inner brake pad gets rest against the disc while at the exact time the caliper body shifts closer to the router.

This process forces the outer brake pad against the router.

The fixed caliper:

Its piston is mounted on each side of the router. The caliper does not bulge out, its rigidly fastened to the spindle. When applying brakes, the caliper piston shifts, pressing the brake pads against the disc.

Advantages of Disc brake System

- It produces more force-stopping power.
- More efficient to apply for a shorter stopping distance.
- Provides a self-cleaning facility.
- This is more durable and lighter.

8. Drum Braking System:

It is the brake type in which a drum which is mainly used for the brake shoes along with its real mechanism is attached with the hub of the wheel in such a way the inner parts remain constant and the outer part of the drum rotates with the wheel.

When brakes are applied, the mechanical linkages cause the brake shoes to expand a little due to which the outward friction surface of the brake shoes gets in frictional contact with the rotating drum part which helps in stopping or de-accelerating the wheels.

Advantages Of Drum Brake System

- It generates less heat since most of the stopping force is generated by the front brakes of the vehicle.

- It produces or emits less particulate matter than disc brakes.
- Its frictional contact area is at the circumference hence it provides more braking force than an equal diameter disc brake.
- It got a low level of maintenance to improve corrosion resistance compared to the disc.
- It is less expensive and reliable.

9. Emergency Brake System:

They are also known as parking brakes, it acts as secondary and an independent Braking System of all the service brakes.

There are several kinds of emergency brake (a level between the driver placed, a third pedal, a handle beside the steering column, etc.)

They are all sourced by cables that apply the pressure mechanically to the wheels, generally maintain the vehicle stationary when parked, and used in emergency situations if the stationary brakes are not at work.

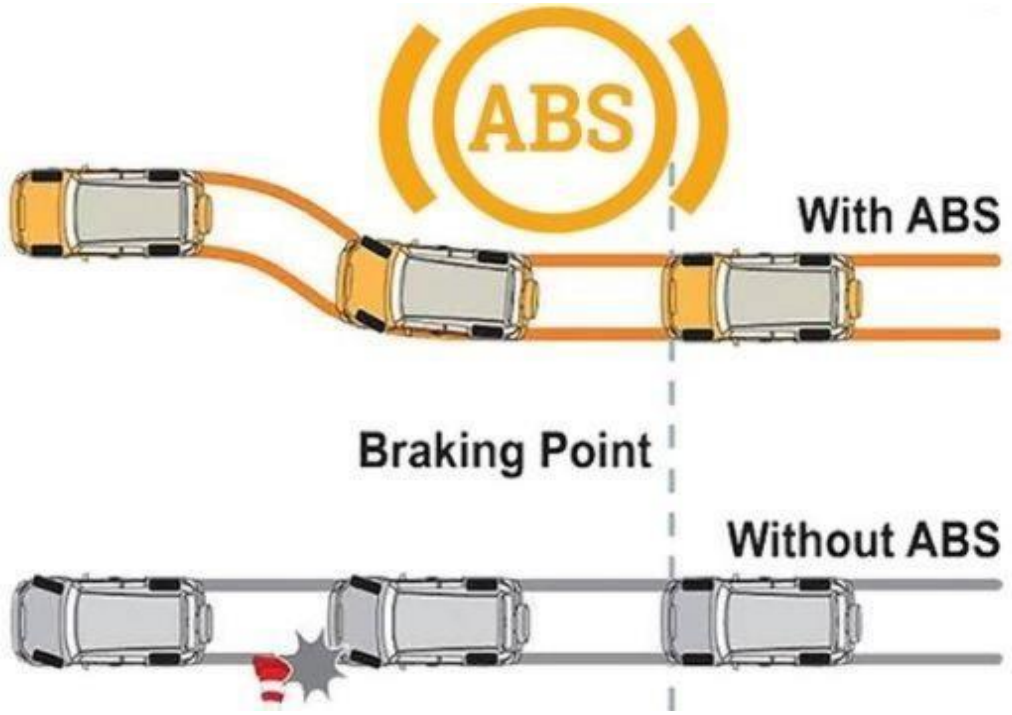
10. Anti-lock Braking system:

Most of the modern vehicles are introduced to anti-lock Braking systems. They are installed for good as the reasons for several advantages mostly having to do with the driver and passenger safety.

For beginners, anti-lock brakes allow drivers to maintain control of their vehicles with all types of road conditions.

It provides rushing stopping at the exact point where the driver wants, without using these brake roads with slippery conditions can turn out a bit risky.

One of its great advantages is that its system parts work together, for instance, ABS controls wheel activity with the sensor placed on both wheels. The sensor is controlled by the brake force ensuring the wheels speed to run in tandem.



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11. Service Brakes or Foot oriented Braking System:

It is an automobile primary braking system operated by one's foot and mechanically separated from partner brake for emergency braking. Its braking system can be compared to both drum brakes or disc brakes.

Its functions are mainly hydraulic, thus uses hydraulic pressure to activate the braking system. It basically uses a bias with most of the braking force to be applied onto the front brakes. It means a vehicle to be under control under heavy braking events.

Vehicles with high rear brake bias, cause vehicles to lose control and slide out under heavy braking conditions. Too much front brake bias also causes the same event to happen.

12. Hand Brake System:

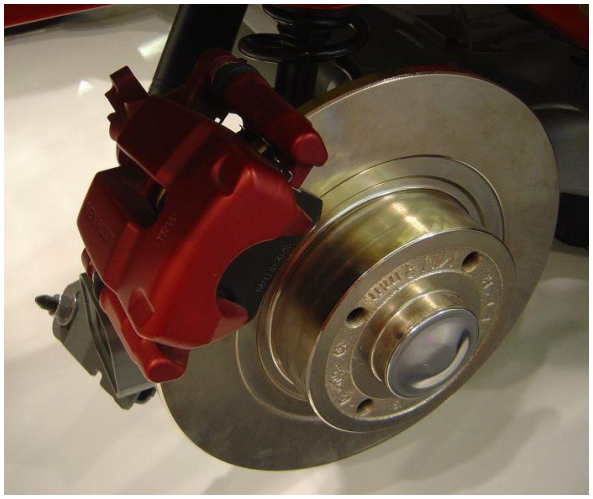
A hand Brake system is also known as a parking brake or emergency brake. It helps to keep the vehicle motionless while parking, it is used to perform in emergency situations when the main hydraulic brakes fail.

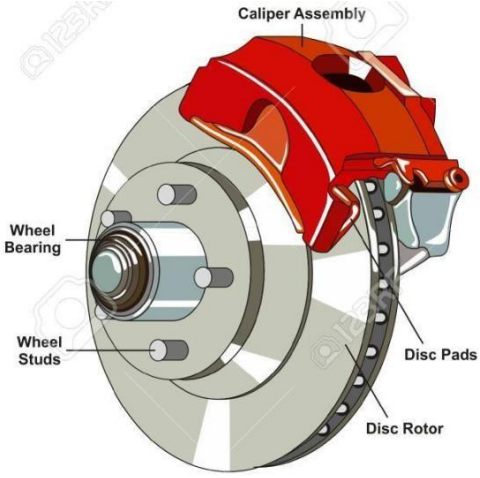
This consists of cable connected with two wheels brakes after then connected to a pulling mechanism.

In most vehicles, the parking brake is found to be operated only on rear wheels, which reduces the traction while braking.
This mechanism consists of a hand-operated and a steering column or foot-operated pedal located with some other more pedals. In the event of failure, the parking brake engages to prevent the wheels from locking up and reduces speed.

Disk brakes

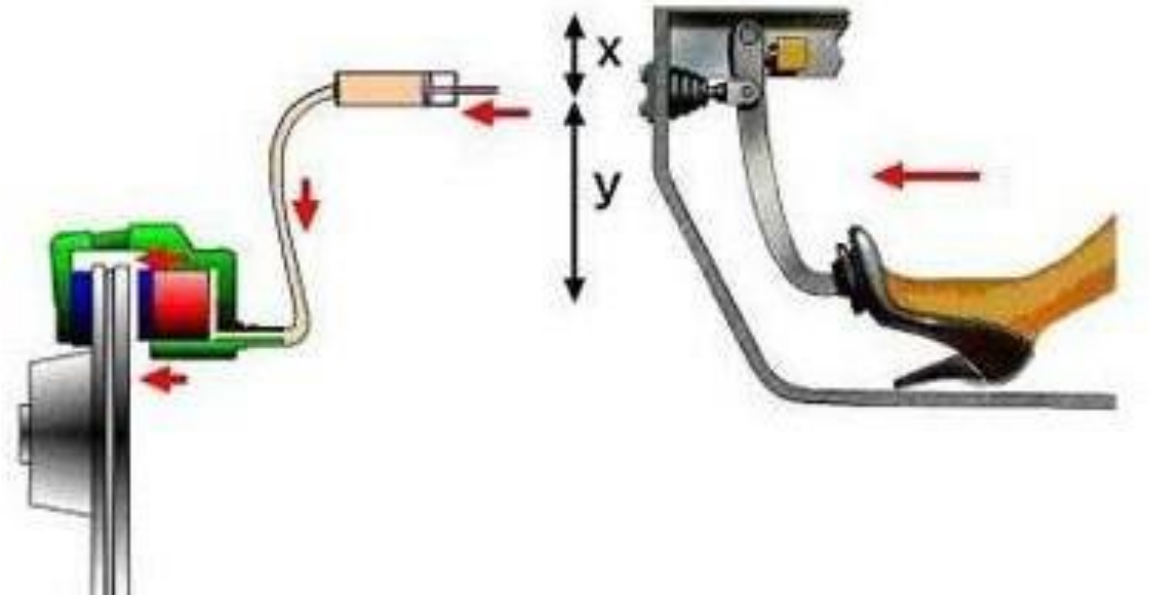
A disc brake is a type of brake that uses the calipers to squeeze pairs of pads against a discor a "rotor" to create friction. This action slows the rotation of a shaft, such as a vehicle axle, either to reduce its rotational speed or to hold it stationary.



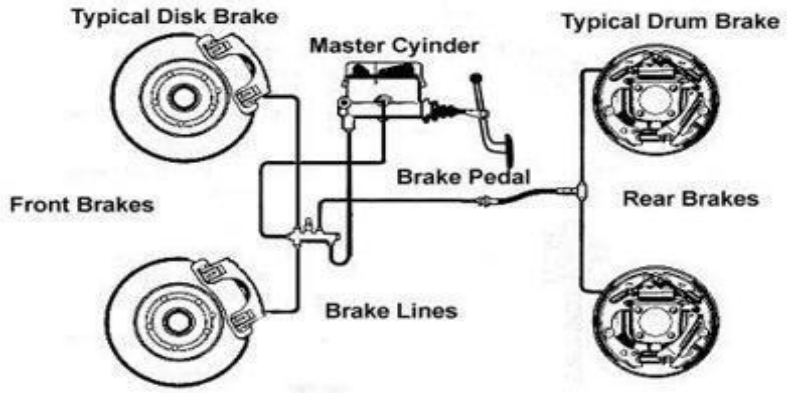


In disc brakes the friction elements are in the form of pads, which are squeezed or clamped about the edge of a rotating wheel. With automotive disc brakes, there is a separate wheel unit called the Rotor (commonly called as **disc)** alongside the vehicle's wheel. This rotor is made of cast iron. Since pads clamp against both sides of it, both sides are machined smooth. Usually the two surfaces are separated by a finned center section for better cooling (such rotors are called ventilated rotors or in common words as **ventilated discs**).The pads are attached to metal shoes, which are actuated by pistons, the same as with drum brakes.

The pistons are contained within a caliper assembly, housing the wraps around the edge of the rotor. The caliper is kept from rotating by way of bolts holding it to the car's suspension frame work.



Mechanical Brakes



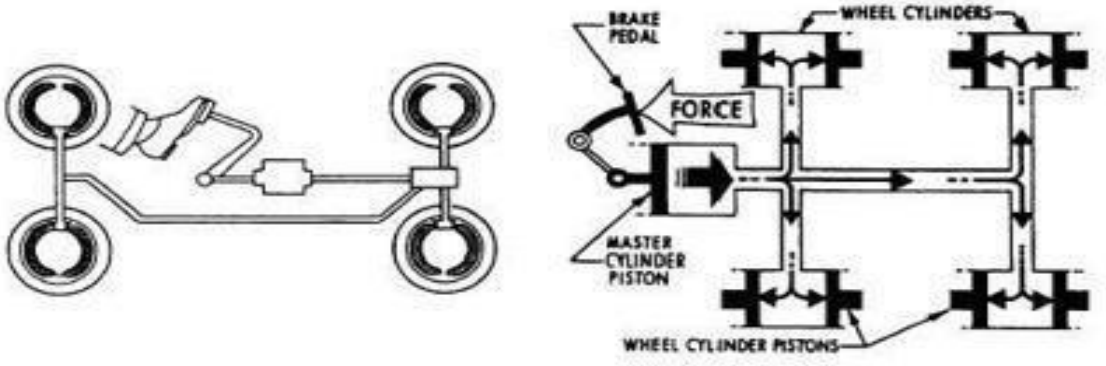
Typical Automotive Braking System

Mechanical brakes are used in Hand brakes (or parking brakes). Here, a lever is provided near the driver seat and through steel wire connections it is connected to brakes at the rear of the vehicle.

When the hand brake is engaged, tension is created at the brakes and the brake shoe holds the drum from rotating and hence the movement of the vehicle is restricted, even if parked in a slightly inclined surface.

Hydraulic brakes

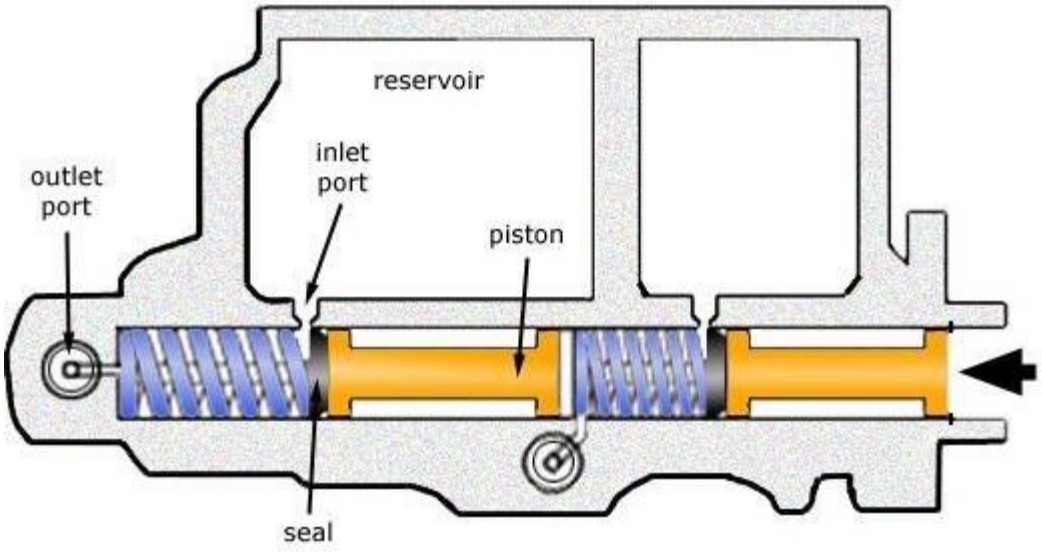
The hydraulic brake system uses brake fluid to transfer pressure from the brake pedal to the pads or shoe. By exercising the pedal, brake fluid transfers this pressure to the brake pads. This transfer of pressure is reliable and consistent because liquids are not compressible, i.e. pressure applied to liquid in a closed system is transmitted by the liquid equally to every other part of system.



A hydraulic brake system apart from liquid pipes mainly consists of Brake pedal, Master cylinder, wheel cylinder and brake pads/shoe connected at the wheel. The function of the Master cylinder is to distribute pressure to lines leading to front or rear wheels as required. At the wheel cylinder, a small piston is provided which is operated due to pressure application through brake fluid. The operation of the piston is converted to movement of brake liners.

In brief, when a driver applies pressure at the brake pedal, the mechanical force (stepping of driver on pedal) is changed to hydraulic pressure which is transmitted through liquid to respective wheel cylinder and changed back to mechanical force (operation of brake pads, shoe).

Construction of master cylinder



MASTER CYLINDER OF H-BRAKES

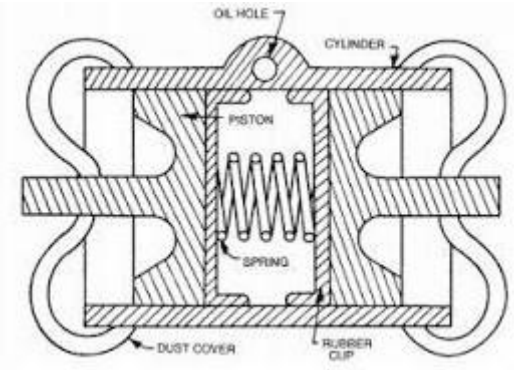
The master cylinder is the start of the brake hydraulic system. It actually is a cylindrical pump. The cylinder closed at one end, and the flexible push rod extends from the other end. The push rod moves a pair of in-line pistons that produce the pumping action. The brake pedal lever moves the push rod this moves the pistons to draw fluid from a reservoir on top of the master cylinder. Piston action forces the fluid under pressure through outlet ports to the brake lines.

All master cylinders for vehicles built since 1967 have two pistons and pumping chambers. Motor vehicle safety standards involve this dual-brake system to provide hydraulic system operation in case one wheel brake assembly loses fluid. Because the brake hydraulic system closed, all the lines and cylinders are full of fluid at all times. The master cylinder develops system pressure the amount of fluid moved is only in less value.

Construction of wheel cylinder

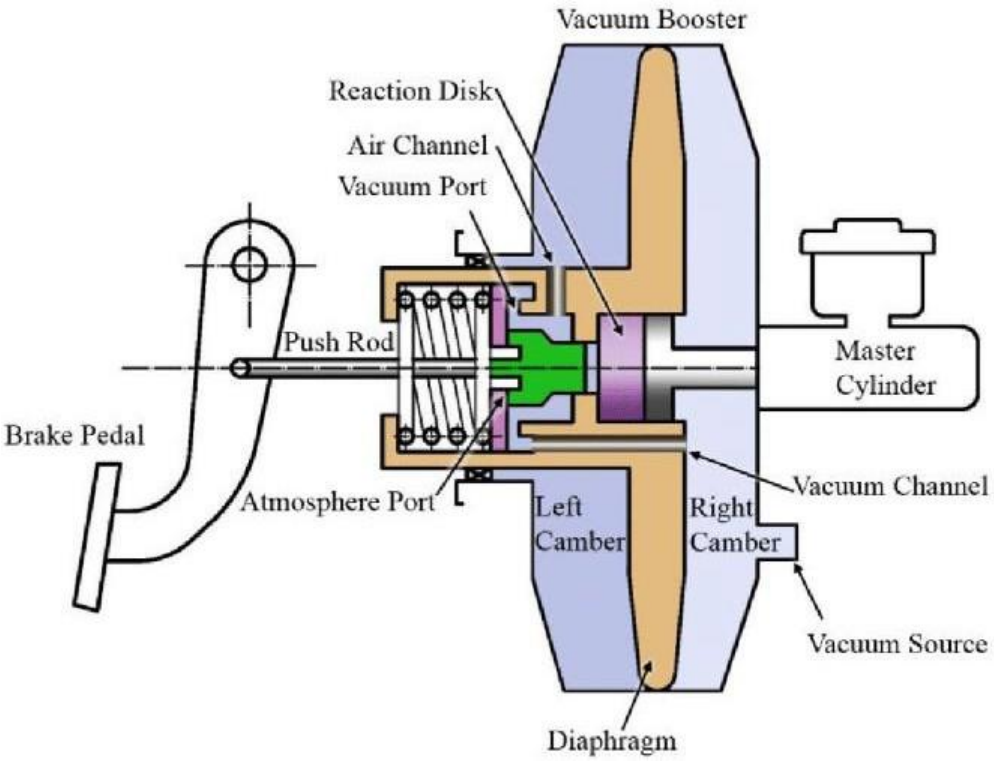
Technically, the wheel cylinders of drum brakes and the caliper pistons of disc brakes are "slave" cylinders because they operate in response to the master cylinder. These hydraulic cylinders at the wheels change hydraulic pressure back into mechanical force to apply the brakes. Most late-model systems with drum brakes have a single, two-piston cylinder at each wheel. Hydraulic pressure enters the cylinder between the two pistons and forces them outward to act on the brake shoes. The shoes move outward, the lining contacts the drums to stop the car.

The caliper pistons for disc brakes also act in response to hydraulic pressure that enters a fluid chamber in the caliper. Hydraulic pressure in stationary caliper is applied to one or two pistons on each side of the caliper to force the pads against the rotor. Pressure is applied to a single piston in a movable caliper on the inboard side to force the inboard pad against the rotor. Hydraulic pressure is equal in all directions in a closed chamber. This equal pressure creates a reaction force that moves the outboard side of the caliper inward so that both pads grip the rotor.



Power assisted brakes

a) Vacuum Servo assisted brakes



A vacuum brake is a type of brake that works by atmospheric pressure acting on a piston in a vacuum cylinder. Vacuum brake equipment has been replaced with modern air brake equipment. A vacuum brake system is operated by a vacuum taken from the intake manifold or carburetor at a point just above the throttle valve.

Construction:

- The vacuum booster is a metal canister that contains a valve and a diaphragm.
- A rod going through the centre of the canister connects to the master cylinder's piston on one side and to the pedal linkage on the other.
- Another key part of the power brakes is the check valve.
- The figure above shows a check valve, which is a one-way valve that only allows air to be sucked out of the vacuum booster. If the engine is turned off, or if a leak forms in a vacuum hose, the check valve makes sure that air does not enter the vacuum booster. This is important because the vacuum booster has to be able to provide enough boost for a driver to make several stops in the event that the engine stops running.
- The diaphragm is connected to a port which opens and lets atmospheric air to the other side of the diaphragm.
- The diaphragm is retained in the back position when not in operation by a spring.

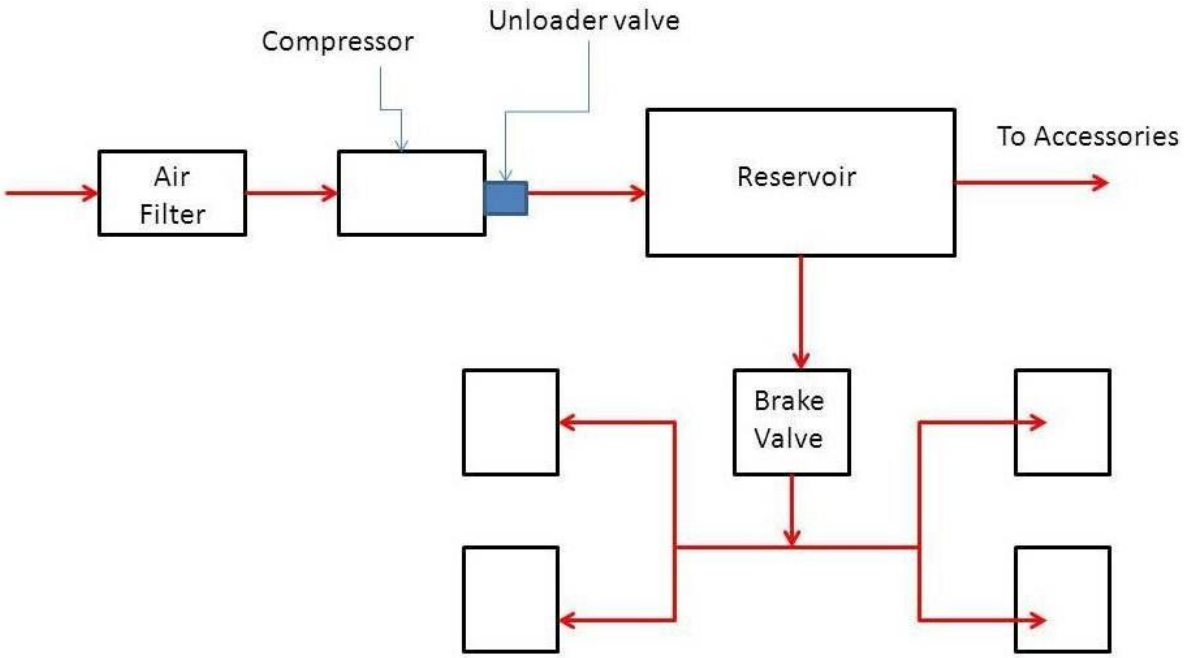
Working:

- When the brake pedal is released, an internal vacuum port is open which allows engine vacuum to flow from the check valve to both sides of the diaphragm. With equal pressure (vacuum) on both sides, the diaphragm is held to the rear by spring pressure.
- As the brakes are applied, the brake pedal pushrod moves forward, which closes the vacuum port and opens the air inlet valve. This action seals off the backside of the diaphragm from the vacuum source and at the same time allows filtered atmospheric air pressure to pass through the air inlet valve to the diaphragm backside. The combination of atmospheric pressure on the backside and vacuum on the front side then moves the diaphragm and master cylinder pushrod forward to apply the brakes.

b) Air brakes

Principle of Air brake system:

Air brake can better understand by the layout diagram as shown in figure. This system mainly consist a compressor, air filter, reservoir, valves and brake pads. The compressor takes air from atmosphere through an filter and compressed it. This compressed air sent to a reservoir through the unloaded valve, which gets lifted or opened at a predetermined reservoir pressure. This air supply to brake chambers which is also called the diaphragm units situated at each wheel, through the brake valve.



Layout of Air Brake System

The brake valve is controlled by the driver who can control the intensity of braking according to the requirement. When the driver pushes the brake lever, pressure in the reservoir decreases which pushes the brakes pad toward types and apply brakes.

Advantage of air brake:

1. Air brake system are much more powerful than the ordinary mechanical or hydraulic brakes and that is the reason they are exclusively used in heavy vehicles.

2. They are easy to install on chassis because it is interconnected by pipes.

The compressor airs can also use for tyre inflation, windscreen wipers, horns and many other accessories. Today we have discussed about air brake system.

Bleeding of brakes

Bleeding the brakes is a common procedure aimed at removing air from the hydraulic brakesystem on your vehicle. The process involves opening a valve to allow air (and some brakefluid) to escape under pressure.

The process of removing air from the hydraulic brake system is called bleeding. Air is compressible, and any air in the system will be compressed during brake application, causing a spongy pedal. When bleeding brakes, using the proper sequence is recommended. It saves time and ensures that the entire system is bled.

The usual RWD procedure is to bleed the components in the following sequence:

1. Master cylinder
2. Combination valve if equipped with a bleeder screw.
3. Wheel cylinders and calipers in succession, beginning with the longest brake line and ending with the shortest. On most vehicles the sequence will be right rear, left rear, right front, left front. This may or may not be correct for every vehicle; the best advise is to a bleeding sequence manual. Doing so you may actually find the sequence to be.
4. A FWD diagonally split system; sequence will be entirely different and will vary upon manufacture.

If a caliper has two bleeder screws, bleed the inboard section first and then the outboard section. If a drum brake has two wheel cylinders, bleed the lower one first, followed by the upper one. Most vehicles with ABS require a special bleeding procedure. Some are bled manually, some by pressure bleeding, and some require a scan tool to activate the pump or solenoids. Check the specific manufacturer's recommendations.

These are the (4) most common methods used:

1. Gravity bleeding
2. Manual bleeding
3. Pressure bleeding
4. Vacuum bleeding

Gravity bleeding: The gravity method simply lets the fluid run down into the calipers and wheel cylinders.

Manual bleeding is the most commonly used method. The master cylinder and brake pedal are used as a pump to cause fluid to flow through an open bleeder screw. This fluid flow should flush air out.

Manual bleeding should be performed smoothly so as not to create turbulence in the fluid, which causes foaming. Foamy fluid contains tiny air bubbles that are very hard to remove.

Pressure bleeding normally uses a pressurized tank of brake fluid to cause fluid to flow through the bleeder screws. Pressure bleeding has the advantage of being a one-man operation, and is an effective method of removing air and flushing the hydraulic circuits.

Vacuum bleeding uses a pump to pull fluid and air out of the bleeder screw. It is fairly simple and is an effective operation

Types of brakes used in various vehicles

- Disc Brakes. Disc brakes consist of a brake rotor which is attached directly to the wheel. ...
- Drum Brakes. Drum brakes consist of a brake drum attached to the inside of the wheel. ...
- Emergency Brakes. ...
- Anti-Lock Brakes
- Hydraulic brakes are used in Maruthi Suzuki cars

Hydraulic **brakes**- Modern **cars** like **Maruthi Suzuki swift** and bikes like KTM Duke 390. Magnetic **brakes**- Bugati veyron and various hyper **cars**. Electric **braking**- Tesla Model S **Use** regenerative **type** electric **braking**. **Disc brake**- All modern **cars** like Hyundai i20

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Short answer question

1. Write the requirements of brakes.
2. Write the functions of braking system.
3. Write the types of brakes.
4. Write the types of electrical braking system.
5. Write the advantages of disc braking system.
6. Write anti-lock braking system.
7. Draw the layout of Air brake system.
8. What is bleeding of brakes?

Long answer questions

1. Explain the Mechanical braking system.
2. Draw the line diagram and explain Hydraulic braking system.
3. Explain the pneumatic braking system.

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6. Suspension System

Introduction

The daily use of the road infrastructure, continuous changes of weather conditions, and vehicle's overweight will produce different road surface wearing pattern. In addition, deficient road construction process will eventually lead to road surface irregularities. Nearly 20% accidents are triggered by infrastructure's condition. Potholes, road cracks, unevenness and different friction levels can promote accidents due to emergency maneuvers.

The main purpose of suspension is supporting both road holding and ride quality. Suspension system affects on the vehicle handling too. It is very important to keep the road wheel in contact with the road surface, for the suspension.

Function

- To safe guard passengers and goods against road shocks
- To preserve the stability of vehicles while in motion (Pitching or Rolling)
- To provide the wheels always in contact with road while driving cornering and braking
- To maintain proper steering geometry
- To provide suitable riding and cushioning properties
- To Allow rapid cornering without extreme body roll
- To prevent excessive body squat or body dive.

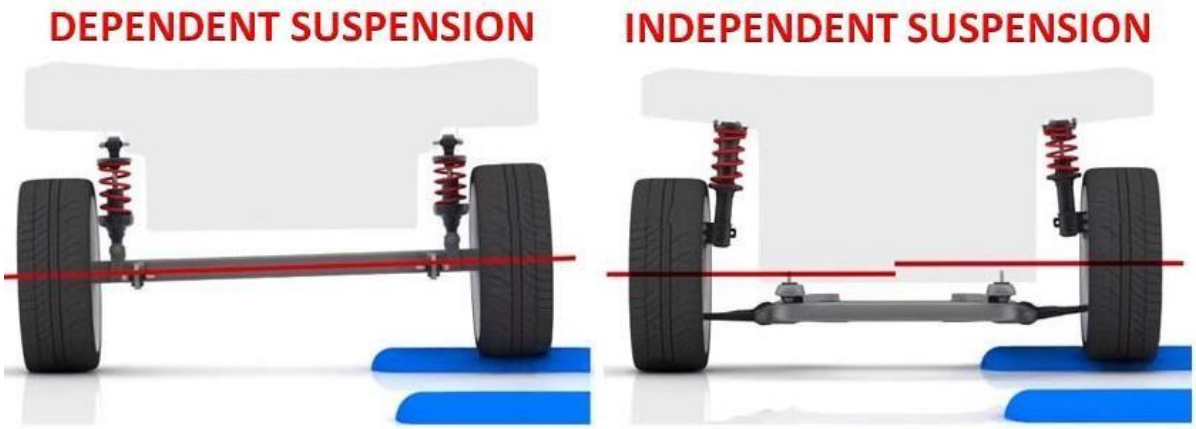
Requirements of good suspension system

1. There should be minimum deflection.
2. It should be of low initial cost.
3. It should be of minimum weight.
4. It should have low maintenance and low operating cost.
5. It should have minimum tyre wear.

types of suspension systems

- Rigid / Non independent suspension System
- Independent Suspension System

1. Non independent/Rigid suspension has both right and left wheel attached to the same solid axle. When one wheel hits a bump in the road, its upward movement causes a slight tilt of the other wheel.



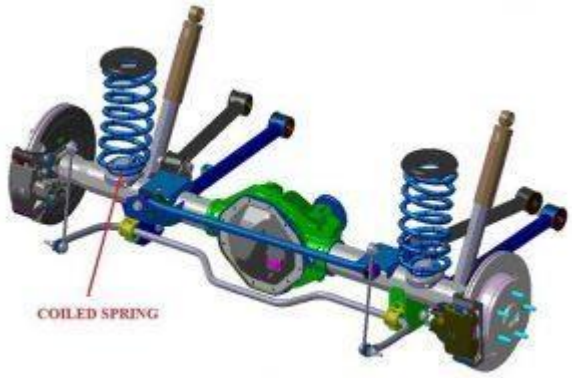
2. Independent suspension allows one wheel to move up and down with minimal effect to the other.

Types of independent suspension systems

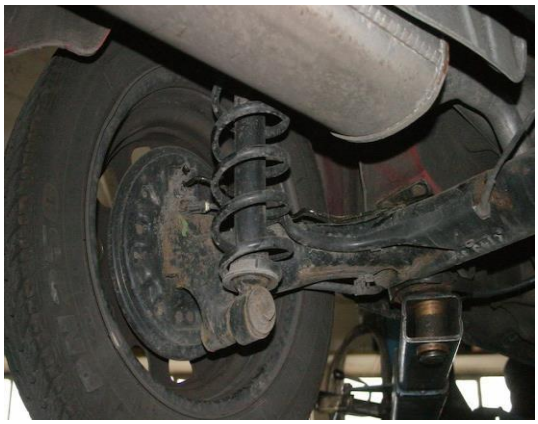
By definition, a suspension system is a system of springs, shock absorbers, and linkages that connect a vehicle to its wheels and allow relative motion between the two. Suspension systems are responsible for a vehicle's handling and braking for safety. A suspension system is responsible for keeping the vehicle occupants comfortable and to deliver a ride quality reasonably well isolated from vibrations caused by bad or uneven road conditions. The suspension system protects the vehicle and any cargo or luggage from damage.

There are a variety of independent suspension systems viz Spring Suspension System and Dampener Suspension System.

1] Spring Suspension System: A spring is an energy storage system. There are two types of springs used under this category.



COIL SPRING SUSPENSION SYSTEM

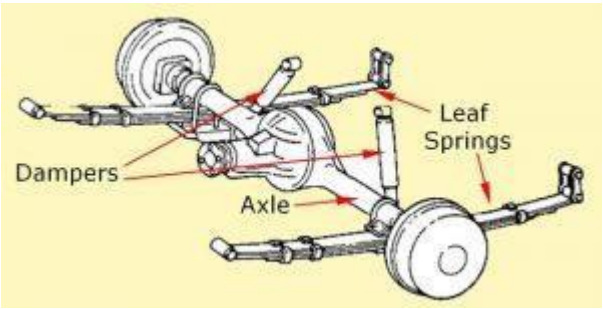


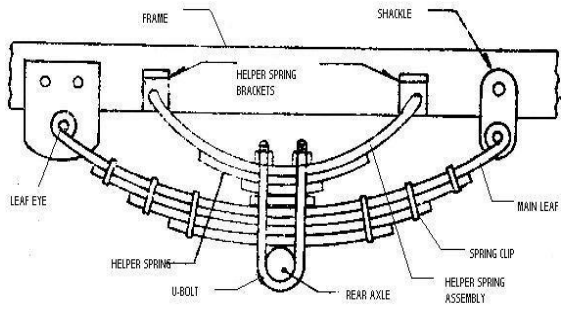
i] Coil Spring: A coil spring, also known as a helical spring, is a mechanical device which is typically used to store energy and subsequently release it, to absorb shock, or to maintain a force between contacting surfaces. They are made of an elastic material formed into the shape of a helix which returns to its natural length when unloaded. Under tension or compression, the material (wire) of a coil spring undergoes torsion. The spring characteristics, therefore, depend on the shear modulus, not Young's Modulus.

However, a coil spring may also be used as a torsion spring: in this case, the spring as a whole is subjected to torsion about its helical axis. The material of the spring is thereby subjected to a bending moment, either reducing or increasing the helical radius. In this mode, it is the Young's Modulus of the material that determines the spring characteristics.

Metal coil springs are made by winding a wire around a shaped former – a cylinder is used to form cylindrical coil springs.

ii] Leaf Spring: Originally called a laminated or carriage spring, and sometimes referred to as a semi-elliptical spring or cart spring, it is one of the oldest forms of springing, dating back to medieval times. A leaf spring takes the form of a slender arc-shaped length of spring steel of rectangular cross-section.

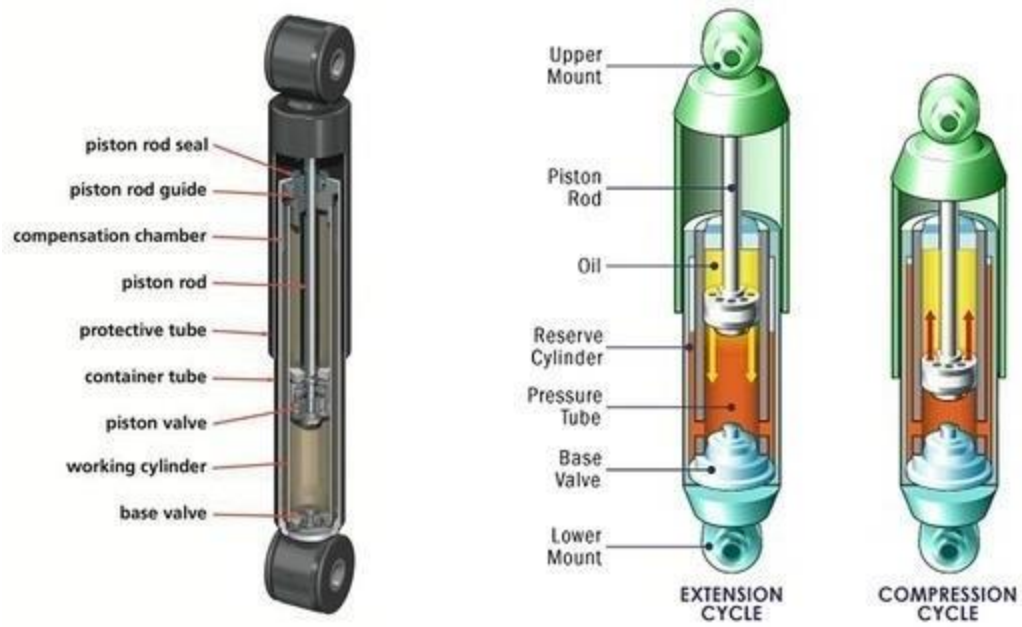




In the most common configuration, the center of the arc provides a location for the axle, while tie holes are provided at either end for attaching to the vehicle body. For very heavy vehicles, a leaf spring can be made from several leaves stacked on top of each other in several layers, often with progressively shorter leaves. Leaf springs can serve locating and to some extent damping as well as springing functions. While the interleaf friction provides a damping action, it is not well controlled and results in station in the motion of the suspension. For this reason, some manufacturers have used mono-leaf springs.

A leaf spring can either be attached directly to the frame at both ends or attached directly at one end, usually the front, with the other end attached through a shackle, a short swinging arm. The shackle takes up the tendency of the leaf spring to elongate when compressed and thus makes for softer springiness. Some springs terminated in a concave end, called a spoon end (seldom used now), to carry a swivelling member.

2] Dampeners Suspension System: A damper or a shock absorber is a mechanical or hydraulic device which is designed to absorb and damp shock impulses. Pneumatic and hydraulic shock absorbers are used in conjunction with cushions and springs. An automobile shock absorber contains spring-loaded check valves and orifices to control the flow of oil through an internal piston. It does this by converting the kinetic energy of the shock into another form of energy (typically heat) which is then dissipated. In most shock absorbers, energy is converted to heat inside the viscous fluid.



In hydraulic cylinders, the hydraulic fluid heats up, while in air cylinders, the hot air is usually exhausted to the atmosphere. In other types of shock absorbers, such as electromagnetic types, the dissipated energy can be stored and used later. The shock absorbers damp out the (otherwise simple harmonic) motions of a vehicle up and down on its springs. In layman's terms, shock absorbers help cushion vehicles on uneven roads.

The three major functions of any vehicle's suspension are to:

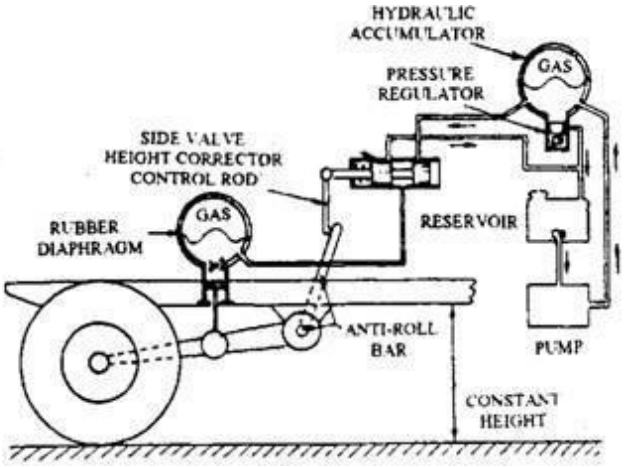
- Support the vehicle
- Absorb impacts from bumps, potholes, and other road irregularities
- Allow the vehicle to turn in response to the driver's inputs. (The steering system can be considered part of the suspension or its own system, but either way, the suspension has to allow for movement of the wheels as the vehicle turns).

Springs in general, and leaf springs in particular help perform the first two of these functions; they support the weight of the vehicle while absorbing bumps.

Air suspension system

Air suspension has several advantages over traditional shocks and struts. The first is that the ride quality is often controlled by the driver of the vehicle. Therefore, if you want a softer ride you can set your air suspension system to deliver that and vice versa if you are looking for a stiffer, rougher ride. The second advantage is that you can control ride height, some systems are advanced in that they automatically control this for you. The final advantage of an air suspension system is weight management. If you load the back of your SUV with a large amount of groceries from the store, the air suspension system either automatically adjusts to handle it or you can manually adjust it. For traditional shocks and struts the level of rebound is set and therefore no matter what the weight of your load is, you have to stick with it. This often creates a sagging rear end when carrying a heavy load.

While an air suspension system is more complex, the advantages are clear. The system is comprised of a central air suspension compressor as well as air struts within an air bag at each wheel. The air compressor pressurizes the air struts as needed to control the feel. Other components can be seen in the diagram above, all of which are mainly air lines to transfer pressure and driers (filter) to complete the system.



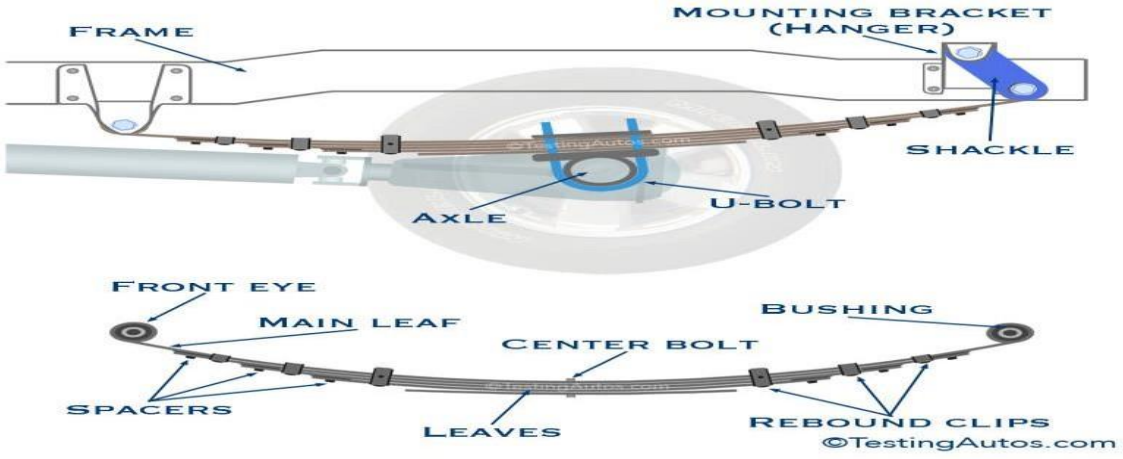
Types of springs

- Compression Springs.
- Extension Springs.
- Torsion Springs.
- Constant Force Springs.
- Belleville Springs.
- Drawbar Springs.
- Volute Springs.
- Garter Springs.

Leaf Springs

Leaf Springs. Leaf springs are a crucial part of the suspension system of a car. They consist of a number of layers of leaves with a gradation in their size, the bigger layer being on the top with each layer joined to the other. Leaf springs are directly attached to the frame, either at both ends or at one end. Leaf springs not only support the load, but hold the rear axle in place. In a typical pickup truck, leaf springs are directional; there is only one way to install them. The front end of the leaf spring is connected to the mounting bracket attached to the frame. The axle is located to the leaf spring center bolt and secured by U-bolts. The rear eye of the leaf spring is connected to the frame through a shackle that can swing back and forth, allowing for spring expansion.

Leaf springs can last long; we have seen many old trucks that still had original leaf springs. However problems related to leaf springs are common. One of possible signs of a problem is when the rear of the truck is sagging or the truck leans to one side. When this happens, the headlights can also point higher, dazzling drivers in oncoming vehicles. Sagging leaf springs can be caught when doing the wheel alignment. In some cases, a broken leaf spring can cause a knocking or rattling noise. Another reason to replace leaf springs is when they become weak and cause axle wrap where the axle twists back and forth. Leaf springs are also known to produce squeaking noises when driving over bumps



Because leaf springs locate the rear axle and maintain a proper driveline angle, problems with the leaf springs or hardware can affect the directional stability of the truck and cause clunking or driveline vibration. For example, worn-out leaf spring bushings can cause the axle to shift back and forth or the angle between the axle and the frame to change when driving over bumps.

Axle wrap under hard acceleration.
Leaf spring bushings are not very expensive, but it might take quite a bit of labor to press the old bushings out and new ones in. Weak leaf springs can twist, causing the change in the driveline angle (axle wrap), which often results in driveline vibrations felt during hard acceleration or when decelerating at 10-30 mph. Some manufacturers offer tapered shims for the leaf springs to correct the driveline angle, others recommend replacing weak leaf springs. Many truck enthusiasts install aftermarket traction bars that limit rotation of the axle.

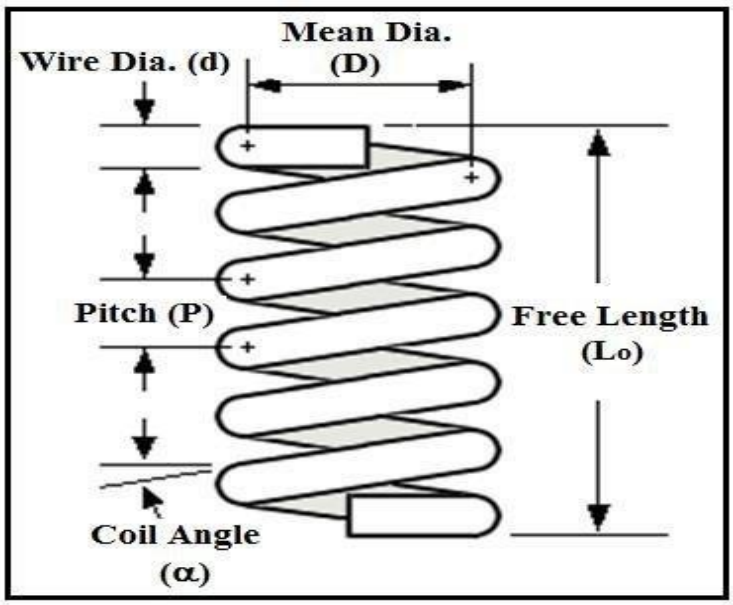
Loose U-bolts or a broken centre bolt can also cause the axle to shift from its place resulting in similar problems.

Coil Springs

A **coil spring** is a mechanical device which is typically used to store energy and subsequently release it, to absorb shock, or to maintain a force between contacting surfaces. They are made of an elastic material formed into the shape of a helix which returns to its natural length when unloaded.

Under tension or compression, the material (wire) of a coil spring undergoes torsion. The spring characteristics therefore depend on the shear modulus, not Young's Modulus.

A coil spring may also be used as a torsion spring: in this case the spring as a whole is subjected to torsion about its helical axis. The material of the spring is thereby subjected to a bending moment, either reducing or increasing the helical radius. In this mode, it is the Young's Modulus of the material that determines the spring characteristics.



Helical Springs

The helical springs are made up of a wire coiled in the form of a helix and are primarily intended for compressive or tensile loads. The cross-section of the wire from which the spring is made may be circular, square or rectangular. Helical compression springs have applications to resist applied compression forces or in the push mode, store energy to provide the "push". Different forms of compression springs are produced.

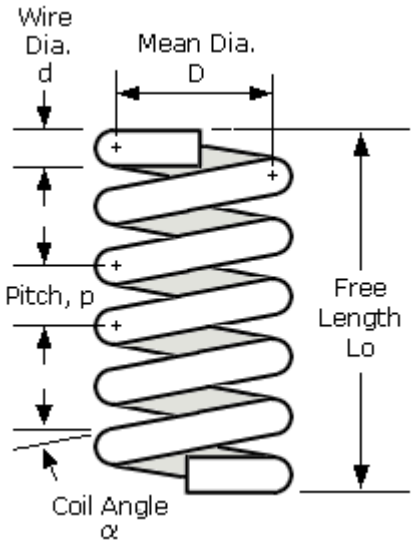
The helical springs are said to be closely coiled when the spring wire is coiled so close that the plane containing each turn is nearly at right angles to the axis of the helix and the wire is subjected to torsion. in other words, in a closely coiled helical spring, the helix angle is very small, it is usually less than 10 degree. The major stresses produced in helical springs are shear stresses due to twisting. The load applied is parallel to or along the axis of the spring. In open coiled helical springs, the spring wire is coiled in such a way that there is a gap between the two consecutive turns, as a result of which the helix angle is large.

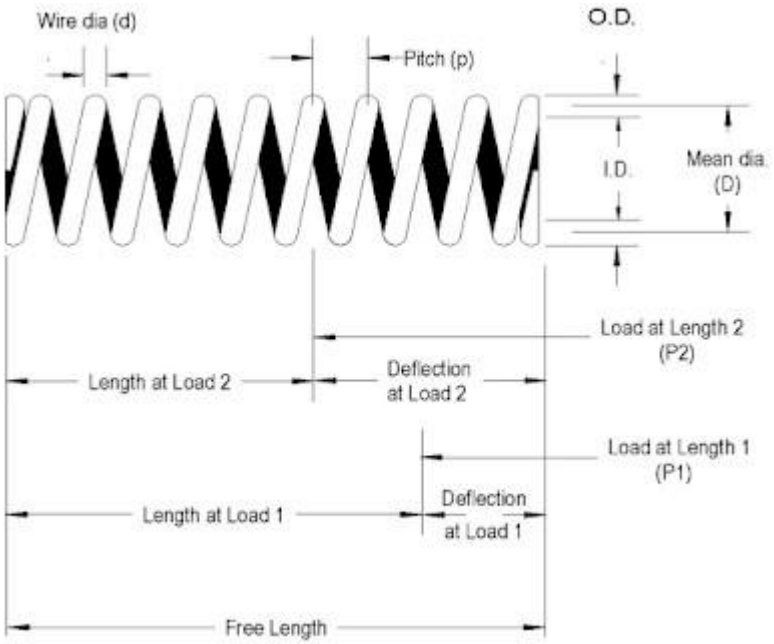
Terms used ¡n Compression Springs

The following terms used in connection with compression springs

Solid length (Ls). When the compression spring is compressed until the coils come in contact with each other, then the spring is said to be solid. The solid length of a spring is the product of total number of coils and the diameter of the wire.

Free length (Lo). The free length of a compression spring is the length of the spring in the free or unloaded condition





Shock absorber

A shock absorber or damper is a mechanical or hydraulic device designed to absorb and damp shock impulses. It does this by converting the kinetic energy of the shock into another form of energy (typically heat) which is then dissipated.

The role of the shock absorber is to keep the car's tyres in permanent contact with the road, helping to provide optimum grip, when cornering and braking. Shock absorbers are part of the suspension, so if the shocks are worn, the vehicle's ride and comfort is compromised.

The principle behind shock absorbers

When you swim, the water resists and restricts your movement, that's why you move much slower in water than you do outside it. This is the principle behind how shock absorbers work. Inside the shock absorber is a piston that moves inside a tube filled with hydraulic fluid. As the piston pushes into the tube, it forces the fluid out through tiny holes and valves, thereby controlling the amount of resistance to movement.

All modern shock absorbers are **velocity-sensitive**, which means the bumpier the ride, the more resistance the shock absorbers provide. This allows for better control over all the unwanted motions that occur when travelling on uneven or rough terrain, including vehicle sway and brake diving.

Types of shock absorbers

When a car hits a bump in the road, the impact shoves the wheel up. In a rigid car with no suspension system to speak of, this means the force of the impact transmits directly to the driver, which can be extremely jarring. Not only that, the impact can also cause a bouncing motion in which the tires lose contact with the road, meaning less control for the driver.

Enter the shock absorber, otherwise known as a damper. Actually, the name 'shock absorber' is a misnomer, because these devices do not actually absorb shocks. Instead, it's the springs that do this.
The dampening process

As the wheels move upward after hitting a bump the springs compress, effectively absorbing the shock of the bump. But as the springs compress, they store potential energy that must be released, or else, it will bounce back and push the vehicle's body further upward than what the bump could cause in the first place.

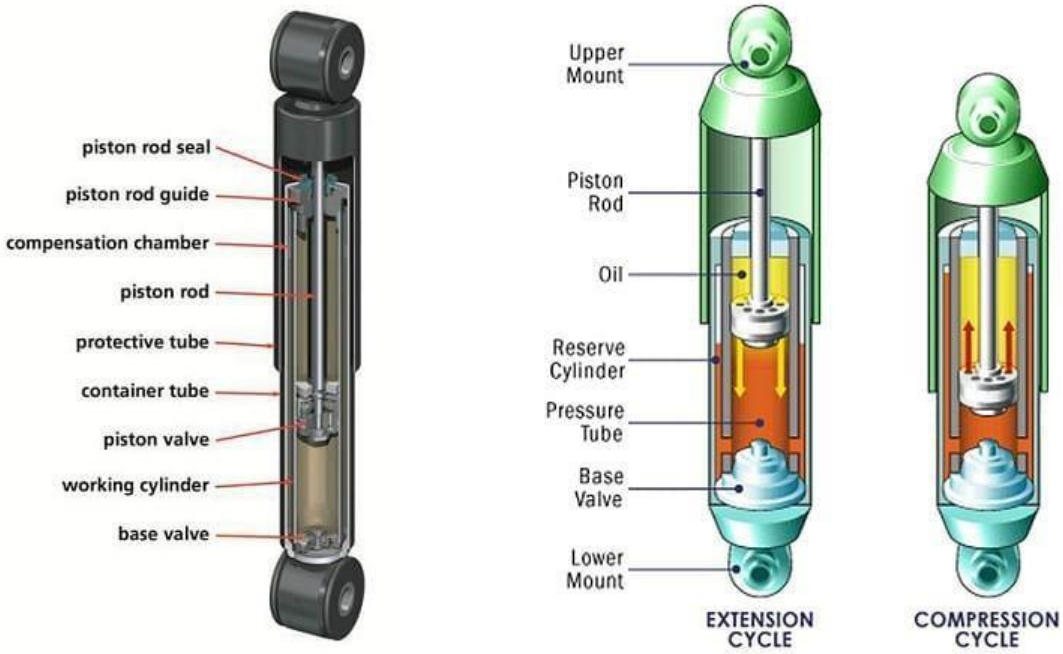
The shock absorbers work to slow down and reduce the magnitude of the bouncing motion by converting the kinetic energy into heat energy that can be dissipated through the hydraulic fluid contained in the absorber assembly. This conversion of energy keeps the vehicle's body from bouncing excessively, providing a more stable ride and helping keep the tires in contact with the road.
Types of shock absorbers
Although there have been many different designs for shock absorbers, they generally come in three different types, serving different purposes depending on the vehicle.

Conventional telescopic type - This is the most common type of shock absorber. Largely inexpensive, conventional telescopic shock absorbers are often replaced than repaired when they wear or break down. They are commonly found in economic, low-end and entry-level vehicles.

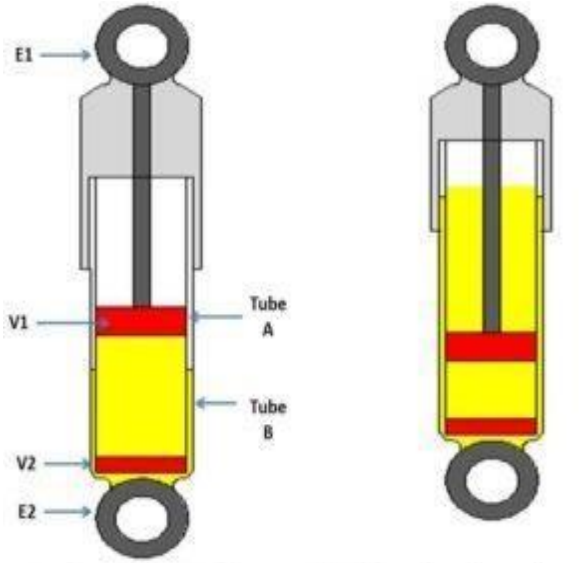
Strut type - This type of shock absorber is used to support strut type suspension systems. Strut-type shocks are built stronger than conventional telescopic and can handle larger loads and stronger impacts. These come in both sealed in repairable units.

Spring seat type - Spring seat shocks combine the simplicity of telescopic shocks with the durability of strut types. Like the latter, spring seat shocks act as both a suspension unit and damping device at once. However, like telescopic shocks, they cannot be repaired once damaged.

Telescopic shock absorber working and construction



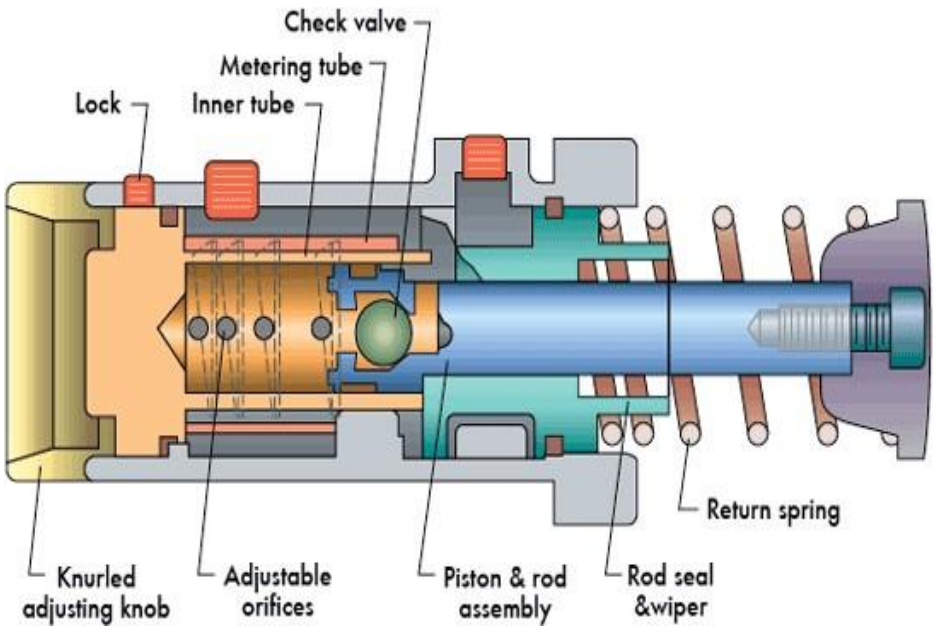
As we shown in the diagram, this type of shock absorber have twin tubes one inner tube shown by symbol A and other outer tube shown by symbol B. There are two 2 way valves one is shown by V1 and other is by V2. Valve V1 is connected with a piston rod and free to move vertically inside the tube A. The Valve V2 is fixed at one end of the tube A. Oil is filled inside the tube A below the valve V1. At the initial condition piston or we can say valve V1 is at middle of the cylinder. The annular space between tube A and B is half filled with the oil. There are two eyes of the shock absorber which is shown by E1 and E2. E1 is connected to the chassis frame and E2 is connected to the axle.



Twin Tube Telescopic Shock Absorber

When the vehicle come across a bump, the eye E2 tends to move upward. Therefor to absorb the bump valve V1 start to move downward which compress the fluid trapped between the valve V1 and V2. This will pressuring the valve V1 and V2 thus the oil start to move from upper side of the valve assembly through valve V1 and also some oil move in the annular space between tube A and B through valve V2. This process converts all the vibration energy into fluid friction and absorbs shocks. When the vehicle rebound, the valve V1 start to move upward which again pressuring the valve V1 hence it open again and the oil start to flow below valve V1. During its upward movement it also sucks some oil from the annular space between tube A and B thus the vehicle get its initial condition.

Hydraulic shock absorber working and construction



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In motion control, it is often desirable — or necessary — to stop a moving load smoothly. A rubber bumper, a compression spring, or a dashpot all can accomplish this by absorbing energy. The bumper and spring store energy and release it after they are compressed, resulting in a rebound. A dashpot is a fluid-filled cylinder with an opening through which fluid may escape at a controlled flow. Any force acting against the piston in the cylinder encounters high resistance from the fluid at the beginning of the stroke, then much less as the piston retracts. However, none of these three items dissipate the energy uniformly. The impact of a moving load against a resisting force produces peak forces, which are transmitted to the machine's moving elements or to the load itself. In order to dissipate the energy uniformly, the use of a shock absorber is required.

In its most general form, a shock absorber consists of a double-walled cylinder with space between the concentric inner and outer walls, a piston, some means of mechanical return for the piston, and a mounting plate. The piston return is usually a spring, which can be mounted externally around the piston rod or internally on the inside of the cylinder body.

A series of orifices are drilled in the inner cylinder wall at exponential intervals. The reason for the exponential spacing is derived from the equation for kinetic energy: $KE=1/2\ mv^2$

The cylinder is filled with fluid; all air is bled from the fluid because air bubbles cut the efficiency of the shock absorbers by causing spongy or erratic action. When a moving load contacts the piston rod, it moves the piston inward, forcing fluid through the orifices in the inner cylinder wall. The fluid is forced through the oil return passages, into the space behind the piston head. As the piston retracts, it closes the orifices behind it, reducing the effective metering area, and maintaining a uniform deceleration force as the load loses its energy.

Fluid pressure is constant in a shock absorber, providing constant resistance to the load. The load slows to a stop as its kinetic energy approaches zero. There is no rebound because the shock absorber stores no energy. To return to its extended position, several events must happen. First, the load must be removed from the piston. The spring then pushes the piston outward, opening a check valve, which permits fluid to flow from behind the piston to the space the piston was in when retracted.

Smaller shock absorbers, with bores under 3 in., have a ball check valve to control fluid flow. Larger models use a piston-ring check valve.

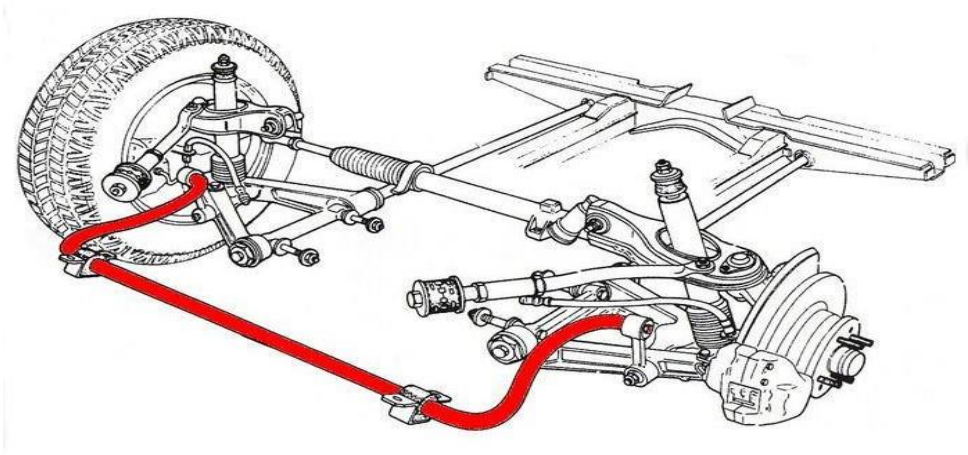
Applications

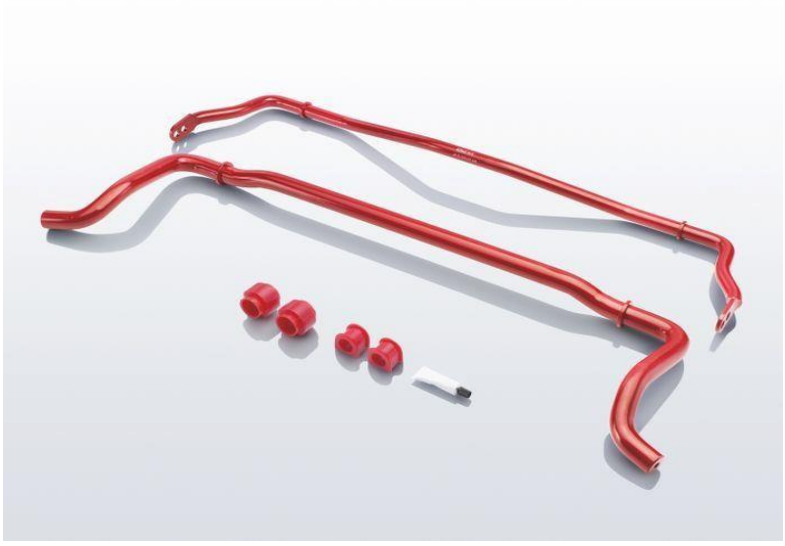
Shock absorbers can be used in a myriad of places. Applications include straight-line functions, as well as rotary, free-falling, rolling, and sliding movements. It makes no difference if the action is driven mechanically, hydraulically, or pneumatically. One common situation for shock absorbers is on high-cycle automation machinery that use rotary motions. For this the shock absorbers should be positioned near the pivot point to provide more clearance for the work area. However, this placement subjects the shock absorbers to high effective weight conditions due to their low velocity. Most of the kinetic energy involved originates from the propelling force rather than from inertia. For such applications, specify shock absorbers designed to operate in a velocity range from 1/4 to 2 ft/sec.

Stabilizer bar

Sway bars, also called stabilizer bars, are used to keep your vehicle from rolling over. It is a U-shaped steel bar that is connected to each of the vehicle's front wheels.

When your vehicle goes around a turn, your vehicle's body rolls to one side, or its weight shifts to one side.





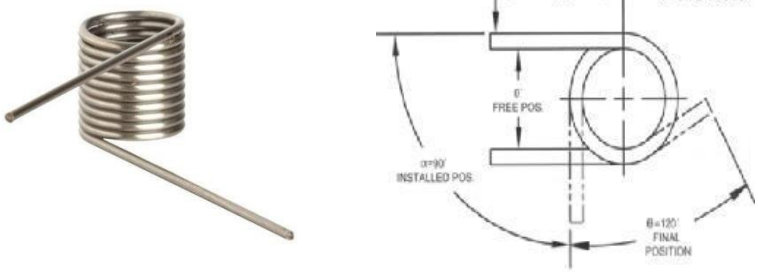
Because front wheel drive, rear wheel drive, and all wheel drive vehicles behave differently, they all respond differently to sway bar upgrades. A front wheel drive car relies on the front tires to both turn and transmit power to the ground. Because of this dual use of the front tires, front wheel drive cars tend to under steer. By increasing the stiffness of the rear sway bar on a front wheel drive car the rear inside wheel of the car will want to lift, and as such you can reduce body roll. This will help keep the car pointed generally in the right direction. You may want to be careful with upgrading the front sway bar on front wheel drive cars because too much stiffness in the front can cause the inside front wheel to lift. Because the front tires are putting power to the ground, this would drastically affect the cars grip and handling in a negative way.

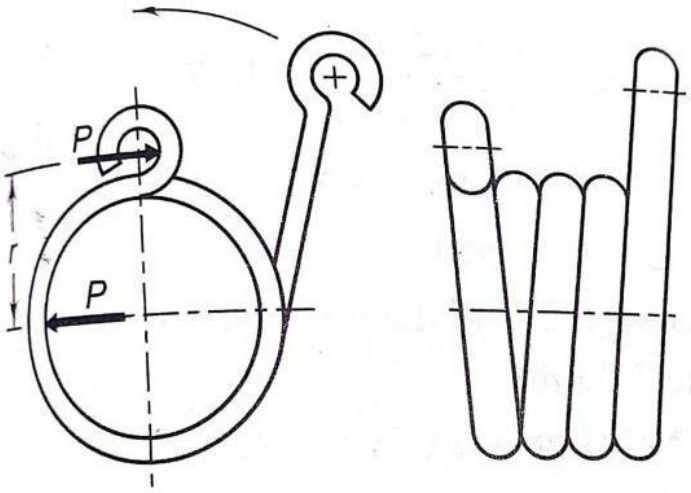
Rear wheel drive cars allow the rear of the car to pivot around the front, and as such they tend to over steer. By increasing the stiffness of a rear wheel drive car's front sway bar you can help to decrease over steer in a corner. Since, in this case, the rear wheels are driving the car, we want to keep them planted. To reduce body roll, however, the front sway bar can be stiffened without negatively affecting suspension dynamics.

Tension bar torsion spring

Tension rods are used in coil spring front suspension systems. They hold the front wheels in place, preventing longitudinal motion. One end of the tension rod runs from the chassis to the wheel area on each side of the car. ... The other end is bolted firmly in place on the control arm or wheel knuckle.

A **torsion spring** is a **spring** that works by twisting its end along its axis; that is, a flexible elastic object that stores mechanical energy when it is twisted. When it is twisted, it exerts a torque in the opposite direction, proportional to the amount (angle) it is twisted.





Air Suspension system

- Air suspension is a suspension where properties of air are used for cushioning effect.
- Air springs are height-controlled load leveling suspension devices.
- With changing loads, air spring reacts initially by changing the distance between air spring support and vehicle body.

Suspension system used in various vehicles

The suspension system comprises of independent Macpherson struts and coil springs in the front and a rigid axle with leaf springs at the rear. It sources the 793 cc two-cylinder diesel engine from the Maruthi Celerio, producing 24 KW (32 hp) at 3500 RPM and 75 Nm at 2000 RPM.

There are three basic types of suspension components: linkages, springs, and shock absorbers. The linkages are the bars and brackets that support the wheels, springs and shock absorbers. Springs cushion the vehicle by dampening shock loads from bumps and holes in the road.

The Hyundai EON promises smooth drive on any kind of terrains as it is equipped with advanced suspension mechanism. At the front, the car has anti-roll bar suspension and McPherson strut with coil spring. The rear wheels have torsion beam axle with coil spring.

The two most common types of independent suspension are Macpherson struts and double-wishbone suspension. Independent suspension is found on most sedans and sports cars today including the Ford Fusion, Lexus LS, and the Subaru Impreza WRX.

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Short answer question

1. Write the requirements for good suspension system.
2. Write the purpose of suspension system.
3. Write the types of springs used in suspension system.
4. Write the types of shock absorbers.
5. Write the principle behind the shock absorber.

Long answer questions

1. Explain the types of suspension system.
2. Explain leaf spring with neat sketch.
3. Explain construction and working of Hydraulic shock absorber.
4. Explain construction and working of Telescopic shock absorber.

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7. Wheels and Tyres

Introduction

Wheels must be strong enough to support the vehicle and withstand the forces caused by normal operation. At the same time, they must be as light as possible, to help keep un-sprung weight to a minimum. Wheels can be made from cast aluminum alloy or magnesium alloy. Alloy wheels are popular because of their appearance and because they are lighter than similar steel wheels. Aluminum is a better conductor of heat, so alloy wheels can dissipate heat from brakes and tyres more effectively than steel ones. Most wheels have ventilation holes in the flange, so air can circulate to the brakes. Most passenger car wheels are of well, or drop-centre design. This design allows for tyre removal and fitting. The removal and fitting of tyres should be carried out according to manufactures instructions.

Requirements of the wheel

1. Wheel must to bear the full load acting on the vehicle.
2. It must to make the vehicle weight easy to move and steer easy.
3. It must to help to move the vehicle without the engine.
4. It must to withstand vibrations of the road.
5. It must to withstand the braking force when the brake is applied.

Properties of the wheel

1. It must be able to withstand the full load of the vehicle.
2. The wheels must be at equal in position while driving the vehicle and at rest as well.
3. The weight of the wheels should be less.
4. The wheels must be easy to remove from the axle and fix in the axle.
5. The wheels must be easy to control by steering mechanism.

Types of wheels

Generally there are three types of wheel. They are

1. Disc wheel
2. Wired wheel
3. Cast wheel

Functions of wheels and tyres

- It ensures the friction between the tyre and the rim prevents the tyre turning on the rim.
- The tyre provides a cushion between the vehicle and the road to reduce the transmission of road shocks.
- It also provides friction to allow the vehicle perform its normal operations.

Wheel Assembly

The wheel includes the hub, spokes, and rim. The point of contact for the axle seat, the lug bolts and the lateral surface of the rotor. A wheel hub assembly (WHA), also referred to as hub assembly, wheel hub unit, wheel hub bearing, etc., is an automotive part used in most cars, passenger vehicles, and light and heavy trucks.

The wheel hub assembly includes wheel studs that attach the wheels of the vehicle to the car and is mounted to the steering and suspension system on the front end and the rear axle on the rear end. The wheel hub assembly is prone to damage caused by multiple driving situations such as: Hitting pot holes.

Construction and working of Disc and spooked wheel

This type of wheel is commonly used in all automobiles. Because its structure is very simple and the construction is very strong and cost effective.

The disc wheel is made of two parts. They are 1. Rim 2. Disc

The terms "wheel" and "rim" are often used as words with the same or nearly the same meaning, but technically speaking it is not really so. Many people use term "wheel" as a "rim" meaning the entire metal part to which the tire is mounted because rim and wheel are usually cast or pressed from a single piece of metal.

The top part of the rim has the provision for fixing the tyre correctly. The disc is connected with the rim by welding. Depending on the size of the wheel and the disc the disc can be made as an integral part of the rim or separate ones. The part of the tyre which is used for place it on the rim is called as the tyre bead. The tyre cannot be removed or fitted if there is no pit in the rim. The tyre fitting area in the rim is generally in tilting angle between 5° and 15°. Therefore, when air is filled in the tyre, the bead makes a tight fit with the rim. In tubeless tyres this tilt structure acts as a tight seal.

The main difference between wheel and rim is that rim is not the whole wheel but only a part of the wheel.

Key parts of the wheel are rim and disc.

The hub may be also considered as a part of the wheel. The hub is wheel base with studs on which the wheel is attached to the suspension.

Types of Rims

The rim is a cylindrical wheel outer edge holding the tire on the wheel. Main function of the rim is supporting and sealing the tire to the wheel. The rim ensures proper fitting between tire and rim and retaining the air inside the tubeless tire.

Disc

The disc is a part of the wheel which connects rim and axle hub.

The rim and disc may be permanently joined together or detachable

The disc in the disc wheel does the work of the spoke. The wheel is fitted on the axle by the bolts. There are holes provided on the wheel disc as shown in the picture. Through these holes air is allowed to enter inside the brake drum and the air cools the brake drum. There is a gap provided for the wheel disc and a hole is made on the rim for placing the tube valve.

Advantages

1. The construction of the disc wheel is simple, durable and cheap.
2. Its maintenance is low.
3. It is suitable for all light and heavy vehicles.
4. No curves or bends occur on the wheel.

Wired wheel or Spoked wheel

Unlike the disc wheel, the hub is located at the center of the wheel and the rim is at the top separately. The rim and the hub are connected by the wires called as spokes.

We can find this type of wheels used in two wheelers such as bicycles and motor cycles. The spokes in the two wheels withstand the vehicle weight, pulling force and braking force. For withstanding these forces the spokes are connected between the wheel hub and the rim. There are splines made in the hub for fixing it on the hub axle. The weight of wired wheel is comparatively lower than the disc wheel and has high cooling efficiency and hence it is used in racing cars.

Wire wheels, wire-spoked wheels, tension-spoked wheels, or "suspension" wheels are wheels whose rims connect to their hubs by wire spokes. The term suspension wheel should not be confused with vehicle suspension.

Advantages of wired wheel

1. It is lower in weight and has more durability than a disc wheel.
2. It allows the brake drum to cool very quickly and easily.
3. It can be fixed and dismantled easily whenever necessary.

Disadvantages

1. Maintenance cost is high.
2. There are possibilities for bends to occur in the wheel.
3. Tubeless tyres cannot be used because of the holes present in the rim for the spoke wires.

Construction and properties of tyres

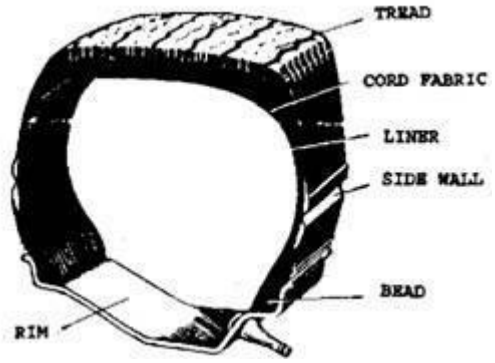
A tyre is made from rubberized fabric piles over a rubber liner and the edges of the piles are wrapped around a wire bead, which holds the tyre to the wheel rim The fabric piles are covered with a rubber compound tread and a different rubber compound for the side walls.

Different parts of the tyre are illustrated in Fig. 23.9. A tyre is made from rubberized fabric piles over a rubber liner and the edges of the piles are wrapped around a wire bead, which holdsthe tyre to the wheel rim. The fabric piles are covered with a rubber compound tread and a different rubber compound for the side walls. The tyre is cured in a mould to vulcanize the parts into a single unit and form the tread design.

Major Components

The carcass, beads, side walls, and tread are the major components of a tyre cover. Carcass. This is a horseshoe-shaped inner lining of the tyre and is made up of a number of layers of textile cord piles. The carcass forms the backbone of the tyre construction and the tread, bead, and walls all are molded on to these cord piles. Bead. This forms the inner edge of the tyre, and locates and centralizes the cover on to the wheel rim. It has the rigidity and strength required to support the carcass. To achieve this endless wire core is molded circumferentially trough the bead. Side Wall. This constitutes the outside rubber covering of the carcass between the bead and the tyre tread. The amount of protection provided to the carcass and the stiffness of the tyre during deflection depends on the thickness of side wall.

Sectional view of a tyre.



Tread

This forms the part of the tyre, which contacts the road surface when the wheel rolls. It is a rubber compound and its pattern design considerably influences the tyre's gripping, road-holding ability and working life.

Merits of radial tyre over cross play tyres

Cross (Bias)- and Radial-ply Tyre Features

Many textile cords are criss-crossed and embedded to provide strength to the cross-ply tyre in the rubber. These cords are arranged in layers, usually referred to as plies, which perform two jobs. Firstly they have to make the walls strong enough to contain the air pressure and yet leave them as supple as possible for deflection. Secondly they have to support the tread. These two requirements conflict each other because to obtain sufficient bracing of the tread, the ply must be reasonably stiff, which then means that the walls has to be rigid. Radial plies perform only one job that is to make the wall of the tyre strong enough to contain the air pressure. They do not support the tread. So they do not require to be criss-crossed, instead are laid readily following the natural profile of the tyre. This provides a supple but strong wall, which is desirable. To support the tread, a layer of rayon or steel cords forming a belt is placed underneath it. The sole purpose of this belt is to brace the whole of the tread firmly flat down and open on to the road.

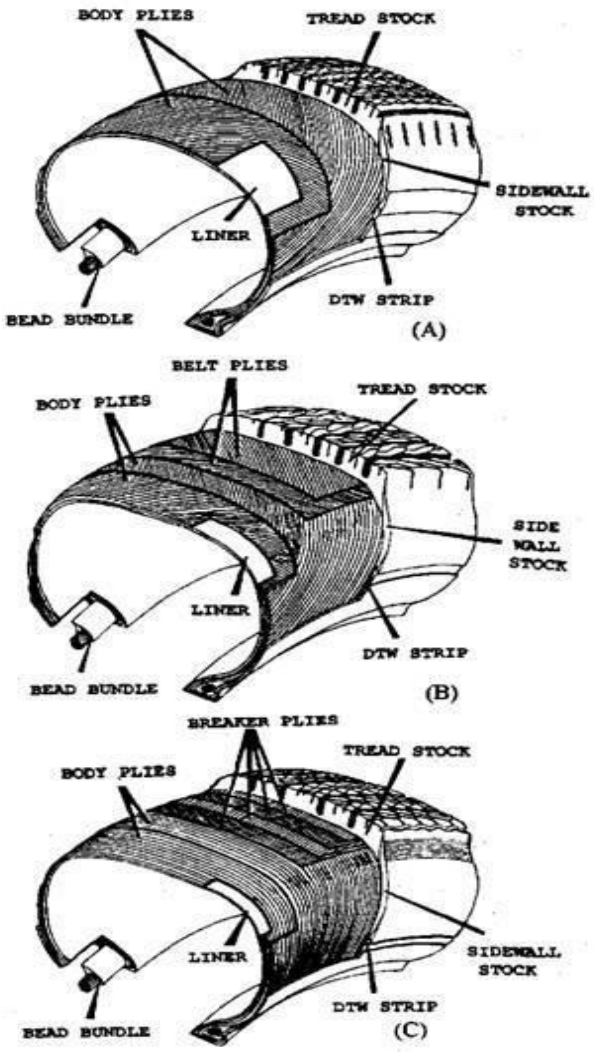
The greatest difference in tyres lies in the cord material and the way it is put into the tyre. The cross-bias cord angle runs from 30 to 40 degrees. This provides a cross-cord side wall, which gives required strength to transfer acceleration and braking torque. The tyres have gone from four-ply to two-ply construction. The strength of the ply is the result of the weight of the cord rather than the number of plies. Two-ply tyres are as strong as four ply tyres, because the tyre cord denier is larger than used in four ply tyres. Two-ply tyres run cooler, are more flexible to absorb shock from road irregularities, and apply greater self aligning torque to the steering system after a turn. Bias-ply allows the tyre to squirm as it moves through the tyre foot print or contact patch. The tread is pushed together as it goes into the foot print. This stores energy in the rubber. As it comes out of the root print, the tyre rapidly expands and goes beyond the neutral point into a stretched position. Closing and opening of the tread as it moves through the contact patches is one of the major causes of normal tyre wear. In belted tyres the tread stability and reduction of squirm results in Upto 100% improvement in tyre running compared to bias-ply tyres. By holding the tread shape, belted tyres run cooler, improve fuel consumption, improve traction, and double blow-out resistance when compared to bias-ply tyres.

Belted tyres do not flex as easily as bias-cord tyres, so that more road shock is transfer into the wheels and suspension system in this tyre, and hence the wheel spindles, knuckles, and suspension system are required to be stronger. Radial-ply belted tyres have been built having radial ply cord angles

Run from 88 to 90 degrees and the belt cords run from 12 to 20 degrees. The radial cord provides a soft side wall, which produces a softer ride than belted bias tyres. The belt (steel wires, Fiberglass, or rayon) around the radial cords holds the tread shape through the contact patch or foot prints. Radial belted tyres, as a result of a lower slip angle, provide more cornering power and less wear than bias belted tyres. These tyres produce a harsh ride at low speed, require a high steering effort, especially when parking and are expensive. The steel-belted radial tyre has less tread flexing so it rolls easier, thereby improving fuel consumption. With the radial belted tyres, loss of tyre-to-road adhesion occurs suddenly, with little warming, especially on wet surfaces.

different tyre patterns

Tyre Construction. A. Bias angle construction. B. Bias belted construction. C. Radial construction.



Specifications of tyres

Cross-ply:			
Rim diameter	Normal (unmarked)	S	H
10 degrees	Upto 120 km/h	Upto 150 km/h	Over 150 km/h
12 degrees	Upto 135 km/h	Upto 160 km/h	Over 160 km/h
13 degrees and above	Upto 150 km/h	Upto 175 km/h	Over 175 km/h
Radial-ply;			
Rim diameter	SR	HR	VR
All sizes	Upto 180 km/h	Upto 210 km/h	Over 210 km/h

Size.

This relates to the tyre nominal section width and wheel-rim diameter (Fig. 23.1A), which are indicated by the first and second numbers respectively. The section of radial-ply and bias-belted tyres is always quoted in millimetres, and of cross-ply tyres in inches. The rim diameter is in inches for all types of tyre. For example, "5.40-12″ indicates a nominal section width of approximately 5.4 inches and a rim diameter of 12 inches. Likewise, "155 SR-14″ indicates a nominal section width of 155 mm and a rim diameter of 14 inches.

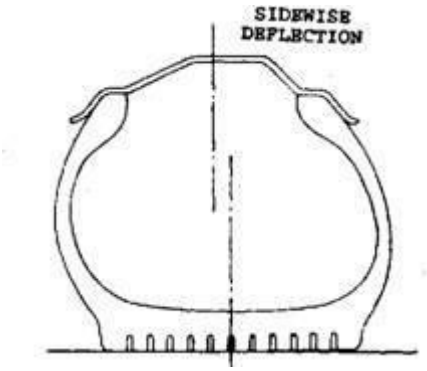
Casing Profile.

This relates to the ratio of the section height of a casing to the section width, the measurement is taken from bead to crown (Fig. 23.1A). The ratio of these dimensions is normally 80:100, and a tyre of this form is said to have an 80% aspect ratio. Low-profile tyres with 70% and 60% aspect ratios are also available with radial-ply tyres. If there is a deviation from the normal 80%, then a further number may be added to the sidewall marking. For example 175/70 HR-13 means 175 HR-13, with a 70% aspect ratio.

Tyre pressure and wear

The tyre is designed to match the rim to maintain a tight air seal, which keeps air pressure in the tyre. The width of the wheel rim in relation to the size of the tyre is important. Engine acceleration torque tries to turn the rim inside of the tyre, and the friction between the bead and rim keeps this away from happening. This type of force also occurs during braking, but in the reverse direction. During a turn, the tyre is deflected sideways. This force tends to loosen the bead from the rim on one side of the tyre.

The tyre bead must be sufficiently secured to hold contact with the rim.



Centrifugal force, at high vehicle speeds, increases the tyre diameter, which tries to throw the bead from the rim. The bead wire holds the bead diameter, so that it remains in contact with the rim. Belted tyres keep the tread from expanding at high speeds, which stabilizes the tread and minimizes heat built up. Tyres flex as they rotate while carrying vehicle load. This flexing distorts the tyre, especially when the tyre assumes a side load while going around a curve. Distortion, a natural reaction of a tyre, allows the tyre of absorb road shock and to flex through the contact patch without skidding as the vehicle takes a turn.
Heat build-up in the tyre due to natural tyre flexing stabilizes at a safe temperature during its normal operation within its load range. Temperatures above 394 K result in the loss of tyre strength, the rubber-to-cord bond separates, and the air escapes, often as a blow out, and in some cases they start to burn. The simplest method to reduce heat is to slow the vehicle 6peed, which decreases flexing per minute and provides more cooling time between flexing.
Tyre inflation pressures are recommended to have the best compromise for load carrying capacity, vehicle handling, and tyre life. The inflation pressures are usually related to the expected wheel load.

Cause of tyre wear

Tyre Sizes and Designations

At present up to four pieces of information are provided through tyre marking. These include, (i) construction type, (ii) speed rating,(Hi) size, and (iv) case profile.

Construction Type.

This is indicated by a letter code and relates to the ply or ply-and-brace construction. Radial-ply tyres use the letter R and bias-belted the letter B, while cross-ply tyres carry no letter identifying construction. Speed Rating. This relates to the maximum speed at which a vehicle should be driven, that is the maximum speed of which the vehicle is capable, not the speed at which it is normally driven. Speed rating is indicated by a code letter.

Characteristics.

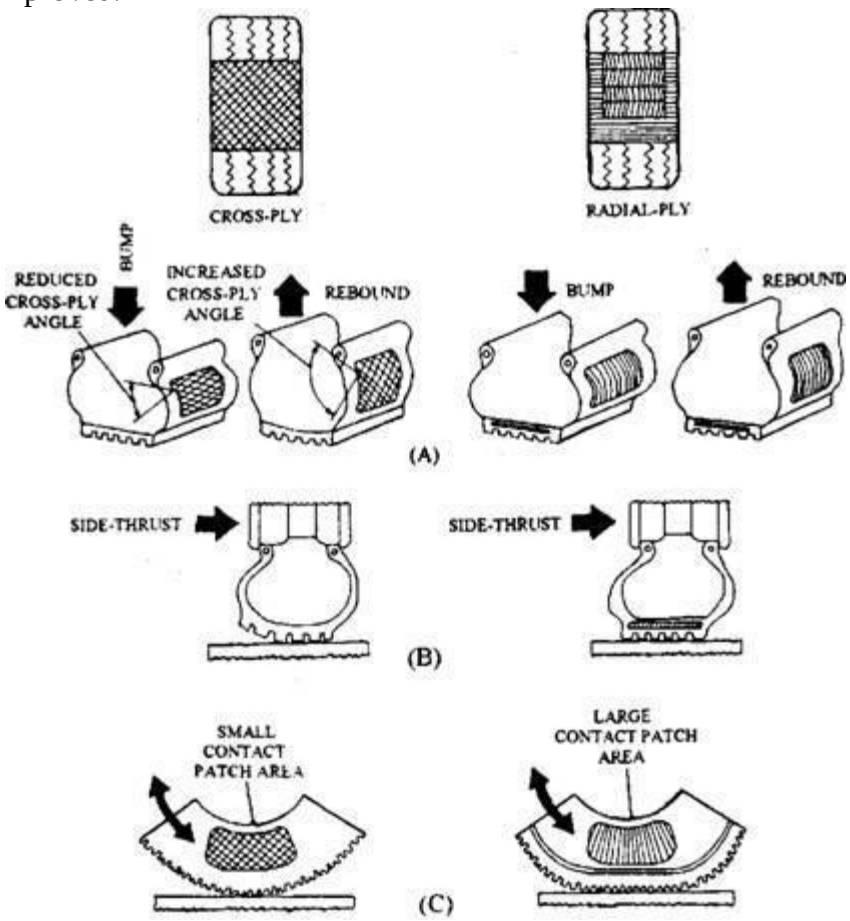
Ride Comfort.

The bending of the walls of cross-ply tyres requires a shear action to change the criss-cross ply angle, which makes the walls very stiff, and hence the bounce on rough roads is not properly cushioned. Radial-ply tyre construction provides a supple wall due to the natural direction of radial-ply cords. These tyres bend readily and hence can absorb a great deal of extra bounce. The radial-ply tyre is more comfortable at higher speeds because of its shock-absorbing deflection characteristic, which is 25% greater than that of the cross-ply type. However at lower speeds the cross-ply tyre provides more smooth riding and the steering is also lighter, so that it is more suitable for parking.

Acceleration and Braking.

Conventional cross-ply tyres tread is affected by every movement of the walls because tread is not braced and held down on to the road. As a result of this the tread blocks are able to shift and dance about on the road surface providing a small contact area, which reduces road grip. In radial-ply tyres, the braced layers of cords act independently of the wall plies. The bracing belt follows the contour of the road during movement of the wheel providing a continuous large flat contact-patch area with the road surface.

The whole of the tread pattern is fully stabilized, so that road-wheel acceleration and braking
traction are improved.



Comparison of cross-ply and radial-ply tyres. A. Ride comfort. B. Acceleration and braking. C. Cornering.

Cornering.

Cross-ply tyres do not bend sufficiently to absorb any sideways strain during cornering. The cross-plies therefore pull and lift up one side of the tread from the ground, reducing road grip and traction. Radial-ply tyre during concerning bends readily and absorbs extra strain. The tread stays firm and flat down, with its whole working area of tread pattern biting into the surface of the road.

Tyre Life.

With a cross-ply tyre, when the wheel rolls, the distortion of the walls tends to pull the tread away from the road surface, thereby scraping the tread blocks as road contact begins and ends. A radial-ply tyre produces a flat full-width track-laying action along the wheel-and-road interface (Fig. 23.11C). The full width tread pattern contact during cornering and the extended flat zone reduce wear during driving and stopping. This extends tyre life considerably by as much as 80%.

Fuel Consumption.

The more flexible casing of radial-ply compared to cross-ply tyres reduces the amount of energy consumed while running, so that saving in fuel consumption in the order of 5% is achieved.

Initial Cost.

The first cost of cross-ply tyres is about 20% less than for radial-ply tyres.

Tyre Material

The efforts are continuously being put to improve the existing tyre materials and to introduce new materials for meeting tyre requirements better. Several types of fabric cord materials are in use for tyre piles. Rayon was introduced in 1938 as a tyre cord material to replace cotton. This material was much more durable, produced a soft ride, and was more resilient and less expensive than cotton. It has tensile strength of648,110 kN/m2. Subsequently to improve its characteristics and to reduce its cost several modifications have been introduced. In 1947 two forms of nylon were introduced as tyre cord material, which has tensile strength of 841,160 kN/m and is more heat and water resistant than rayon. The nylon cord tyres have less flexibility than rayon, which tends to produce better vehicle handling. The major disadvantage is that nylon cord tyres take a set while standing, which produces flat spots causing a thump when the car first starts to roll. As the tyres warm from rolling the cords relax and the flat sport quickly disappears. To reduce the flat-spotting tendency, the nylon cord is stretched and tempered using special techniques prior to use in a tyre. In 1962 the Polyester cord having tensile strength of 717,050 kN/m was introduced for car tyres.

This material provides a soft ride and does not produce flat spot. It is less heat resistant than nylon and more heat resistant than rayon. In 1962, fibreglass was used as a special cord in tyres. But because of its low flexibility it is rarely used as a side wall cord. It was initially used in 1968 for belt between the tyre ply and tread, and provided a much longer life. Steel cords are used for belts in many radial ply tyres, which are quite rigid and have high impact strength. Two to ten piles of cord fabric may be used in tyres. Rubber, an elastomer compound, is used in tyres to blend natural and synthetic rubbers. Chemicals and filler compounds are added to rubber to produce desired characteristics. In order to increase wear and abrasion resistance of the tyre tread, large amounts of carbon black are added to the tread rubber. Traction depends on the tread rubber hardness, compounding, and tread design. Hard compounds provide good wear and poor traction whereas soft compounds give good traction and poor wear. The tread compound is chosen as compromise to provide the properties required for each tyre application. The impregnated rubber used for side wall and ply is a more flexible rubber compound than tread rubber. The side wall must be sufficiently flexible to deflect as it passes the tyre contact patch on each revolution and also to absorb any shock produced by road surface irregularities. It must have sufficient strength to transfer all the acceleration and braking torque between the wheel rim and tyre tread, and to withstand cornering forces that are applied to the automobile. Tyre rubber deteriorates with temperature and age. Rubber compounds are, therefore, varied to provide the expected service life required for the tyre.

Natural and Synthetic Rubbers.

Synthetic rubbers have been developed as substitutes for natural rubber. There are several synthetic rubbers used for tyre construction in addition to the natural rubber as presented below.

Natural Rubber (NR).

Natural rubber provides good wear resistance and excellent tear resistance. It also offers good road holding on dry roads but provides only a moderate grip on wet surfaces. Additionally it has low heat build-up, but this merit is contrasted by high gas permeability. Also the resistance offered by this material for aging and ozone deterioration is only fair. The side walls and treads have been made from natural rubbers but nowadays it is normally blended with other synthetic rubbers to exploit their desirable properties by minimizing their shortcomings.

Chloroprene (Neoprene) Rubber (CR).

This synthetic rubber was one of the earliest to compete with natural rubber and is made from acetylene and hydrochloric acid. This rubber compound has good wear and tear resistance with a reasonable road surface grip. A major limitation is its inability to bond with the carcass fabric due to which a natural rubber film is provided between the cords and the Neoprene covering. Neoprene rubber provides moderately low gas permeability and does not indicate signs of weathering or aging throughout the service life of the tyre. If blended with natural rubber it becomes suitable for side wall covering.

Styrene-butadiene Rubber (SBR).

It is probably the most widely used synthetic rubber for the manufacturing of the tyre. This rubber compounds are made from styrene (a liquid) and butadiene (a gas). Styrene-butadiene rubber (SBR) forms a very strong bond to fabrics and it provides a very good resistance to wear, but exhibits poor tear resistance compared to natural rubber. One remarkable feature of this rubber is its high degree of energy absorption or high hysteresis and low resilience, which allow exceptional grip characteristic, especially on wet surfaces. Because of the high heat build up, this rubber is used only for the tyre tread while the side walls are normally made from low hysteresis compounds, which provide greater rebound response and run cooler. Blending SBR and NR provides the best properties of both synthetic and natural rubber to be utilized so that only one rubber compound is used for some types of car tyres. The high hysteresis characteristic of SBR is partially achieved by adding an extra high styrene content and a large proportion of oil, the overall effects being to increase the rubber plastic properties and to lower its resilience (i.e. reduce its rebound response).

Polyisoprene Rubber (IR).

This rubber exhibits very similar characteristics as natural rubber, however provides improved wear and specifically tear resistance. It has an additional advantage of an extremely low heat build up with normal tyre flexing. This rubber material is blended with natural rubber and styrene-butadiene rubber to produce tyre treads with very high abrasion resistance. This material is highly suitable for heavy duty application such as track tyres where high temperatures and driving on rough terrains are a problem.

Ethylene Propylene Rubber (EPR).

This rubber provides the major advantage of mixing it with large amounts of cheap carbon black and oil without loosing its rubbery properties. Depending upon the compound composition it gives excellent abrasive ageing and ozone resistance with varying road holding qualities in wet weather. It has also varying skid resistance on ice. A great disadvantage with this rubber compound is that it bonds poorly to cord fabric. Therefore, rubber compounds containing EPR have not proved to be successful as a material for tyre till date.

Poly butadiene Rubber (BR).

This compound provides very high wear resistance and a high resilience i.e. a low hysteresis level. It is exceptionally stable with temperature changes. When blended with SBR in the correct proportions, its wet road holding ability reduces slightly but considerably improves its ability to resist wear. Due to its high resilience (large rebound response), the road holding in wet weather becomes relatively poor. For its application in tyres it is normally mixed with SBR in the proportion of 15 to 50%. It is, however, expensive to produce.

Isobutene-isoprene (butyl) Rubber (IIR).

This kind of rubber has exceptionally low permeability to gas. In practice it retains air in tubes ten times longer than the natural rubber, so that it has been extensively used for tyre inner tubes and for inner linings of tubeless tyres. Unfortunately it does not blend with SBR and NR unless it is chlorinated. Its resistance to wear is good and it has a high hysteresis level so that it becomes more plastic like than rubber to distortion. It provides good road grip for both dry and wet conditions. Its desirable properties are generally improved when mixed with carbon black. Due to its high hysteresis it does not readily give out energy to the surroundings so that tyre treads made from this material do not generate noise in the form of squeal. **Merits and Limitations of Natural and Synthetic Rubbers.** Some cross-ply tyres are completely made using only one rubber compound from tread to bead. The severity of the carcass flexure with radial-ply tyres dictates to use different rubber composition for various parts of the tyre matching their properties to the functional requirement of the part (i.e. tread, side wall, inner lining, bead, etc.)Side walls are usually made from natural rubber alone or blended with poly butadiene rubber (BR) or styrene-butadiene rubber (SBR) or to a lesser extent Neoprene or Butyl rubber.

The properties required for side wall material include a resistance against ozone and oxygen attack, a high fatigue resistance to prevent flex cracking and good compatibility with fabrics and other rubber compounds when moulded together. Tread wear fatigue life and road grip depends, to a large extent upon the surrounding temperatures, weather conditions including dry, wet, snow or ice bound, and the type of rubber used. For more clarity a comparison is made with natural rubber and styrene-butadiene (SBR), possibly the most important synthetic rubber. At low temperature, styrene-butadiene (SBR), wears more than natural rubber but at higher temperatures it wears less than natural rubber. As the severity of the operating condition of the tyre increases, SBR tends to wear more compared to NR. The fatigue life of all rubbers reduces with the increase of the degree of cyclic distortion. For small tyre deflection SBR provides a better fatigue life but for large deflections NR offers a longer service life. The NR offers better skid resistance on ice and snow. But as temperatures rise above freezing, SBR offers an improved resistance to skidding.

However it depends to some extent on the amount of oil extension (plasticizer) provided in the blending in both NR and SBR. Following are the two typical examples of rubber compositions suitable for tyre treads :

(a) High styrene butadiene rubber**.** 31%

	Oil extended butadiene rubber	31%
	Carbon black	30%
	Oil	6%
	Sulphur	2%
(*b*)	Styrene butadiene rubber	45%
	Natural rubber	15%
	Carbon black	30%
	Oil	8%
	Sulphur	2%

Tyre Tread

In a pneumatic tyre a cushion of air trapped between the well of the wheel rim and the toroid-shaped casing known as the carcass supports the wheel load. The tread, a thick layer of rubber compound, is wrapped around the outside of the tyre carcass to protect the carcass from damage due to tyre impact with the irregular contour of the ground and the abrasive wear as the tyre rolls along the road. During rotation of the wheel the tread provides driving, braking, cornering and steering grip between the tyre and ground. Tread grip may be defined as the ability of a rolling tyre to continuously develop an interaction between the individual tread elements and the ground. Tyre grip must be available under a variety of road conditions such as smooth or rough hard roads, dry or wet surfaces, muddy tracks, fresh snow or hard packed snow and ice, and sandy or soft soil terrain. The main function of a tyre tread pattern is (i) to provide a path for drainage of water trapped between the tyre contact patch and the road, and (ii) to provide tread to ground bite when the wheel is subjected to both longitudinal and lateral forces under various driving conditions.

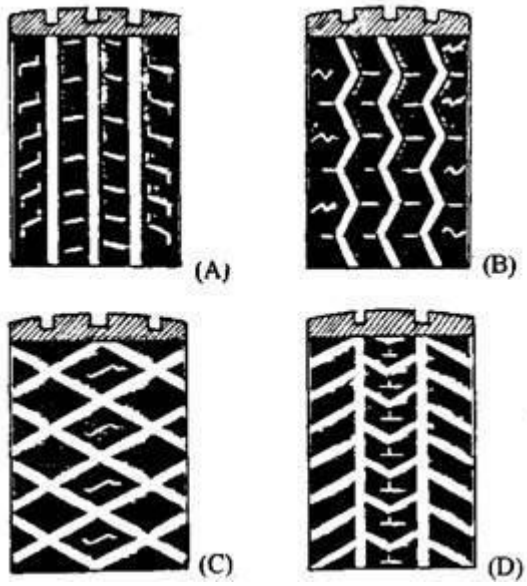
Tread Bite

Bite is obtained through a tread pattern, which divides the tread into many separate element, and each elements has a reasonably sharp well defined edge. As the wheel rotates these tread edges engage with the ground providing tyre to ground interlock and also develop frictional forces during transmission of tractive or braking forces. Following are the major features of tread pattern that control the effectiveness of the tyre in wet weather:(i) Drainage grooves or channels. (ii) Load carrying ribs.(Hi) Load bearing blocks. (iv) Multiple micro slits or sipes.

Tread Drainage Grooves.

If water is trapped between the tread ribs or blocks, the tread elements life become separated from the ground, so that the effective area of the contact patch reduces, so also the tyre's ability to grip the ground. A number of circumferential grooves placed across the tread width facilitate the removal of water films from the tyre to ground interface. These grooves help the leading elements of the tread to push water through the enclosed channels formed between the road and the underside of the grooves. Water therefore emerges in form of jets from the trailing side of the contact patch.

The total cross-sectional area of tyre should be sufficient to channel all the water immediately ahead of the leading edge of the contact patch away.



Basic tyre treads patterns. A. Circumferential straight grooves and ribs with multiple sipes. B. Circumferential zig-zag grooves and ribs with multiple sipes. C. Diagonal grooves with diamond shaped blocks and central sipes. D. Diagonal bars with central vee blocks and sipes.

Lateral grooves are used to join together the individual circumferential grooves so that a direct side exist can be provided for the outer circumferential grooves. Normally many grooves are preferred to a few large ones. This arrangement speeds up the water removal process under the contact patch.

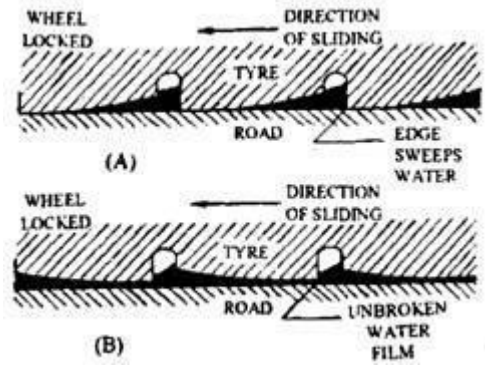
Tread Ribs.

Circumferential ribs provide a supportive wearing surface for the tyre and also become the walls for the drainage grooves. Lateral ribs provide the optimum bite for tractive and braking forces whereas circumferential ribs control cornering and steering stability. For both longitudinal and lateral directional stability, ribs may be arranged diagonally. Also it may be in the zigzag circumferential form to improve the wiping effect across the tread surface under wet conditions. It is desirable to have the tread pattern with many narrow ribs than a few wide ones for better road grip.

Tread Blocks.

The consequences of both longitudinal and lateral drainage channels, used for effective drainage of water at speed, is that the grooves encircle portions of the tread forming isolated island blocks.. These blocks provide a sharp wiping and biting edge where the interface of the tread and ground meet. To improve their biting effectiveness for tractive, braking, steering and cornering forces, these forces are required to be resolved into diagonal resultants and to achieve this the blocks are sometimes arranged in an oblique formation. A limitation to the block pattern concept is due to inadequate support around the blocks, which causes the rubber blocks to bend and distort under severe operating conditions.

Bar shaped:

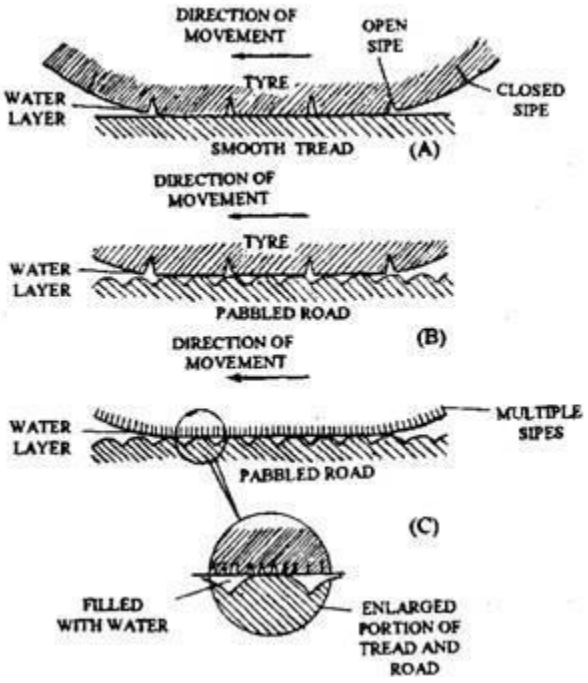


Effect of irregular tread block wear. A. Toe to heel treads wear. B. Heel to toe treads wear.

Tread blocks, arranged in a herringbone fashion, have proved to be effective on rugged ground. Square or rhombus-shaped blocks provide a tank track unrolling action so that movement in the tread contact area greatly reduces. This pattern helps to avoid the break-up on the top layer of sand or soil so that the tyre is prevented from digging into the ground. Since the individual blocks bend to certain extent when subjected to ground reaction forces, they suffer from toe to heel rolling action causing blunting of the leading edge and trailing edge feathering. To maintain the wiping action of the tread block element on wet surfaces, wear should from toe to heel. If wear occurs from heel to toe i.e. in the reverse order, the effectiveness of the tread pattern severely reduces since the tread blocks then allow for the formation of a hydrodynamic water wedge, which tries to lift the tread blocks off the ground at speed.

Tread Slits or Sips.

Micro slits or sipes are incisions made at the surface of the tyre tread, extending down to the full depth of the tread grooves. They reassemble a knife cut, mostly of a zigzag fashion



Effectiveness of micro slits on wet road surfaces. A. Effective sipe wiping action on a smooth road. B. Ineffective sipe wiping action on a knobbly road. C. Close pitched sipe wiping action on a pebbled road.

Sometimes one end of the knife cut intersects the side wall of a drainage groove. In some designs the tread patterns use the sipes arranged at a similar angle to each other, where the zigzag shape provides a large number of edges pointing in various direction. Other designs set sipes at different angles to each other so that these sipes are effective for the wheel pointing in whichever way and for the ground reaction forces operating in whatever direction. Sipes or slits are almost closed in their free state, but as they enter into the contact patch area the ribs or blocks distort and open up. In this open position, the sipe lips scoop up small quantities of water that still exist underneath the tread. This wiping action produces some biting edge reaction with the ground.

If the sipes are smaller in size and more in number, they are more effective for road griping. The sipes with normal spacing on a tyre tread are ineffective on a pebbled road surface as several pebbles exist between the pitch of the sipes, collecting water between these rounded stones, so that only a few of the stones are subjected to the wiping edge action of the opened lips. Therefore to improve the wiping process there should be many more wiping slits, which is very difficult to manufacturing with the present techniques.

Selection of Tread Patterns.

Normal Car Tyres.

General duty car tyres, which effectively operate at all speeds use tread blocks arranged in an oblique fashion with a network of surrounding drainage grooves so that both circumferential and lateral water release are provided.

Wet Weather Car Tyres.

These car tyres are usually similar to the general duty car tyre except that the tread grooves are made wider to allow easier water dispersion and to provide better exposure of the tread blocks to snow and soft ice without damaging much the tread.

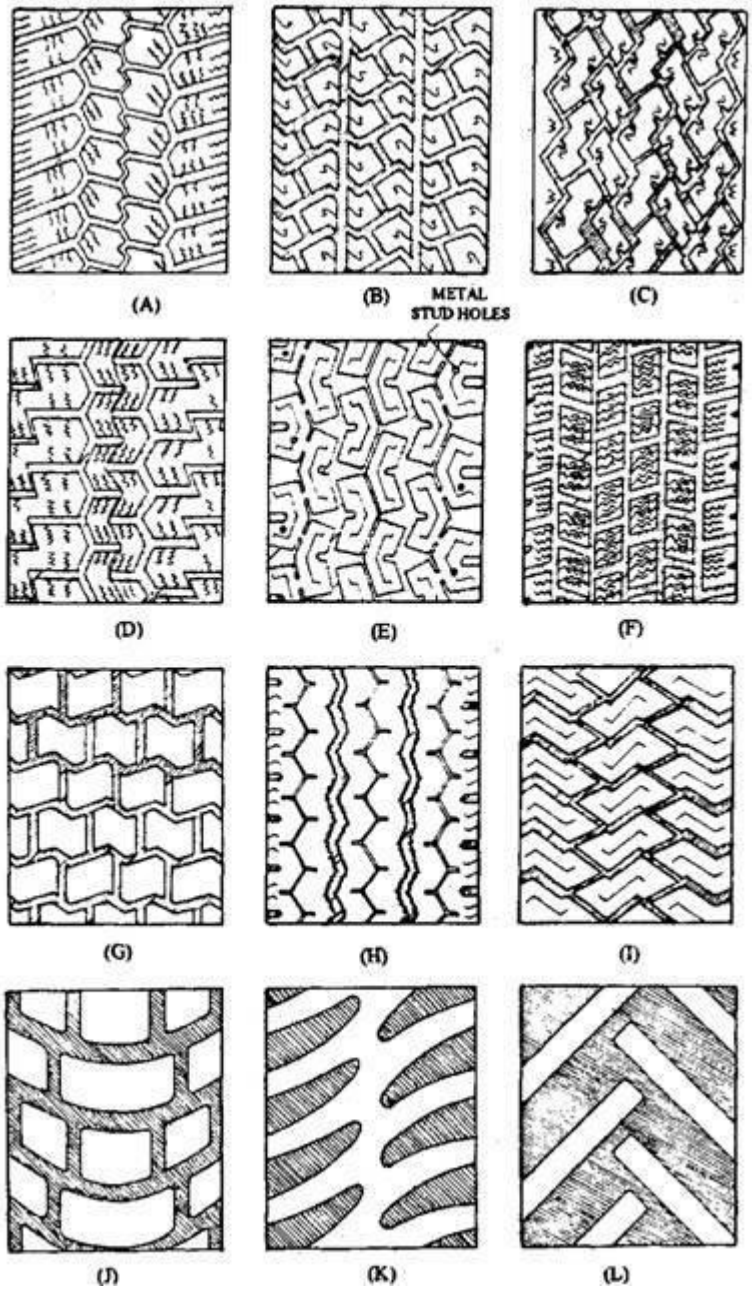
Truck Tyres.

Truck tyres designed for steered axles normally use circumferential zigzag ribs and grooves so that very good lateral reaction on curved tracks is available. On the other hand, the drive axle tyre is designed so that tread blocks have adequate grooving for optimum traction grip under both dry and wet conditions. Some of these tyres also incorporate provision for insertion of metal studs for severe winter hard packed snow and ice conditions.

Off On Road Vehicles.

Off on road vehicle tyres normally use a much simpler bold block treads with a relatively large surrounding groove. This arrangement permits each individual block to react independently with the ground causing biting and exerting traction on soil, which may be hard on the surface but soft underneath without break-up of the top layer, so that the tyre is prevented from digging in. The tread pattern blocks are also designed sufficiently small to operate on hard road surface without causing excessive ride harshness at moderate speeds. Truck and Tractor off Road and Cross-country Tyres.

Truck or tractor tyres for off road operation generally use slightly curved rectangular blocks separated with wide grooves, which provide a strong flexible casing as well as present a deliberately penetrating grip. Cross-country tyres, for operating on soft soil, have diagonal bars either merging into a common central rib or arranged with separate overlapping diagonal bars to provide exceptionally good traction on muddy soil, snow and soft ice.

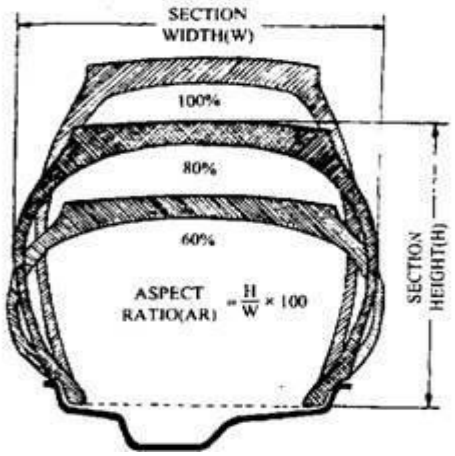


Survey of tyre treads patterns. A. Car moderate speed radial. B. Car high speed radial. C. Car very high speed radial. D. Car wet weather radial. E. Car winter radial with moulded stud holes. F. Car winter radial. G. Light vehicles off I on road winter tread. H. Truck steer axle tread. I. Truck drive axle tread. J. Truck rough ground tyre. K. Truck cross-country tyre. L. Tractor cross country tyre..

Tyre Profile and Aspect Ratio

A tyre carcass profile considerably influences its rolling and handling characteristics. The tyre's cross-sectional configuration determines its suitability for better performance under various applications. The aspect ratio of tyre may be defined as the ratio of the tyre cross-sectional height (the distance between the tip of the tread to the bead seat) to that of the section width (the outermost distance between the tyre walls). This ratio is constant for a particular tyre and is used for predicting the suitability of a tyre for an application.

$$\text{Thus,} \qquad \text{Aspect ratio} = \frac{\text{Section height}}{\text{Section width}} \times 100.$$



Tyre profiles with different aspect ratios.

A tyre with a large or small aspect ratio is known respectively as a high or low aspect ratio profile tyre. Until about 1934 aspect ratios of 100% were used. With a better understanding and improvement in tyre construction lower aspect ratio tyres become available. Due to lowering the aspect ratio the tyre side wall height is reduced so that the vertical and lateral stiffness of the tyre increases, thereby establishing a shorter and wider contact patch.A short and wider contact patch (a) increases the load carrying capability of the tyre ; (6) generates larger cornering forces so that vehicles are able to travel faster on bends; (c) decreases the pneumatic trail so that the self-aligning torque correspondingly reduces and becomes more consistent; and (d) under certain driving conditions, reduces the slip angles generated by the tyre when subjected to side forces. Consequently the tread distortion reduces and as a result scuffing and wear decrease.

Water drainage at speed becomes difficult with wider tyre contact patches, particularly in the mid tread region. Therefore it is more critical to design the tread pattern with low profile tyre on wet" roads, in case the tyre holding is to match with the higher aspect ratio tyres. The increase is vertical and lateral stiffness's causes the following, (a) Due to an increase in vertical stiffness and a reduction in tyre deflection, less energy is dissipated by the tyre casing thereby reducing the resistance. This also causes the tyre to run continuously at high speeds at lower temperatures, which increases the tyre's life.(b) The increased lateral stiffness of a low profile tyre increases the sensitivity to camber variations and quicken the response to steering changes.

(c) The increased vertical stiffness of the tyre reduces static deflection of the tyre under load, due to which more road vibrations are transmitted through the tyre. This provides a harsher ride reducing ride comfort unless the body is further isolated from the suspension. The availability of lower aspect ratio tyres over the years was as follows : 1950s — 95%, 1962-88%, 1965-80% and about 1968-70%. Since then for special applications even lower aspect ratios of 65%, 60%, 55% and even 50% have become available.

Tyre Manufacturing

Tyre fabric is primarily strands of tyre cord running lengthwise in the fabric. The fabric after required processing is stretched and heated to give it uniform mechanical properties. Adhesive is used as a bonding agent between the cord and rubber compound. The treated fabric then goes to large steel rollers, called calendars, which squeeze and uncured rubber into the cord fabric to produce a sheet. This rubberized sheet is cut into strips at an angle or bias, and then reassembled into a long strip with the cords running at the required bias angle for bias-ply tyres. The cords remain straight for radial tyres. Tread rubber and side wall rubber compounds are extruded into the required shape and cut to length at an angle to provide a long tapered joint. Wire is rubber coated and rolled into the required size bundle or bead, two per tyre, for use as the tyre bead. In order to manufacture bias-ply tyre, one bead is slid over the drum and kept in position. The drum rotates as the tyre is built in layers.

The first layer consists of a rubber sheet that takes place of a inner tube to seal the air. This is followed by two or more plies of rubberized cord fabric. The fabric is carefully cut to length parallel to its cords, and then lapped over the other end of the ply with the required overlap joint, to produce an enclosed cylinder shape. Adjacent plies have their bias in alternate directions to give the tyre strength. The plies are followed by belts for breakers when required. The beads are placed over the edges of the ply. The ply is then wrapped over the bead back onto itself, locking the bead bundle into place. A tread and side wall rubber strip is wrapped around the plies and trim is moulded within the side wall strip. The entire assembly is pressed together by a process called stitching. The tyre looks like an open ended barrel and can be repaired, if deviations are observed on inspection, because it is still green or uncured rubber.

The manufacture of the radial-ply tyre is somewhat different from the bias-ply tyre. The radial tyre is built on a drum that forms the green tyre in nearly the same shape as the finished tyre. The green tyre is sent to the mould to be cured after it passes the inspection. The green tyre slides over a bladder that expands as the hot mould closes around the tyre. This bladder forces the tread surface outward into the mould. The tread pattern and identification data for the tyre are cut into the mould surface. The rubber composition determines the mould temperature, which is about 433 K, and time needed for curing is around twenty minutes. The tyre is trimmed and inspected when it comes from the mould.

_*_*_*_*_*

Short answer question

1. Write the requirements of wheels.
2. Write the functions of wheels and tyres.
3. Write the advantages of Disc wheel.
4. What is tyre?
5. Write the different types of tyre patterns.

Long answer questions

1. Explain the various types of rims.
2. Explain the construction of Disc wheel.
3. Explain the causes of tyre wear.
4. Explain the selection of thread patterns

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Mechanical & Auto Mobile Technician

Paper – III

Automobile Servicing & Maintenance

INDEX

1. Service Station and Garage

Introduction

Automobiles need maintenance from time to time. Like humans are required to maintain hygiene, similarly automobiles also need to be kept clean. Automobiles have to run on dirty roads and in a polluted environment. They run on uneven roads with potholes and other obstructions, and are therefore subjected to loads which damage them. Therefore, there is a need for regular maintenance and servicing of automobiles, which is usually done in auto workshops or auto service stations. In this Unit, you will understand the concept of vehicle maintenance and servicing.

As you may be aware, there is an increase in the number of vehicles, such as motorcycle, scooter, bus, car, jeep, tempo, truck, tanker, etc., running in the cities. Every new vehicle comes with a vehicle maintenance manual. The owner of the vehicle is expected to read and use this manual, as it mentions vehicle maintenance tips during driving. It has been noticed that after getting a car or vehicle, the owners do not care much about a regular car or vehicle maintenance. Even if the owners regularly service their vehicle, the vehicle maintenance tips given in the vehicle maintenance manual increases the longevity or life of the vehicle to a great extent. Vehicle maintenance and servicing is carried out when the vehicle completes certain kilometres on its normal running or when the vehicle does not give proper performance. It is suggested that the vehicle owners carry out regular and periodical checks on their vehicle, some of which are mentioned below.

Daily Inspection (DI)

It is the responsibility of a driver or owner of a vehicle to carry out the following inspection and checks daily, before starting the engine, to avoid any type of breakdown on the road.

(i) Check tyre pressure in all the tyres visually or by hitting the tyre wall with the help of a stone and judge the sound
(ii) Check the radiator's coolant level
(iii) Check the fan belts for looseness
(iv) Check the level of engine oil
(v) Check the windscreen, rear-view mirror and rear-window glass for their cleanliness

Maintenance Check-up

When one plans a long distance travel, it is necessary to carry out a routine check-up. One should read the vehicle maintenance manual for clarity. Some important check-ups are done for better maintenance.

(i) Topping of oil level
(ii) Proper tension of belt
(iii) Battery for cleanliness and level of electrolyte (add only distilled water for topping of electrolyte water)
(iv) Brakes
Topping up of coolant, if required, in the coolant reservoir

Vehicle maintenance is generally done at a vehicle service centre. You could make a visit to a nearby vehicle service centre to see how a vehicle is maintained and what all checks are carried out by service mechanic. Some important check-ups are discussed here.

Check or Top-up All Vehicles'

Oil Levels Service mechanic, with the help of a measuring stick, checks the engine oil, coolant, brake oil and water. During routine check-up, oil, water and coolants are topped up or otherwise they are changed

Belt Check-up

Checking of belt is very important. If it is loose or broken, then it needs to be replaced immediately.

Battery

It is a very important component of a vehicle. It should be checked regularly. Battery electrolyte (distilled water) is checked by removing the battery caps and looking inside. If the level is low, it is topped up with distilled water. Nowadays, batteries are maintenance-free which means they have sealed caps and require no checking. But, some batteries though said to be maintenance-free, do have removable caps. These should be checked in the usual manner.

Brakes

The service mechanic checks the brake by pushing the pedal. If there is need of servicing, the service mechanic informs the customer accordingly.

Cooling System

The technician checks the cooling system by topping up the coolant. The cooling system should be refilled with the correct coolant, and not with water alone.

Air Conditioning

The service mechanic checks cooling and heating by examining if the airflow is coming from all appropriate vents.

Tyres

The mechanic at the service station examines the tyres by checking correct tyre pressure, and also checks whether there is any external damage.

The safety rules to be followed during servicing of vehicle include:

(i) Always select appropriate tools for a specific job. An inapt tool could damage the part being worked on and could cause one to get hurt
(ii) Keep tools and equipment under control
(iii) Wipe excess oil and grease off hands and tools so that one can get a good grip on tools or parts
(iv) Work quietly and with full concentration
(v) Keep jack handles out of the way. Stand the creeper against the wall when not in use
(vi) Do not put sharp objects, such as screwdrivers, in one's pocket. One could cut oneself or get stabbed, or could damage the seat
(vii) Make sure that the technician's clothes are right for the job and one wears full leather safety shoes

(viii) If oil, grease, or any liquid spills on the floor, clean it up to avoid falls
(ix) Always wear eye protection when using a grinding wheel or welding equipment, or while working with chemicals, such as solvents
(x) While using a jack, place it properly to avoid slip
(xi) Never run an engine in a closed garage or service station that does not have proper ventilation system. The exhaust gases contain carbon monoxide, a colourless, odorless, tasteless poisonous gas that can be toxic

Service station equipment and tools

The following suggestions help in better maintenance of a vehicle, and must be observed in day-to-day life.

(i) Drive the vehicle with care every day
(ii) Be patient during the accident or breakdown of a vehicle, call helpline number of vehicle
(iii) Buy petrol from reputed and trustworthy service stations
(iv) Do not fill up fuel if your vehicle is parked around an oil tanker
(v) Car keychain should be light
(vi) Preserve the car during long-term storage
(vii) Clean the inside too
(viii) Clean dash gauges carefully
(ix) Preserve door and window seals
(x) Do not carry too much load
(xi) Use upholstery cleaners on soiled seats.
(xii) Place a towel under baby seats
(xiii) Protect car paint from the sun by parking it in a spot that is out of direct sunlight. You can also apply high-quality wax as it prevents sun damage to car paint from ultraviolet radiation
(xiv) Maintain proper tire inflation
(xv) Check for uneven wear
(xvi) Rotate your tyres
(xvii) Get wheel alignment checked
(xviii) Top off brake fluid
(xix) Care for anti-lock brakes
(xx) Check engine oil at every other fill-up
(xxi) Change oil frequently
(xxii) Do not mix coolants
(xxiii) Avoid hose hassles
(xxiv) Check drive-belt tension
(xxv) Clean your engine
(xxvi) Keep the AC functional, even occasionally during winters
(xxvii) Maintain your car's battery
(xxviii) Seal a leaky radiator
(xxix) Dilute your coolant

Car washing equipment

INTRODUCTION TO VEHICLE SERVICE PROCEDURE

The authorized automobile service centers adopt certain procedures during the service of a vehicle. In this session, we will discuss the common activities done in the service centre. One of the most important part is job card and its filling procedure.

Common Activities in the Workshop

(i) Job card and its filling procedure
(ii) Washing of vehicle and Washing Procedure
(iii) Engine minor tune up
(iv) Oil replacement
(v) Checking of battery — electrolyte level and top-up
(vi) Clutch and brake-free play and their adjustment
(vii) Lighting system, its various parts and their checking
(viii) Identification of greasing points of wheelers and procedure of greasing
(ix) Checking of tyre inflation and procedure of inflation

Job Card and Its Filling Procedure

When a vehicle owner enters the service centre, he or she is attended by the supervising engineer. The customer informs about the vehicle defect. After getting feedback from the vehicle owner or driver regarding defects of the vehicle, the supervising engineer in a service station or workshop inspects it. The defects pointed out or listed are noted down in a standard format, which is called the job card or work order.

In order to indicate his satisfaction with the diagnosis made by the supervising engineer, the customer of the vehicle signs the job card before the repairs on the vehicle are started. Work is then assigned to the concerned person to carry out repairs and the supervisor signs the job card too. The work order or job card is prepared in duplicate.

Car washing equipment

Automobile washing system include. mobile wash systems, pressure washer, conveyor, self-service equipment, chemicals (e.g. solutions for cleaning, wax, pre-soaks, etc.), dryers, vacuums, brushes, towels, pumps, and a water system and billing systems.

The mechanism inputs the wash PLU into a master computer or a tunnel controller automatically. When the sale is automated, after paying the car is put into a line-up called the stack or queue.

Steps for Washing Your Car

1. Park the vehicle in the shade.
2. Rinse the car to remove loose dirt.
3. Use two buckets, one for the cleaning solution and the other for clean water.
4. Start at the top, and work your way down. .

5. Rinse, and dry the car.
6. Feel the surface; consider using a clay bar if needed.
7. Wax your car.

A car wash (also written as "carwash") or auto wash is a facility used to clean the exterior and, in some cases, the interior of motor vehicles. Car washes can be self-serve, fully automated, or full-service with attendants who wash the vehicle.

The Four Types of Car Washes. When it comes to car washes, there are typically four main types available. Your choice is influenced by your access to water, time, and money. For instance if you have access to water, the time to wash your vehicle, and the money to do so, you're more ap t to hand-wash.

Types of Car Washes:

1. Hand washing

All detailing experts will tell you that hand washing is the safest method for washing your vehicle. Several different techniques fall into this category, including the conventional two-bucket wash to newer foam cannons that cover your vehicle in snow foam

. The Vehicle Labs says that regardless of the method you go with, all of them involve sudsing car shampoo and washing your vehicle with a microfiber towel or mitt and the best car wash brush

Hand washing is simply more effective than any other type of car wash. This is because it is successful in removing heavy contamination and while still being very gentle on your vehicle's finish.

Advantages

- Able to remove heavy particulates
- Reduced scratching

Disadvantages

- Costs more than an automatic wash
- Takes more time than other techniques
- Needs large amounts of water
- Hard to accomplish in colder climates

2. Waterless Car Wash

During a waterless wash, only two things are used. The first is waterless car wash that you apply to your vehicle with a spray bottle applicator, and the second is a handful of microfiber towels that you use to wipe your vehicle down with.

This form of car wash isn't very effective at getting rid of heavy debris and particles, and there is a good possibility of scratching, since you might pick up particles and drag them over the finish.

Advantages

- Water isn't necessary
- Achievable in a smaller space
- Quicker than hand washing

Disadvantages

- Unable to get rid of heavy contaminants
- Higher odds of scratching

3. Rinse less Washing

Don't confuse rinse less washing with waterless washing. There are similarities to a degree, but this is more of a mix of both waterless washing and hand washing. In this case, you mix a small bit of rinse less wash product into a bucket with water. You don't get any suds in doing this, but that's also why you won't have to rinse. All that you have to do is once you wash any area, wipe it dry with either microfiber towels or wash mitts.

Rinse less car washing is a favourite of anyone that doesn't have a lot of space or has to work within water restrictions. It might be a good choice for you if you are worried about scratching up your vehicle. This technique does carry a higher risk of scratching than hand washing does, but it's still safer than waterless washing.

Advantages

- Takes less time than hand washing
- Lower chances of scratching as compared to waterless washing
- Less water necessary than hand washing
- Can be done using limited space

Disadvantages

- Won't dissipate heavy contaminants
- Higher risk of scratching than hand washing

4. Automatic Washing

You might know automatic washing as 'tunnel' washing. They are often found at some gas stations but there are also independent car washes. Your vehicle goes through a conveyor belt that takes the car through a sequence of both brushes and blowers. These brushes are rough, and they typically contain a certain level of contamination.

Over time they pick up abrasive grime from the previous vehicles that can truly mess up your finish. Another thing they use is harsh cleaning chemicals which might dry your paint out or strip coatings and waxes. This can fade your colour or lead to cracking.

The big advantage to these is how cheap and convenient they are. That alone makes them the most common kind of car wash available.

Advantages

- Fast
- Cheap

Disadvantages

- Might miss heavy contaminants
- Harmful chemicals can hurt your finish
- A direct source of heavy scratching

Vehicle hoist

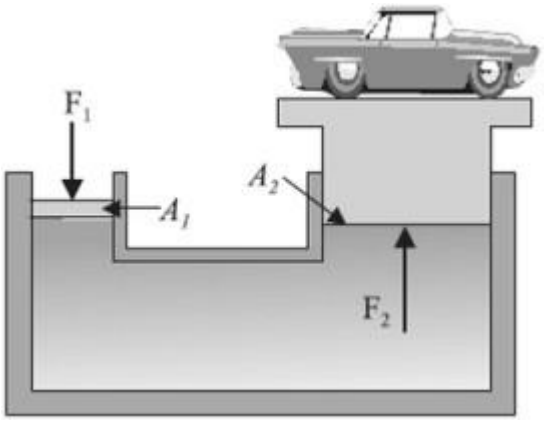
Hydraulic lifts work on a basic principle: to go up, a pump pushes oil into the cylinder, pushing the piston (which pushes the lift car) up. To go down, the valve opens and oil is allowed to flow back into the reservoir, and is pushed back using the gravitational force of the lift car.

A hydraulic lift is a device for moving objects using force created by pressure on a liquid inside a cylinder that moves a piston upward. Incompressible oil is pumped into the cylinder, which forces the piston upward. When a valve opens to release the oil, the piston lowers by gravitational force.

The Advantages of Hydraulic Lifts

- Hydraulic lifts are cheaper to install than other elevator types.
- They occupy less space in a building, requiring almost 10% less area for the lift shaft.
- They are highly effective with heavy loads, as the hydraulic power provides great lifting strength.

The most common base stock for modern hydraulic fluid is mineral oil, which is referred to as a Group I base oil. Other types of base stock may be required for specialty purposes and may include fluids such as propylene glycol or silicone oils.



One simple application is shown in the diagram above, the lifting of a car. If there is a relatively small force F1F1, pushing down on piston A1A1,
the pressure on the fluid is

$$p_1 = \frac{F_1}{A_1}$$

The pressure is transmitted via the **incompressible** fluid to the other piston A_2

$$p_1 = p_2$$

$$\frac{F_1}{A_1} = \frac{F_2}{A_2}$$

$$F_1 = \frac{A_1}{A_2} F_2$$

If the area A_2 is made much larger than that of A_1, the force F_1 is now 'multiplied' many folds. This force, F_2 can be used to lift very heavy objects such as cars.

Hydraulic press

In the hydraulic press, a small force applied to a small piston in a small cylinder is transmitted through a tube to a large cylinder, where it presses equally against all sides of the cylinder, including the large piston, which, in turn, produces a large compressive force upon a stationary anvil or base-plate. A pump is used to force the liquid into the cylinder.

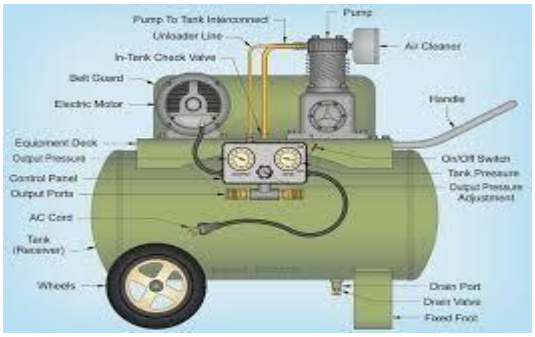
The hydraulic press is widely used in industry for forming metals and for other tasks where a large force is required. It is manufactured in a wide variety of styles and sizes and in capacities ranging from 10 KN or less to 100 KN or more.

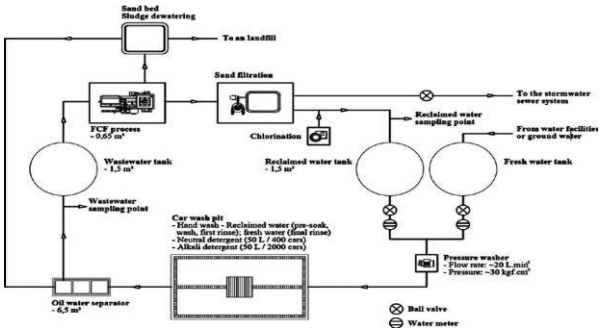
2.3. Air compressor

A compressor is a mechanical device that increases the pressure of a gas by reducing its volume. An air compressor is a specific type of gas compressor.

Compressors are similar to pumps: both increase the pressure on a fluid and both can transport the fluid through a pipe. As gases are compressible, the compressor also reduces the volume of a gas. Liquids are relatively incompressible; while some can be compressed, the main action of a pump is to pressurize and transport liquids.

Many compressors can be staged, that is, the fluid is compressed several times in steps or stages, to increase discharge pressure. Often, the second stage is physically smaller than the primary stage, to accommodate the already compressed gas without reducing its pressure. Each stage further compresses the gas and increases its pressure and also temperature (if inter cooling between stages is not used).





Lubrication equipment

Lubrication Equipments are used for timely lubrication of different parts of the machine. These systems ensure that each part of application on the machine is supplied with adequate lubricant, in order to facilitate its smooth & persistent performance.
Lubrication Tools & Equipment

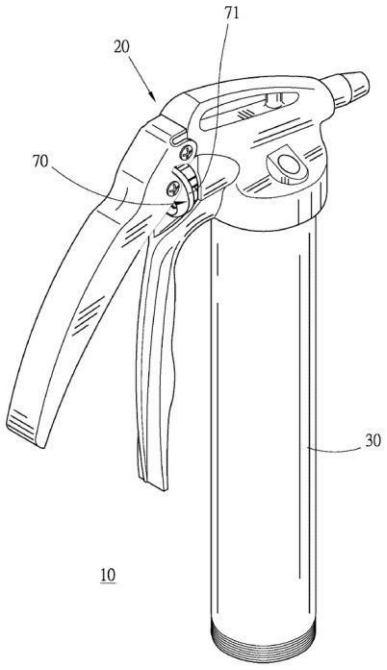
- Greasing Equipment.
- Oiling Equipment.
- Hose Reels.
- Waste Oil Handling.
- Specialty Pumps.
- Drum Handling.
- Air Line Accessories.

Grease guns

A grease gun is a common workshop and garage tool used for lubrication. The purpose of the grease gun is to apply lubricant through an aperture to a specific point, usually from a grease cartridge to a grease fitting or 'nipple'. The channels behind the grease nipple lead to where the lubrication is needed. The aperture may be of a type that fits closely with a receiving aperture on any number of mechanical devices. The close fitting of the apertures ensures that lubricant is applied only where needed. There are four types of grease gun:

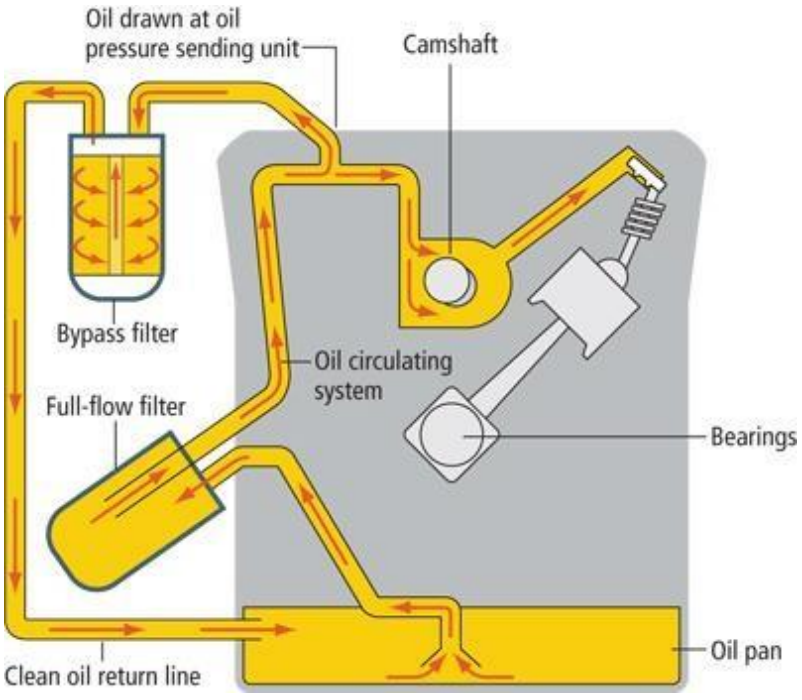
1. Hand-powered, where the grease is forced from the aperture by back-pressure built up by hand-cranking the trigger mechanism of the gun, which applies pressure to a spring mechanism behind the lubricant, thus forcing grease through the aperture.
2. Hand-powered, where there is no trigger mechanism, and the grease is forced through the aperture by the back-pressure built up by pushing on the butt of the grease gun, which slides a piston through the body of the tool, pumping grease out of the aperture.
3. Air-powered (pneumatic), where compressed air is directed to the gun by hoses, the air pressure serving to force the grease through the aperture. Russell Gray, inventor of the air-powered grease gun, founded Greco based on this invention.[*citation needed*]
4. Electric, where an electric motor drives a high pressure grease pump. These are often battery-powered for portability.

The grease gun is charged or loaded with any of the various types of lubricants, but usually a thicker heavier type of grease is used.



High pressure lubrication

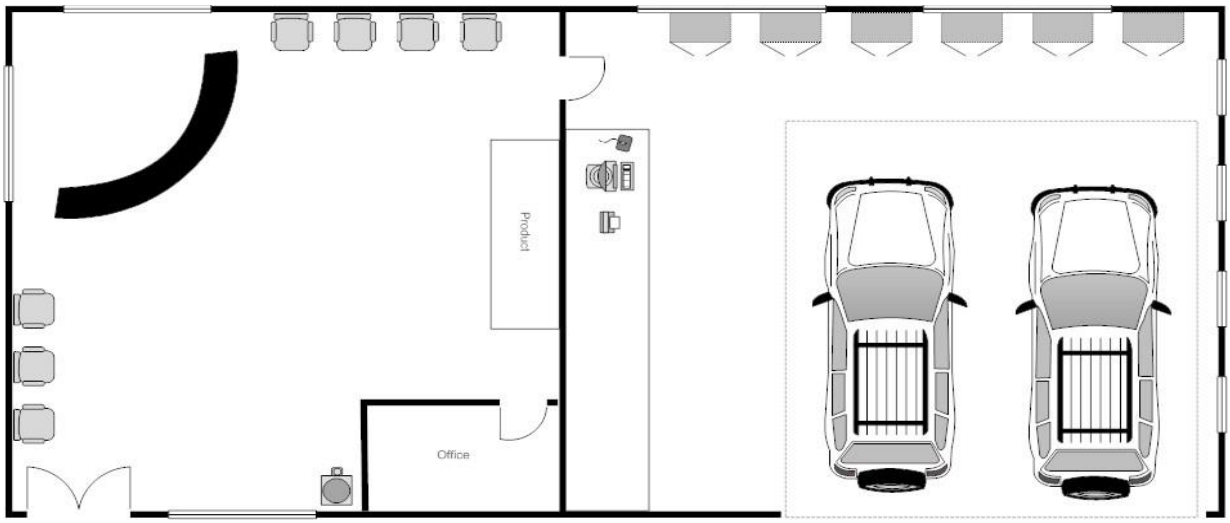
Extreme pressure additives, or EP additives, are additives for lubricants with a role to decrease wear of the parts of the gears exposed to very high pressures. They are also added to cutting fluids for machining of metals. The chemical reaction between the additives and the surface is confined to this area.



Pressure lubrication is a process where an oil pump precisely distributes oil to key areas of the pump. Typically, the oil is pumped through an oil filter and into the pump where it is then recycled and reused; using a replaceable oil filter can further improve the life of the oil.

Layout

Car Workshop Layout Workshop Design Showroom Design Shop Interior Design Garages Automotive Shops Automotive Furniture Garage Floor Plans



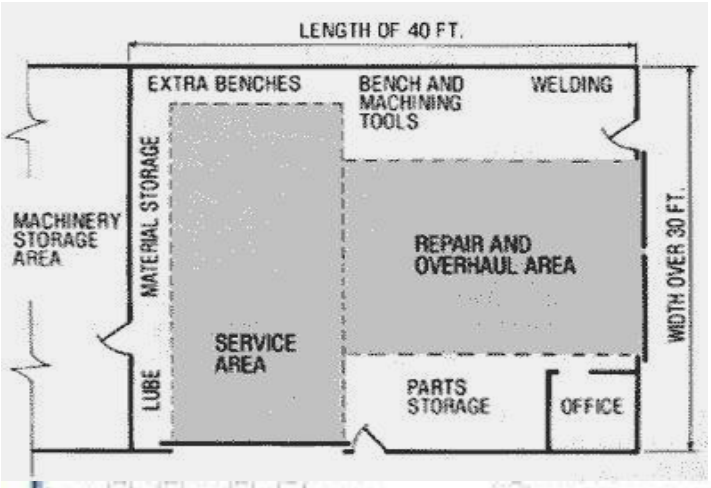
Tools and Equipment used in garage

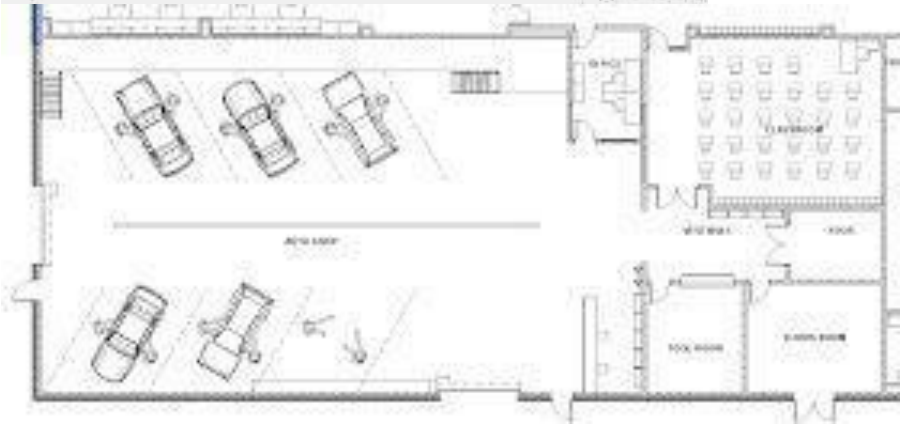
Tools and equipment used in garage

- Screw drivers.
- Spanners, wrenches etc.
- Pliers.
- Hammers.
- Chisels.
- Files.
- Hacksaw.
- Drilling machine
- Tape measure.
- Utility knife.
- Hammer(s)
- Screwdrivers (Phillips and flathead)
- Hex keys.
- Wrenches (crescent and socket)
- Saw(s)
- Pliers (needle nose and vice grip)

Garage Equipment: battery chargers, car jacks, car ramps. A comprehensive range of garage equipment is available at Machine Mart, including engine cranes, engine stands and trolley jacks..... Those looking for automotive hand tools, accessories or car mechanics looking for more heavy-duty workshop products are catered for.

Layout of Auto Garage





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Short answer question

1. Write the daily inspection of a vehicle.
2. Write the car washing equipment.
3. Write the various types of grease guns.
4. Write the tools used in garage.
5. Write the common activities in the workshop.

Long answer questions

1. Explain various types of car washes.
2. Explain working of vehicle hoist with neat diagram
3. Explain working of Air compressor with neat diagram
4. Draw the layout of auto garage.

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2. Maintenance and Servicing

Auto maintenance helps keep the ride running smoothly and can prevent costly repairs down the road. Maintenance is regular service that will help prolong the life of the vehicle, while auto repair is when a part or fluid is not performing and needs to be fixed

Automobiles need maintenance from time to time. Like humans are required to maintain hygiene, similarly automobiles also need to be kept clean. Automobiles have to run on dirty roads and in a polluted environment. They run on uneven roads with potholes and other obstructions, and are therefore subjected to loads which damage them. Therefore, there is a need for regular maintenance and servicing of automobiles, which is usually done in auto workshops or auto service stations.

Necessity and procedure for servicing and maintenance

(i) Topping of oil level
(ii) Proper tension of belt
(iii) Battery for cleanliness and level of electrolyte (add only distilled water for topping of electrolyte water)
(iv) Brakes
(v) Topping up of coolant, if required, in the coolant reservoir

Types of maintenance

- Preventive Maintenance.
- Condition-Based Maintenance.
- Predictive Maintenance.
- Corrective Maintenance.
- Predetermined Maintenance.
- Gaining Maintenance Knowledge with Interplay Learning.

Preventive maintenance

Preventive Maintenance is done before a failure occurs and consists of maintenance types like: Time Based Maintenance, Failure Finding Maintenance, Risk Based Maintenance, Condition Based Maintenance and Predictive Maintenance.

Preventive maintenance (or preventative maintenance) is basically a type of maintenance that is done at a regular interval while the equipment is still functioning with the objective of preventing failure or reducing the likelihood of failure.

Preventive maintenance can be time based i.e. every week, every month or every three months. But preventive maintenance can also be based on usage e.g. every 150 cycles, every 10,000hrs or like your car: service every 10,000km.Apart from the regular interval approach (time based maintenance) there are also other types of maintenance that fall within the category of preventive maintenance:

- Time Based Maintenance (TBM)
- Failure Finding Maintenance (FFM)
- Risk Based Maintenance (RBM)
- Condition Based Maintenance (CBM)
- Predictive Maintenance (PDM)

Importance of preventive maintenance

Preventive Maintenance is done before a failure occurs and consists of maintenance types like: Time Based Maintenance, Failure Finding Maintenance, Risk Based Maintenance, Condition Based Maintenance and Predictive Maintenance.

Corrective maintenance is done after a failure has occurred either as Deferred Corrective Maintenance or as Emergency Maintenance.

Brake down maintenance

Breakdown maintenance is maintenance performed on equipment that has broken down and is unusable. It is based on a breakdown maintenance trigger. It may be either planned or unplanned.

Advantages of breakdown maintenance

- Minimal planning is required.
- The process is very simple so it is easy to understand.
- Fewer staff are required as less work is done day-to-day.

Purpose of operation maintenance

Operations & Maintenance (O&M means the functions, duties and labor associated with the daily operations and normal repairs, replacement of parts and structural components, and other activities needed to preserve an asset so that it continues to provide acceptable services and achieves its expected life.
The purpose of maintenance is to ensure the maximum efficiency and availability of production equipment, utilities and related facilities at optimal cost and under satisfactory conditions of quality, safety and **protection** for the environment.

Quick service

- Make the wait less painful. Waiting areas, including those for quick-service customers
- Use quick service to boost overall customer satisfaction
- Turn service customers into vehicle buyers
- Bring customers back

Procedure for components cleaning

Cleaning processes include **solvent** cleaning; hot alkaline detergent cleaning, electro cleaning, and acid etch. The most common industrial test for cleanliness is the water break test, in which the surface is thoroughly rinsed and held vertical.

Regardless of what kind of engine work you do, cleaning the parts is almost always the first step in any job. Parts need to be cleaned before they are machined for four major reasons:

- It helps keep your shop equipment cleaner
- It uncovers the bare metal surface so you can see hairline cracks, and other flaws that may need repair
- It creates a clean surface that can be painted or left "as is" in the case of aluminum
- It helps remove accumulated dirt, grease, carbon, and corrosion from the parts

Cleaning is also one of the last steps you do after parts have been machined. It is necessary to remove the cutting lubricants, metal chips and/or grinding or honing debris from the parts. The final cleaning is particularly essential as anything that is not washed away can end up inside the engine. Residual shot blast media or metal chips that get stuck in a recess, or end up in an oil galley may find its way to the bearings.

How are Automotive Parts Cleaning Ovens Helpful?

Automotive parts cleaning has always been a complex process requiring special treatment and processing for components like engine blocks, brakes, and clutch parts. Specially, it is hard to keep parts, such as stators, rods, and crankshafts, free from rusting or coating. All these issues can be combated with the help of industrial cleaning burn off ovens. These ovens offer the following distinctive benefits:

- They are 100% pollution free.
- They reduce dependence on acids, chemical cleaners, solvents, and other such hazardous elements for cleaning purposes.
- They are environment friendly as they emit only odorless and harmless water vapors and carbon dioxide into the atmosphere.
- These equipment can clean multiple parts of an automotive system, such as brake components, engine blocks, clutch and cylinder heads, together at the same time.
- They come with the option of complete automation, which helps in saving labor costs.
- The ovens are completely safe and easy to operate.
- The fuel efficiency rate of

Greasing

Greasing Franklin suspension components is an important part of good auto maintenance. Many modern suspension components rely on grease to function properly, and to prevent wear. While much of a car's suspension is sealed with grease today and made so that you can't properly grease it yourself, there are still some areas of a vehicle's suspension that benefit from regular grease application. Vehicle owners looking to get the most out of their cars, trucks and SUVs should purchase a grease gun and regularly fill grease fittings with fresh grease, or they should hire a mechanic to keep up with regular maintenance, including filling those grease fittings.

Springs are often subject to high surface pressure, small movement or external influences.

Methods of lubricating spring

Springs. Spray down the garage torsion springs that lift your garage door day in and day out. Again, you want to only lubricate them enough that they move better, without a lot of extra lubricant dripping out.

- Lubricating greases.
- Lubricating oils.
- Lubricating pastes.
- Lubricating waxes.
- Lubricant sprays.
- Bonded coatings.
- Corrosion inhibitors.
- Process lubricants.

There are three methods of lubricating LM systems: manual greasing using a grease gun or manual pump, forced greasing with the aid of an automatic pump, and oil-bath lubrication. To achieve efficient lubrication, it is necessary to mount the grease nipple or the plumbing fixture ac- cording to the mounting orientation.

Engine tune-up

engine tune-ups include checking, diagnosing, and replacing bad spark plugs, spark plug wires, distributor caps, fuel filters, air filters, and oil filters. Tune-ups can also include checking emission levels, fuel lines, wiring, coolant hoses, and serpentine belts.

1. Changing spark plugs. Changing spark plugs is a great way to freshen **up** a motor. ...
2. Changing your air filter. The air intake filter can be one neglected item on any car. ...
3. Checking your distributor Cap and Wires. ...
4. Changing your oil. ...
5. Topping off fluids.

A major tune-up for electrical components consists of the replacement of all spark plugs, spark plug wires, distributor cap, rotor, and points and condenser, if applicable for an older vehicle. The mechanic will check the timing and adjust it to specifications.

Parts of engine tune up

- Air Filter. Driving in areas with heavy traffic requires you to replace air filters more frequently.
- Fluids.
- Oil and Oil Filter.
- Battery.
- Belts and Hoses.
- Windshield Wipers.
- Wheel Bearings and Alignments.
- Headlights, Tail lights, Break lights, and Blinkers.

Maintenance role in trouble shooting

Systems break down—that's just a fact of life. Whether it's a conveyer belt or an industrial drill, we've all run across a piece of equipment that is unresponsive, faulty, or acting abnormally for seemingly no reason at all. It can be downright frustrating.

Troubleshooting is the process of identifying what is wrong with these faulty systems when the problem is not immediately obvious. Troubleshooting usually follows a systematic, four-step approach; identify the problem, plan a response, test the solution, and resolve the problem. Steps one to three are often repeated multiple times before a resolution is reached.

This is often how the process happens when troubleshooting for maintenance, especially when a facility relies on paper records or Excel spreadsheets. The process is based on collecting as much information as possible from as many sources as possible to identify the most likely cause of the breakdown. You can never go wrong when you gather information, but it's the way that information is gathered that can turn troubleshooting from a necessity to a nightmare.

Advantages of good maintenance

- Less equipment downtime.
- Fewer interruptions to critical operations.
- Longer asset life.
- Improved efficiency (assets in good repair tend to operate better)
- Increased workplace safety and improved compliance with OSHA.
- Equipment downtime is decreased and the number of major repairs are reduced.
- Better conservation of assets and increased life expectancy of assets, thereby eliminating premature replacement of machinery and equipment.

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Short answer question

1. Write the necessity of maintenance of vehicle.
2. Write the types of maintenance.
3. Write the methods of lubrication of chassis.
4. What is the necessity of engine tune up?
5. Write the advantages of good maintenance.

Long answer questions

1. Explain various types of maintenance.
2. Write the procedure for cleaning of components of vehicle.

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3. Engine Maintenance

3.1 Introduction

One of the most important aspects of engine maintenance is keeping the fluids the engine requires clean and fresh. The engine is the heart of the car, and its fluids are its blood.
it's important to change an engine's oil regularly, and to make sure that change happens before the oil gets too dirty. Dirty oil in the engine is like dirty blood in your bloodstream.
Even small amounts of dirty buildup over time can lesson an engine's lifespan.
The engine's breathing also affects how long it lasts, because if an engine can't breathe well, it has to work a lot harder. A hot engine is also something you want to avoid -- the heat wears down vital engine components -- so make sure your engine's cooling system is working well, too.

Inspection of engine

A general engine inspection can detect potential problems before they occur, or current issues before they turn into major expenses. .... When you book a tune-up for your vehicle, the technician will inspect the following components: Spark plugs and wires to check for wear and proper performance.

Washing of an engine

Automobile engines attract and accumulate particles during its operation and these deposits could come in these forms: - water soluble deposits, organic soil, rust or scale. Effectively cleaning these deposits require the use of the most appropriate cleaning method, bearing in mind that cleaning takes a very significant part of the running budget of an automobile workshop.
The three widely applied cleaning methods are:

- Wet cleaning
- Abrasive blast cleaning
- Thermal cleaning

In most small automotive workshops, the wet cleaning method is mostly used.

Wet Cleaning;

Water/chemical solution cleaning: this cleaning method involves the application of water only, water and chemicals (acid or base) or chemicals (acid or base) only. The choice of wet cleaning method is dependent on the dirt in or on the engine.

In automobile engines, to clean soil, a chemical must wet the material and suspend the dirt so that it can be washed off. Dirt is a water soluble particle or material found on the part of an engine. On the other hand, organic soils which includes petroleum by-products, carbon, gasket sealers and paint and other products of combustion, cannot be effectively washed off with water, as a result of this introduction of a chemical is required. The introduced chemical makes the dirt soluble before they are washed off.

Chemical Cleaning of the Outer Part of an Engine
Cleaning with Alkaline
Alkaline materials are good cleaning materials for greasy surfaces and they work best when heated up. It should be noted that most automobile soaps are alkaline based and using soap and hot water effectively cleans greasy surfaces. Cleaning with bases: used on greasy parts

Cleaning with Acid

Acid materials are good for only cleaning rusts and scales. It does not clean grease; therefore, if rust is to be removed from a greasy surface, an alkaline agent is first used for the cleaning to remove the grease before acid is applied.

It is to be noted that alkaline materials do not remove rust and scale. 2 Scales are removed from the cooling system of an automotive using acid.

Cleaning with solvents

Solvents employed in engine cleaning come in three different types:

(i) Water Based
(ii) Mineral Spirits and
(iii) Chlorinated Hydrocarbon

Cleaning of the Inside Part of an Engine Some of the cleaning methods employed in washing off unwanted materials inside an engine are: (i) Chemical Cleaning (ii) Abrasive Cleaning and (iii) Thermal Cleaning

Chemical Cleaning: they involve the following:-

- Solvent cleaning
- Alkaline cleaning
    - Cleaning aluminum
    - Hot Soak Tanks
- Spray Washer: the use of hot spray jet

Abrasive blast cleaning

For engine parts to be cleaned with this method, they must be grease free. Two types of abrasive blasting are employed for cleaning various engine parts.

They are:-

- Shot: Which is round in shape and
- Grit: Which is sharp and angular

Different types of blast materials, which choice is subjected to the parts cleaning requirement, are used by engine rebuilders for cleaning engine parts. For cleaning in which the wear of the parts surface is a concern, steel shots and glass beads are used for cleaning such automotive parts. These shots and beads also come in sizes, and their applications vary. While smaller beads and shots are used for cleaning tight concerns and crevices (such as the threads or gear teeth), the large beads are used for loosening heavy deposits or cleaning flat surfaces. In situations where the engine parts are plastics or soft metals or when there is a chance of the shot getting trapped in the engine part or destroying an engine part or transmission, plastic chips are used.

For heavy-duty cleaning, grit is used and it makes use of blasting materials called media. They are mostly made of steel (steel grit) and aluminum oxide. As opposed to other blasting materials which have spherical shapes, the blasting material, “media”, has an angular shape and this makes it remove materials from the engine part surface during cleaning.

It gives a good part surface for preparation for painting. It is not widely used choice for cleaning.

BLASTERS these are machines used for cleaning engine parts in an automotive machine shop. They include the following:-

Glass Bead Blasters

This is a very effective method of removing carbon from an engine part and this machine is found in most automotive shops.

The disadvantage of the use of this machine is that it requires an operator and is labor intensive. Some of the time, glass bead blaster is used improperly. This could be the case in the following instances:-

- When used to clean parts that have oil galleries. This cleaning could leave blind spots¬ in oil channels/passages where beads could be lodged and are pulled out later by flowing engine oil when the engine is in operation
- Where it could get trapped in spot-welded locations in oil pans or valve covers.
- Where it could cause abrasive wear to engine parts especially those made of –aluminum.

Soda Blaster

This is a blast-cleaning method that involves the use of a baking powder as a cleaning medium. The soda material can only be used once (it cannot be reused).

Airless Blaster

This is a centrifugal blasting machine that uses an impeller to scatter steel shots in a sealed cabinet on the engine part. Shot blasting is widely used to clean ferrous parts like the engine top cylinder head, block and sometimes the connecting rod and crankshaft. This is the common used cleaning method amongst the three methods, because it is more environmentally friendly.

The cleaning process involves two stages:-

(i) the pre-cleaning of oil and grease on the engine part to be cleaned and
(ii) the removal of trapped shots before assembling the engine

Thermal cleaning:
This type of cleaning is employed in automotive workshops. It is a cleaning procedure in which a pyrolytic (high-temperature) oven heats oil and greasy, turning them into ash. Hard and dry deposits are left on the surface of the engine part and are removed by jet washing or shot blasting.

Convention Oven:
This type of oven is referred to as a flameless and insulated oven from the bottom. The parts in this system are not exposed to flame but they are gradually heated as the oven heats up. An advantage in the gradual heating of the parts is that there is a lesser chance of "Warpage".

The cleaning cycle usually last between 1 to 4 hours. Aluminum is cleaned at about 450 F (232 C) while ferrous metals are cleaned at about 700 F (371 C).

Open Flame Oven:-

In this setup, parts are mounted in a cage that avoids hot spots by slowly rotating the part directly over the flame. This set up makes cleaning of aluminum and ferrous metals together possible, because the temperature of air inside the oven is about 500 F (260) while the temperature of the flame is an average of about 1100 F (593 C).

After about 10 minutes of exposing the part or parts to the flame, the flame is turned off and a 20 minutes baking is allowed. Within 30 minutes, the total cleaning cycle is completed.

For thermal cleaning, the three processes are observed:- (i) Pre-cleaning, (ii) Baking and (iii) Post-cleaning

Shot blasting is mainly employed in post-cleaning because the cooling down of the baked parts is not required as opposed to jet washing which requires the parts to be cold before the process starts. One possible problem with jet washing during post-cleaning is that ash might find its way into the jet's nozzles.

Advantages of thermal cleaning are:-

- It is cheaper
- There are lesser hazardous wastes to dispose
- The inside of oil galleries are thoroughly cleaned
- Rust and scales are turned by the heating to powder
- Carbon deposits in the manifolds and combustion chambers are loosed.
- Warped cylinder head can be straightened
- Aluminum wielding is easier after open flame because the contaminants are thoroughly cleaned
- Stress raisers are removed from the part's surfaces by shot blasting

Other Cleaning Methods:-

- Vibratory parts cleaner
- Salt bath cleaning
- Ultrasonic cleaning

Vibratory parts cleaner:

This machine cleans the engine part by causing the beads covering the engine to vibrate thereby knocking off the deposits.

Salt bath cleaning methods are used in large and nonautomotive applications. This method is mostly used by large production engine rebuilders.

Ultrasonic cleaning is used commonly by jewellers and dentists. It is used for small parts cleaning by some rebuilders.

Manual Cleaning Methods Hand-held brushes are employed in cleaning engine parts like the top cylinder head, crankshaft, valve guides, oil galleries in engine blocks, etc. sandpaper or scotch bright can also be employed in cleaning engine parts manually or with the aid of power tools.

Small wire brush can be used to remove dirt and deposits from some engine parts surfaces by fixing/fitting them to electric or air drills. Other cleaning tools are:- the plastic abrasive disc, hand-held gasket scraper, special wire wheel, etc

Tuning of fuel system

During a tune up a technician may replace the air filter and the fuel filter. Both of these are critical for ensuring no contaminants from the gas or air make their way inside the engine. Unwanted debris could cause problems in the motor.

Engine tuning is the adjustment or modification of the internal combustion engine or Engine Control Unit (ECU) to yield optimal performance and increase the engine's power output, economy, or durability.

Tuning can include a wide variety of adjustments and modifications, such as the routine adjustment of the carburetor and ignition system to significant engine overhauls. Performance tuning of an engine can involve revising some of the design decisions taken during the development of the engine.

Setting the idle speed, air-fuel ratio, carburetor balance, spark plug and distributor point gaps, and ignition timing were regular maintenance tasks for older engines and are the final but essential steps in setting up a racing engine. On modern engines equipped with electronic ignition and fuel injection, some or all of these tasks are automated but they still require periodic calibration.

Tuning of Ignition system

In a spark ignition internal combustion engine, Ignition timing refers to the timing, relative to the current piston position and crankshaft angle, of the release of a spark in the combustion chamber near the end of the compression stroke.

The need for advancing (or retarding) the timing of the spark is because fuel does not completely burn the instant the spark fires. The combustion gases take a period of time to expand and the angular or rotational speed of the engine can lengthen or shorten the time frame in which the burning and expansion should occur. In a vast majority of cases, the angle will be described as a certain angle advanced *before top dead center* (BTDC). Advancing the spark BTDC means that the spark is energized prior to the point where the combustion chamber reaches its minimum size, since the purpose of the power stroke in the engine is to force the combustion chamber to expand. Sparks occurring after top dead center (ATDC) are usually counter-productive (producing wasted spark, back-fire, engine knock, etc.) unless there is need for a supplemental or continuing spark prior to the exhaust stroke.

Setting the correct ignition timing is crucial in the performance of an engine. Sparks occurring too soon or too late in the engine cycle are often responsible for excessive vibrations and even engine damage. The ignition timing affects many variables including engine longevity, fuel economy, and engine power. Many variables also affect what the 'best' timing is. Modern engines that are controlled in real time by an engine control unit use a computer to control the timing throughout the engine's RPM and load range. Older engines that use mechanical distributors rely on inertia (by using rotating weights and springs) and manifold vacuum in order to set the ignition timing throughout the engine's RPM and load range.

Early cars required the driver to adjust timing via controls according to driving conditions, but this is now automated.

There are many factors that influence proper ignition timing for a given engine. These include the timing of the intake valve(s) or fuel injector(s), the type of ignition system used, the type and condition of the spark plugs, the contents and impurities of the fuel, fuel temperature and pressure, engine speed and load, air and engine temperature, turbo boost pressure or intake air pressure, the components used in the ignition system, and the settings of the ignition system components. Usually, any major engine changes or upgrades will require a change to the ignition timing settings of the engine.

Tuning of lubricating system

With up to 70 percent of mechanical failure directly/indirectly attributed to ineffective lubrication practices, resource-type reliability is intrinsically linked to good lubrication practices (GLP).

1. Consolidate the lubricants
2. Contamination control
3. Filtration
4. Spill containment
5. Engineered lubricant delivery
6. Disposal program
7. Lubrication training

Tuning of cooling system

Most of the energy created from your vehicle's gasoline is converted to heat energy. Your engine produces large amounts of heat that must be controlled by your engine's cooling system. A cooling system keeps your vehicle's engine from overheating, but it also allows the engine to become hot very quickly and stay at a constant temperature. Engines are less efficient and more prone to pollution when they are cold. Cooling systems use fluid called antifreeze to control the engine's temperature. Engine coolants must be able to withstand temperatures below 0 degrees without freezing and above 250 degrees without boiling. Water is very capable of withstanding heat, but it also freezes at temperatures too high to be suited for your engine. Therefore, your vehicle uses a substance called ethylene glycol, which improves boiling and freezing points; ethylene glycol is mixed with water to control your engine's temperature. This substance is also called antifreeze. Antifreeze is typically 50% water and 50% ethylene glycol. It travels through the engine's pipes and passageways to absorb heat and cool the engine. It also contains rust and corrosion inhibitors as well as lubricants. A cooling system flush and fill is very simple. Your vehicle's old engine coolant/antifreeze is drained from the radiator, your cooling system is flushed, and new antifreeze is added to the radiator.

Tuning of Fasteners

Tuning-Type Fasteners provide a fast, efficient method of attaching radio and TV coil forms. This light-weight, multiple-function fasteners are easily snapped in place. Special tension fingers bear against the adjusting screw to assure vibration-resistant, fine tuning adjustment and trouble-free service.

Slug screw is first thread into the Tuning-Type Fastener. Sheared Tab provide prevailing torque on the screw.

Coil tube is inserted into the fastener and retained by four small barb on the inside of the fastener.

The assembly is then snapped into the chassis. A location tab on one leg of the Tuning-Type Fastener fits into a small hole in the panel to prevent turning of the fastener during adjustment or under vibration.

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Short answer question

1. Why engine maintenance is required?
2. Name the methods of engine cleaning.
3. Write the advantages of thermal cleaning.
4. What is meant by tuning in engine maintenance?
5. What is the necessity of tuning for fasteners?
6. Write the various steps involved in Tuning of lubrication system.

Long answer questions

1. Explain wet cleaning and chemical cleaning of engine parts.
2. Explain Abrasive blast cleaning method.
3. Explain thermal cleaning method.
4. Explain tuning of fuel system.
5. Explain tuning of Ignition system.

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4. Transmission system

Introduction transmission system

Vehicles need a transmission to transfer the power from the engine to the drive shaft and the differential to let the wheels turn. The transmission varies the torque, the speed and the direction by changing the transmission ratios and enables the car to start with a high torque. An automatic gearbox, or automatic transmission system, is a gearbox which, after switching on the gear, does not require manual switching.

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Maintenance of clutch

Clutches need periodic service and maintenance to avoid big problems and increase the lifespan of the vehicle. Even if it's not bundled in with auto transmission services, maintenance to be performed by a mechanic certified in transmissions.

Clutch adjustment and inspection typically takes about an hour, and includes checking and topping off the hydraulic fluid level. It should be performed according to the service schedule for your make and model. As with other automotive fluids, clutch hydraulic fluid should also be replaced at longer scheduled service intervals.

For clutches wear is most significant on the flywheel, pressure plate, and bearings. Here are some common signs that it's time for clutch repair service.

- Slipping — when there's not enough friction between the pressure plate and flywheel you'll experience jerks or slipping out of gear. You're likely to first notice it going up a steep grade, with a heavy load, and when towing. Most likely you have a worn out clutch.
- Sticking — even with the pedal to the floor you have difficulty shifting gear. That could mean a simple adjustment, or the need to replace the linkage or plate.
- Mushy Pedal — If the pedal feels soft there's probably air in the hydraulics that needs to be bled out. If the pedal feels loose or floppy that's probably a linkage issue.
- Odor — If you smell something like burning paper you need a clutch adjustment, and there may have been excessive wear.
- Sounds — grinding or grating sounds may also indicate the need for repair services.

For some vehicles slipping or sticking may mean a clutch cable repair or adjustment. Hydraulic issues may mean replacing seals and gaskets or perhaps replacing the master and/or slave cylinders. Other common repairs include resurfacing or replacing the flywheel.For the best reliability and lifetime, it's often best to replace all components together. A "clutch job" typically includes replacing the pressure plate, disk, and bearings (release, pilot, and/or throw-out bearings).

Clutch adjustment

The clutch is a critical component in the operation of manual transmission vehicles. The clutch allows the transmission to disengage from the engine, allowing the operator to change gears.

To work correctly, the clutch needs the right amount of free play in the linkage between the foot pedal and the clutch operating lever. If the amount of free play or clearance is low, it results in a slipping clutch. If there is too much free play, the clutch may be dragging.

Over time the clutch wears down and requires adjustments. The clutch free play must checked and adjusted at every 6,000 miles or as specified in the maker's service schedule.

Newer vehicles use a hydraulic clutch and slave cylinder that are self adjusting and do not require adjustments. Older vehicles use a clutch cable and clutch lever that require adjustments at regular service intervals to keep the clutch wearing evenly and in good working condition.

- **Warning**: Improper clutch adjustment can cause the clutch to slip or uneven wearing of the clutch. Ensure that you follow the manufacturer's specifications while adjusting the clutch and refer to the owner's manual of your vehicle for the right process.

Measure Clutch Pedal Free play

The first step in adjusting a clutch is to check the clutch pedal free play. This measurement will give you a baseline to go back to and you can then adjust the clutch pedal free play to fall in the manufacturer's specification range for your vehicle.

Materials Needed

- Block of wood to draw on
- Eye Protection
- Gloves
- Measuring tape
- Socket Set
- Wrench set

Step 1: Measure the clutch position. Set a block of wood down next to the clutch pedal. Mark the height of the clutch pedal without depressing it at all.

Step 2: Press the clutch and measure its position. Press the clutch pedal several times. Mark the height of the clutch pedal at the location where you feel the clutch engage.

- **Note**: You will need another person to depress the clutch pedal for you so that you can get an accurate measurement.

Step 3: Determine clutch pedal free play. Now that you have a measurement of the clutch pedal height when it is disengaged and engaged, you can use the measurements to determine the free play.

Calculate the free play by determining the difference between the two numbers obtained earlier. Once you know the free play, compare the number to the vehicles free play specifications given by the manufacturer.

Adjust the Clutch Cable

Step 1: Locate the clutch lever and the adjustment locations on the clutch cable. Depending on the vehicle, you may need to remove parts such as the battery and air box to gain access to the clutch cable.

Most vehicles will have a locknut and an adjuster nut. The first step is to loosen the locknut and adjuster nut slightly.

Next pull up on the clutch cable and make sure the locknut and adjuster can be turned by hand.

Step 2: Adjust the clutch lever. Now that the adjustment nut and locknut are loose, pull up on the clutch cable again.

You will feel a point where the clutch lever engages. This is where the clutch cable should be adjusted too.

While keeping constant pressure on the clutch cable, place the locknut and adjuster so the clutch lever engages fully and smoothly without have any over travel. This may take a few attempts to get the adjustment just right.

Tighten the clutch cable locknut and adjuster in place once you are happy with the placement.

Check clutch pedal free play

Step 1: Check the free play after adjustment. After the clutch cable has been adjusted, get back into the car to check the clutch feel and free play measurement again.

Depress the clutch several times and check the feel of the pedal. The clutch should engage smoothly. This will also seat the clutch cable fully after a few depressions.

Now measure the clutch pedal free play as outlined in part one. The free play should be within manufacturer's range specifications now. If it is not within specifications, you will need to adjust the cable again.

Step 2: Reinstall any parts removed. Put back any parts that were removed to gain access to the clutch cable.

Take the vehicle on a test drive once repairs are completed, to check for proper operation of the vehicle. Now that you have adjusted your clutch pedal, you can enjoy the smooth clutch while driving.

Lubricating of gear box

The three most common methods of lubricating a gearbox include;

Grease Lubrication

Grease lubrication is most suitable for gearboxes that are open or closed and operate at a low speed. The grease should have the right viscosity with sufficient fluidity, especially when used in an enclosed system.

However, it is crucial to note that grease lubricants do not provide cooling effects as efficiently as their oil counterparts. For this reason, they are not recommended for systems undergoing continuous operations and operate with heavier loads, even if they run at a slow speed.

For the best results and to ensure that gear teeth are adequately lubricated, the right amount of grease must be used. Applying too little grease will prevent an adequate lubrication film from forming, whereas excess grease will result in extreme power loss and add viscous drag.

Splash Lubrication

Oil splash lubrication is frequently used for helical, spur, and bevel gearboxes. This method is also known as an oil bath method because it utilizes a reservoir that is completely or partially filled with oil. The process works by dipping the gear teeth in the oil and then splashing that oil onto the other gears and bearing components meanwhile rotating at a tangential speed of at least 3 m/s.

Splash lubrication has some limitations, one of them being oil level. It is highly essential to monitor oil levels during this process because if the oil level is too high, there will be agitation loss. If the oil level is too low, there will not be enough lubrication, and the gears will not cool down. The former also creates a condition called churning in which the gears have to work extra hard to move through the lubricant.

Spray Lubrication

Spray lubrication, also known as forced oil lubrication, is most suitable for high-speed industrial gearboxes and includes techniques such as oil mist, oil spray, and oil drop. In the oil mist technique, oil is fragmentized into tiny vapors that saturate all parts of the gears and other internal components. Whereas, the oil spray method applies oil lubricant directly to the gears and other elements. However, this approach is not always useful, as high centrifugal forces influence the spray's direction.

Lastly, the oil drop technique takes lubricant from a reservoir via an internal piping system and pumps drops of oil directly onto the gear's surfaces and elements. This method is often combined with the splash or oil bath technique, where some parts may be challenging to reach via oil splash.

Setting of gear box:

A method of showing an engine's speed ratio is given in the figure. This is based on the assumption that engine revolutions should not fall below the speed of maximum torque. The point at which the top gear line crosses the maximum torque line is the point at which a gear change should be made. The change is indicated by a vertical line and the line drawn from b to the origin 0 represents the conditions after the change down. The process is repeated for the other ratios. The horizontal distance between the vertical lines increase in geometrical progression or approximately to this (depending upon whether modifications to some or all the calculate ratios has been made).

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Short answer question

1. What is transmission system?
2. Write the materials used to measure clutch pedal free play.
3. Write the methods to lubricate gear box.

Long answer questions

1. Explain the maintenance of clutch.
2. Explain procedure for clutch adjustment.
3. Explain the methods for lubrication of gear box.

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5. Maintenance of other supporting system

Steering maintenance

Maintenance of the steering system consists of regular inspection, lubrication, and adjusting components to compensate for wear. When inspecting the steering system, you will need someone to assist you by turning the steering wheel back and forth through the free play while you check the steering linkage and connections. You will also be able to determine if the steering mechanism is securely fastened to the frame. A slight amount of free play may seem insignificant, but if allowed to remain, the free play will quickly increase, resulting in poor steering control.

After prolonged use, steering components can fail. It is important that the steering system be kept in good working condition for obvious safety reasons. It is your job to find and correct any system malfunctions quickly and properly

Steering Linkage Service

Any area containing a ball-and-socket joint is subjected to extreme movements and dirt. The combination of these two will cause the ball- and-socket joint to wear. When your inspection finds worn steering linkage components, they must be replaced with new components. Two areas of concern are the idler arm and the tie-rod ends.

IDLER ARM SERVICE. - A worn idler arm causes play in the steering wheel. The front wheels, mostly the right wheel, can turn without causing movement of the steering wheel. This is a very common wear point in the steering linkage and should be checked carefully.

To check an idler arm for wear, grab the outer end of the arm (end opposite the frame) and force it up and down by hand. Note the amount of movement at the end of the arm and compare it to the manufacturer's specifications. Typically, an idler arm should NOT move up and down more than 1/4 inch.

The replacement of a worn idler arm is as follows:

Separate the outer end of the arm from the center link. A ball joint fork or puller can be used to force the idler arms joint from the center link.
With the outer end removed from the center link, unbolt and remove the idler arm from the frame.
Install the new idler arm in reverse order of removal. Make sure that all fasteners are torqued to manufacturer's specifications. Install a new cotter pin and bend it properly.

TIE-ROD END SERVICE. - A worn tie-rod end will also cause steering play. When movement is detected between the ball stud and the socket, replacement is necessary.

The replacement of a worn tie-rod end is as follows:

Separate the tie rod from the steering knuckle or center link. As with the idler arm, a ball joint fork or puller can be used.
With the tie rod removed from the steering knuckle or center link, measure tie-rod length. This will allow you to set the new tie rod at about the same length as the old one.

The alignment of the front wheel is altered when the length of the tie rod is changed.
Loosen and unscrew the tie-rod adjustment sleeve from the tie-rod end. Turn the new tie-rod end into the adjustment sleeve until it is the exact length of the old tie rod.
Install the tie-rod ball stud into the center link or steering knuckle. Tighten the fasteners to manufacturer's specifications. Install new cotter pins and bend correctly. Tighten the adjustment sleeve and check steering action.

Manual Steering System Service

Steering system service normally involves the adjusting or replacement of worn parts. Service is required when the worm shaft rotates back and forth without normal pitman arm shaft movement. This would indicate that there is play inside the gearbox. If excess clearance is NOT corrected after the adjustments, the steering gearbox must be replaced or rebuilt.

Inspection of steering linkage

The best times to inspect your steering and suspension include:

- Most car manufacturers recommend inspecting each system at every 50,000 miles
- Annually - regardless of miles - age deteriorates rubber and hydraulic parts
- When tires are replaced - worn parts can reduce tire life
- When your brake system is serviced
- When oil and filter is changed a visual inspection should be performed
- If you observe fluid leaking where you park
- Anytime your vehicle is in for routine service and the steering and suspension is accessible
- When you feel that your car exhibits any irregular control or handling characteristics

If your vehicle experiences any of the following symptoms, a mechanic should inspect your steering and suspension systems:

- Unusually bouncy or harsh ride
- Vibration at any speed
- Unusual noise in the front end of your car when going over bumps
- Unexpected noise when turning the steering wheel
- Steering wheel is no longer aligned straight
- Car drifts left or right when driving in a straight line
- Uneven tire wear
- You observe fluid leaks under the front of your car
- Car sways, feels loose or wanders when driving

The term “steering linkage” applies to the system of pivots and connecting parts placed between the steering gear and the steering arms attached to the front or rear wheels. The steering linkage transfers the motion of the steering gear output shaft to the steering arms that turn the wheels to maneuver and control vehicle direction.

Components used in the steering linkage depend on the type of steering gear used in the vehicle. There are basically two types of steering gears used today. The rack and pinion steering gear and a steering gear box with a Pitman arm. The vast majority of modern vehicles use a rack and pinion steering gear. A steering gear box with a Pitman arm is still used on some trucks and other heavier vehicles.

There are three basic types of steering linkages used in passenger vehicles and light trucks. These include the rack and pinion linkage, parallel linkage, and Haltenberg steering linkage. There are variations of these linkages, but these are the three fundamental types. The parallel and Haltenburg linkages are used with a steering gear box. The rack and pinion linkage is used with a rack and pinion steering gear.

The steering linkage, depending on which steering gear is used, may consist of the following components; outer tie-rod end, inner tie-rod end, tie-rod, steering knuckle/arm, pitman arm, center link, drag link, idler arm, and steering damper or stabilizer.

The rack and pinion linkage, which is by far the most common steering linkage, consists of inner and outer tie-rod ends on each side and steering knuckles or arms. Advantages of this linkage include precise steering geometry, simple design, and relatively low weight and cost. Disadvantages include relatively low carrying capacity and inflexibility when it comes to fitting around other vehicle components.

The parallel linkage consists of a pitman arm, idler arm, center link, tie-rods, tie-rod ends, steering knuckles or arms, and possibly a steering stabilizer.

Advantages of this linkage include precise geometry, high strength, and it can be designed to fit around other vehicle components. The main disadvantages are cost, relatively higher weight, and more components to wear out.

The Haltenberg linkage consists of a pitman arm, drag link, tie-rods, outer tie-rod ends, steering knuckles or arms, and possibly a steering stabilizer. Advantages of this linkage include very high strength, lower cost than parallel linkage, and can be designed to fit around other vehicle components. The main disadvantage is the steering geometry is not precise.

Steering linkage components can be either wear or non-wear components. If the component has a ball joint socket, it is considered a wear component. If the component does not have a ball joint socket but has a bore for the ball joint stud of another component to fit into, it is considered a non-wear component.

Typical wear components include the pitman arm, idler arm, inner tie-rod ends, and outer tie-rod ends. These components use a socket arrangement similar to a ball joint that allows the linkage to move side to side and up and down freely so steering effort does not interfere with the vehicle's suspension up-and-down motion as the wheels move over the road.

The ball joint socket used in steering linkage components may be either grease-able or lubed for life. Lubed-for-life joints are the most common type. However, it is important to note the life of a part is not necessarily the life of the vehicle. Without regular maintenance, the grease-able ball joint could fail more quickly than a lubed for life joint. In a way, the lubed for life joint was designed for those who are negligent of regular maintenance.

A steering stabilizer may be found on some steering linkages. The steering stabilizer is similar to a shock absorber. The component is connected from one of the steering linkage components to the chassis or frame of the vehicle. The steering stabilizer helps absorb road shock and prevents it from reaching the steering wheel.

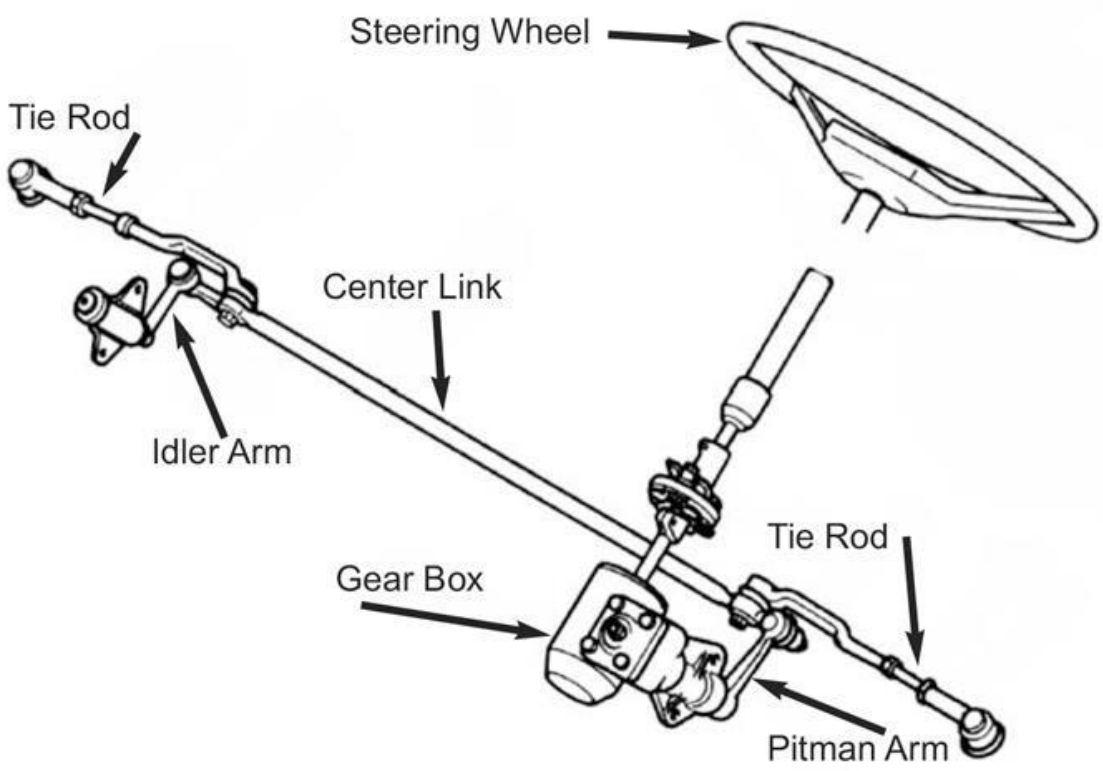
The steering linkage is adjustable to be able to vary the toe setting and perform an alignment on the vehicle. This is necessary to account for tolerance stack-ups in frame and suspension components, component wear, and impact damage such as potholes. Did you know the force from hitting a pothole can exceed several tons? This can damage the steering linkage and change the toe setting instantly. The toe setting affects vehicle handling, tire wear, and fuel economy.

Steering linkage components should be inspected for looseness, torn or deteriorated grease seal boots, and other damage. The steering linkage is the most critical part of the steering system because a worn linkage can not only cause excessive tire wear, it can also become a serious safety and liability issue. For this reason, it is important to have the entire steering linkage inspected at least annually by an ASE certified technician.

Manual steering

A manual steering rack uses a rack and pinion to turn the rotational movement of the steering wheel into the back-and-forth movement required to turn the wheels. The pinion is a round gear connected to the steering column; the pinion engages the rack, which is a flat bar with gear teeth cut into the top.

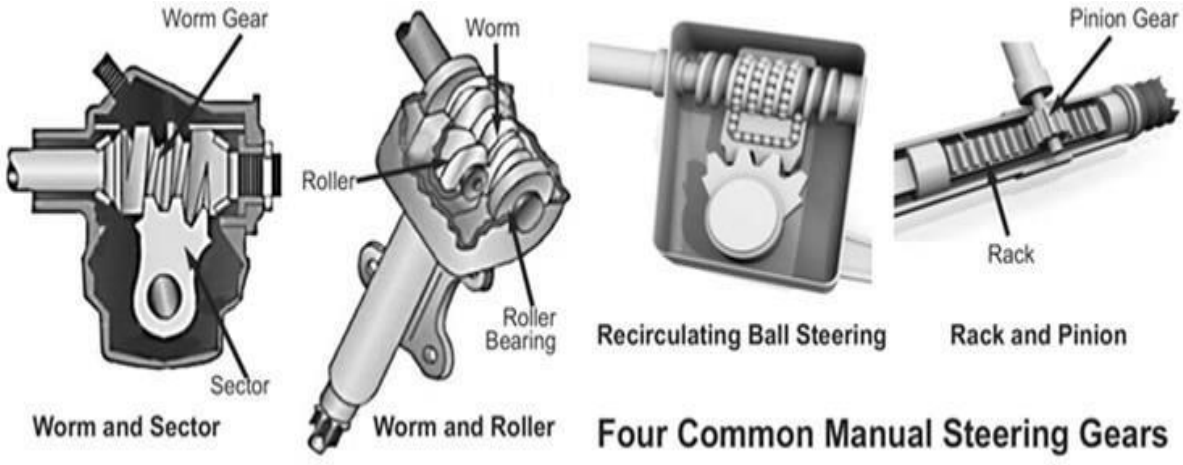
The steering gear mechanism allows the driver to turn the front wheels of the vehicle. This includes the steering wheel, steering gear box, pitman arm, drag link, tie rods, steering arms, and steering knuckles which support the wheels. Turning the steering wheel left or right turns the steering shaft to which a worm gear is attached within the gear box. The steering worm gear moves the sector gear, and this motion is transmitted to the pitman arm which moves fore and aft. A drag link connected to the pitman arm transmits this movement to the tie rods which are connected to the steering arms. The steering arms turn the steering knuckles and the wheels which are pivoted left or right on the front end suspension.



There are four common manual steering gears in use. The worm and sector, worm and roller, recirculating ball steering and the rack and pinion. In the worm and sector style the worm is connected at the end of the steering shaft. The sector is mounted on a sector shaft. The teeth of the worm mesh with the teeth of the sector. The friction value is very high in this design because most of the load is concentrated on the gears at their mesh point. The worm and roller is similar to the worm and sector type.

A toothed roller is mounted on a roller shaft, and a worm gear is mounted on the steering shaft. Gear teeth of the worm gear mesh with the roller, and motion is transmitted. The roller is mounted on a ball bearing. This bearing provided low friction as it took the load, and the roller distributed the wear more evenly. The recirculating ball steering offers extremely low friction and power loss. A ball nut on bearings is meshed with the worm gear and screws up and down relative to the movement of the worm. The rack and pinion steering consists of a pinion attached to the steering shaft which meshes with a flat rack. The pin-ion travels left or right on the rack to move the road wheels.

Steering linkage arrangements vary de-pending upon need and basic design. There are two basic types of steering control systems; those that have a pitman arm and a steering box, and those that use rack and pinion steering. The most common type of steering using a pitman arm is the parallelogram type. It uses two tie rods and a center link between the tie rods There is an idler arm on the passenger side and the pitman arm on the driver's side that attach to the center link. When the steering wheel is turned the center link transfers the movement to the steering arms and outer tie rods. All of the joints which mount these components use small ball joints to provide the freedom of movement. The two sides of the linkage run parallel to each other and are equal in distance thereby forming a parallelogram steering linkage. In the rack and pin-ion system the center rod is replaced with a steering rack which is a long, toothed bar with tie rods attached to each end. On the end of the steering shaft there is a pinion gear that meshes with the rack. When the steering wheel is turned, the pinion gear turns, and it moves the rack from left to right. Changing the size of the pinion gear changes the steering ratio.



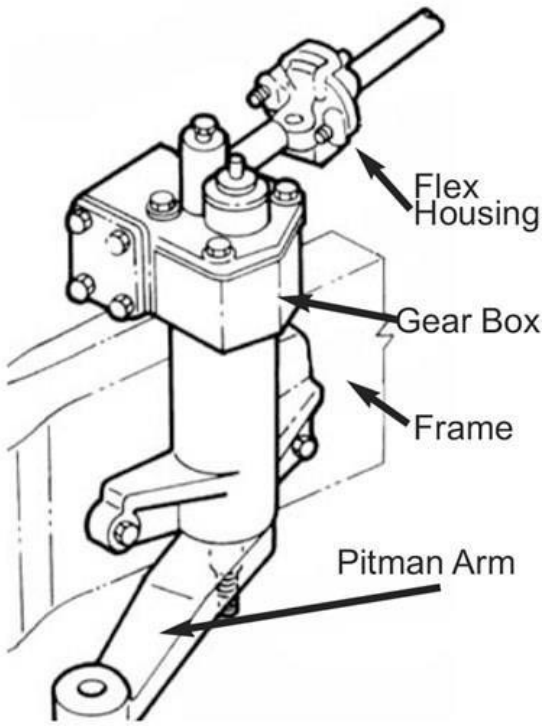
ROAD TEST

During the road test, listen for any unusual noises related to the suspension and steering. Check for steering problems such as: steering wander or drift, high steering effort and binding, excessive steering wheel free play, steering wheel return and front wheel shimmy. Back at the shop raise the front of the vehicle on safety stands.

Inspect for worn suspension parts and/or worn tires. Hard steering can be caused by damaged steering linkage, worn steering linkage, damaged spindles and bent steering arms causing incorrect turning angles. Front tire shimmy can be caused by tire imbalance and/or tire run out. Vehicle instability can be caused by driveline misalignment, drive-line imbalance or unequal weight distribution be-tween the wheels. Inspect the shock absorbers or struts for loose mounting bushings and bolts. Examine for leaks. Inspect the wheel bearings for lateral movement. Inspect the steering linkages and tie rod ends for wear (looseness). Inspect for loose steering gear mounting bolts, worn mounting brackets and bushings. Replace worn parts, and/or adjust front wheel bearings.

MANUAL STEERING GEAR

The gearbox is attached to the frame, and it can be directly connected to the steering shaft and wheel or by a U-joint/rag joint. Check for excessive free play (more than 1½ - 2") at the steering wheel. Check the steering shaft U-joint/rag joint for wear, if the steering gear is of this style. If they are worn, replace Gear Box them. Check that the pitman arm is Frame tight to the sector shaft. The steering wheel should start to move the pit-man arm within the approved range. If it doesn't, there is an adjustment at the gearbox to tighten up the free play. There are two adjustments: the worm bearing preload and the sector shaft mesh. Check lubricant level, and if it is low, check for a gasket leak, sector shaft seal leak or a cracked gearbox. To replace the seal the pitman arm has to be removed. If the gearbox is cracked, check with the local parts recycler.



REPLACING RAG JOINT

The rag joint is basically a vibration dampener. It keeps the chassis vibration from transferring through the steering column to the steering wheel. It can also correct a slight misalignment of the steering shaft and gearbox. Kits are available to replace the rag joint with a universal joint. Cover the left fender with a fender cover to prevent a belt buckle from mar-ring the paint fin-sh. To replace a rag joint remove the bolts that hold the coupler to the steering box and steering shaft. Loosen the steering column brackets so you can pull it back to remove the steering shaft from the coupler. Remove the coupler from the gearbox. Take the coupler to the auto parts store, and purchase a rebuild kit that includes new bolts and washers, if you want/need the experience of rebuilding, or go for a new coupler. Install the new or rebuilt rag joint in the vehicle. Excessive steering wheel free play is now corrected, if this was the problem. If not, the steering gear may need adjustment.

ADJUSTING WORM AND ROLLER

The worm and roller type of gearbox was introduced in 1926 and is still being used today. The Gemmer style worm and roller gears were a popular gearbox in Ford and Chrysler vehicles during the '30s and up to the early '60s, The roller rides on needle bearings and mounts on a shaft at the head of the sector. The rotating roller engages the worm, and there is much less friction than a worm and a fixed tooth design. Rolling friction is much smoother than sliding friction. Two Gemmer designs were popular. The 1937-52 Ford models used a two-tooth roller, and the 1953-60 models use a three-tooth roller which provides longer service life. There are several wear points, (the worm teeth and roller teeth and the upper and lower worm bushings), but they can be adjusted The sector shaft bushings and oil seal are replaceable.

ADJUSTING STEERING SHAFT BEARING PRELOAD

Sit in the driver's position, and check for steering shaft endplay by pulling/pushing on the steering wheel. If there is endplay, it must be adjusted out to set the bearing preload. Power wash the gearbox and pitman shaft area. Raise the front of the vehicle on safety stands. Remove the left front tire and wheel.

Disconnect the steering linkage (drag link) from the pitman arm. If the ball on the pitman arm is worn oval, replace the pitman arm. Move the pitman arm up/down and sideways. If there is movement here and oil is leaking past the oil seal, the bushings need to be replaced. If the sector shaft is worn in this area, you are taking on an expensive repair. If pitman arm movement is not excessive, you can try a new seal. The pitman arm has to be removed to install a new seal. Check the torque on the pit-man arm nut. It can range to over 200 foot pounds on some vehicles. Tight it must be.

Slide under the vehicle on a creeper, and locate the four bolts that hold the end cover in place. Find a container to catch any oil. Remove the bolts, and carefully separate the shims using a box cutter. You will find the metal shims are easier to separate then the paper ones. Remove one shim at a time by slitting the top edge of the shim, if the horn wire is in place. Retighten the bolts, and check for end play by turning the steering wheel full right and left. Repeat this procedure until there is no noticeable endplay. Retighten the bolts. If you have a spring scale, test the bearing preload. Attach the scale to the outside rim of the steering wheel. If the pull is less than 1½ pounds, remove a shim, and retest. If the pull is more than 1½ pounds, add the necessary shims until the bearing preload is set. The steering wheel must turn smoothly from left to right.

SETTING SECTOR SHAFT MESH

Loosen the sector shaft adjusting screw in the cover. With the steering wheel in center position, tighten the adjustment screw slightly. Do not over tighten. Check amount of steering wheel free play before the pitman arm moves. Steering wheel movement can be 1½ - 2", Use the spring scale on the steering wheel rim, and if there is more than 2½ pounds pull, loosen the adjustment screw slightly. The steering wheel should turn freely from one extreme to the other without binding or stiffness. When you are satisfied with steering wheel movement, tighten the locknut on the adjusting screw. If the wheel does not turn freely, the gearbox has to be rebuilt. Recheck with the spring scale, Reconnect the pitman arm to steering linkage. Turn the adjuster plug in until tight, and then back off to where you can fit the cotter pin. Lubricate the joint. Fill the gearbox with proper lubricant (90W hypoid gear oil). Replace the wheel and tire. Recheck the toe-in. Road test.

RECIRCULATING BALL-AND-NUT TYPE STEERING

Saginaw, a division of General Motors, pioneered this design. A ball rack carries the load, and friction forces are greatly reduced. The worm shaft has a groove machined into its surface. This precision groove is the inner half of a ball bearing race inside the ball nut rack. Another machined groove serves as the outer ball race. A set of ball bearings in guide tubes roll continuously around the shaft and ball nut. The ball bearing fit is precise. As the steering wheel rotates the worm shaft, the ball nut rack slides smoothly up and down the shaft. Teeth on the ball rack engage teeth on the inner end of the sector shaft. Although the sector teeth do not rotate, the ball nut load distributes evenly over the set of ball bearings. The result is a smoother, easier steering than the roller type gearbox.

The Saginaw recirculating ball-and-nut design is the best design to date for pitman type steering boxes, and vehicle manufacturer's have used this design into the 1990s for the durability and strength in the design.

Refer to the service manual for the type of recirculating ball nut steering used in the vehicle. Note whether the adjustment calls for dis-connecting the steering linkage. Check the level of gear lube. Gear lube can seep out. Clean the area around the filler plug before removing it. The level of the gear lube should be at the base of the plug threads in the housing. Fill with 90W hypoid gear lubricant. Some steering gears do not have a filler plug. Remove the bottom bolt on the gear cover, and fill through a top bolt until lubricant flows out of the bottom hole. Some manufacturers recommend a mix of cup grease and gear lube on higher mileage vehicles.

GEAR ADJUSTMENTS

There are two adjustments to make on a recirculating ball type steering. They are both end-play adjustments because steering gear mesh is almost eliminated by the recirculating ball bearings. Raise the front of the vehicle on safety stands. It is a good idea to disconnect the steering linkage at the pitman arm to set a proper adjustment. Do not turn the steering wheel to the far right and left extremes because you may damage the ball bearings. Locate the steering wheel about one turn from full left or right position. Back off the locknut on the pitman shaft, and loosen the adjuster a few turns counter clockwise to take the mesh load off the gears. Remove the horn button from the steering wheel.

Position yourself in the driver’s seat, and push/pull on the steering wheel to check for end-play in the steering shaft. If there is excessive endplay, the steering gear may have to be re-moved for service. Measure the worm bearing preload with an inch-pound torque wrench. Attach the torque wrench to the steering wheel nut. With the steering wheel off center, read the pull required to rotate the steering shaft 1½ turns either side of center. Refer to specifications. Pull should be between 5 to 8 inch pounds. If the bearing preload is not within specifications, ad-just as follows. Loosen the steering shaft bearing adjuster locknut, and tighten or back off the bearing adjuster to bring the bearing preload within specified limits. Tighten the steering shaft bearing adjuster locknut, and recheck the preload. Turn the steering wheel slowly to either stop. The wheel should turn freely without binding or roughness. If roughness is present, the worm bearings may need replacement. If the steering wheel binds, and the steering shaft does not have a flexible coupling, loosen the steering column support. Move the steering shaft into alignment. Tighten the steering shaft support.

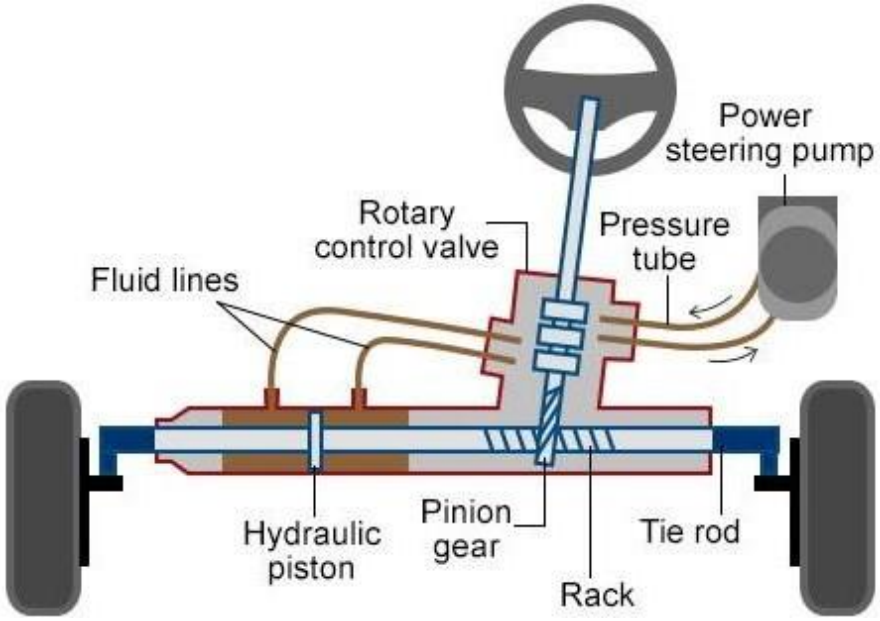
To adjust the pitman shaft end-play and mesh load adjustment rotate the steering wheel to center position. This places the worm and sec-tor gears in the center of their travel. Make sure the sector shaft cover bolts are tight. Using the inch pound torque wrench rotate the steering wheel back and forth through the center position.

Mesh load can be 4 to 10 inch pounds depending on the type of vehicle. To adjust, loosen the sec-tor shaft adjuster screw locknut. Move the sector shaft adjuster screw as required to obtain the correct reading. Tighten the locknut while holding the adjusting screw. There must be a slight amount of play between the sector gear teeth and the ball nut teeth in the extreme right or left turn position. Do NOT try to adjust it out because the over center adjustment will become too tight. Some manufacturers suggest using a spring scale on the rim of the steering wheel instead of a inch pound torque wrench on the steering wheel nut.

RACK AND PINION STEERING

A rack and pinion steering mechanism found its way to America on the early sports cars that were imported from England during the 1950s. A pinion gear attached to the steering shaft converts the rotational motion of the steering wheel to the lateral motion of the rack. It was a simple design which meant it was cheaper to build. When the local manufacturers started to build compact front wheel drive econoboxes the rack and pinion became the choice for steering because they were lighter which meant better gas mileage. There was no need for idler arms, center links, tie rods or pitman arms. The rack and pinion is less efficient than the recirculating ball type, but there is less backlash, and it provides a better steering 'feel' and better overall handling. Rack and pinion steering is now the most popular choice for vehicle manufacturers.

Power steering Hydraulic power steering systems work by using a hydraulic system to multiply force applied to the steering wheel inputs to the vehicle's steered (usually front) road wheels. The hydraulic pressure typically comes from a gerotor or rotary vane pump driven by the vehicle's engine There are three basic types of power steering systems found in vehicles: the hydraulic power steering (HPS), the electric power hydraulic steering (EPHS), and the fully electric power steering (EPS). Electric and electronic power steering both refer to the same system.



Steering system adjustment

The first adjustment is the input shaft/worm gear thrust bearing preload. The manufacturer's procedure will typically center the stub shaft before adjusting the sector shaft. Loosen the lock nut and turn the adjustment screw in to decrease the lash and remove any looseness in the wheel.

Maintenance of brakes

- Check **Brake Pads** and Rotors. The **brake pads** and rotors are the point of contact between your braking system and your tires.

- Flush Your **Brake Fluid**.
- Bleed the Brake Lines
- Replace or Upgrade Brake Parts.
- Braking System Care
-

How to take care of your brakes

1. Have your brake and brake pads checked once per year.
2. Check your brake fluid regularly.
3. Listen and watch for warning signs.
4. While driving, try coasting to slow down before applying brakes whenever possible.
5. Avoid braking when cars ahead of you brake unnecessarily.
6. Invest in good, reliable brakes.

Brakes overhauling and adjust

If brakes are not serviced when it comes time to do so, and the owner continues to drive the vehicle while there are issues with the brakes, then the chance of having an accident can increase or at the very least it can make for an unpleasant ride that consists of annoying vibrations when breaking and loud screeching sounds. On the other hand, having the brakes serviced as soon as signs of bad brakes are present can make for a pleasant ride and allow you to better trust the vehicle's performance while on the road.

Also, the sooner brake parts are replaced, the less expensive the service is likely to be. In many cases when servicing the brakes on time, all that needs replacement is the brake pads, whereas a vehicle driven with worn brake pads may require the brake pads, rotors and various other parts to need replacement as well.

Of course, it is essential to gain a better understanding of what bad brakes look like to know when it is time to have them serviced, and we are here to help you do exactly that.

Start with the master cylinder. Before opening it up clean the exterior with mineral spirits, then with soap and water. Dry it off and then remove the cover, pushrod, any seals and bleed screws. Then, following your shop manual, remove the inner piston (or pistons, if a dual cylinder). Clean out the interior of the cylinder with soap and water or alcohol. If it's caked-up with brown sludge, remove it with wooden or plastic items (such as chop sticks) so there's no chance of scratching the walls.

Next, shine a bright light into the cylinder and look for rust, major scratches and pitting. Pitting is the result of oxidation and it leaves the inside surface looking a little like the surface of the Moon. How deeply it is pitted will determine whether the cylinder can be honed out, re-sleeved or thrown away.

Brake Diagnostics

The first step towards better brakes is to bring your vehicle in to have the brakes examined by a professional mechanic. Once at the repair shop, they will inspect the entire brake system, which includes the anti-lock braking system(ABS). After a thorough examination, in addition to considering the problems the driver has been experiencing, the mechanic should be able to decide on what is needed to fix the issue.

Brake Pad Replacement

One of the more common tasks performed during auto brake repair is the replacement of the brake pads, which are steel plates that provide friction that slows the vehicle down. The brake pads, which are one of the main components of the brakes, is incredibly important. In many instances, the brake pads are the first to become worn, and they are often the first thing a mechanic is likely to check.

How To Service Your Brake Rotors

The rotors - otherwise referred to as the brake disks - are what the brake pads place pressure on to stop the vehicle, and maintaining the condition of the rotors is just as important as the brake pads. Here at Action Jackson Auto, we check the rotors during an auto brake repair inspection. In some instances, the brake pads may need replacement while the rotors are still in good condition. In other cases, both the brake pads and rotors might need replacement.

Noise Control

Everyone has probably heard the annoying sound of squeaky breaks, whether it has come from your vehicle or others around you. In some instances, the noise may be a separate issue than a problem with the brake pads or rotors, and some things can be done to eliminate the noise. Whether it is replacing the brake pads or changing the brake fluid, servicing your brakes is a great way to control how noisy your breaks are.

How To Test The Brakes

The last thing an auto repair shop should do during auto brake repair is the test the brakes and make sure they are working as they should. A short drive should be all that is needed to ensure the issue was resolved. In the event the problem with the brakes continues, they can fix the issue and make sure the vehicle returns to the owner in excellent condition.

Precaution during servicing of

5 Basic Precautions for Repairing Hydraulic Brakes

- Use the correct set of tools and safe working practices.
- Be sure about the signs that tell you your car brakes need a fix or replacement.
- Check the brake fluid before doing anything.
- Choose the replacement parts wisely.
- Test multiple times after repairing

Hydraulic brakes

1. Remove Brake Fluid. You should drain out some of the brake fluid from your vehicle before beginning the pad replacement work.
2. Clean the Hardware. You should not simply remove your old brake pads and slap the replacement components into position during the repair process.
3. Replace the Rotor.
4. Lubricate Guide Pins

Mechanical brakes

1. The springs used on a drum brake system are under high pressure during removal or installation. Always use the correct tools for maximum safety.

2. When bleeding the brakes, brake fluid must be forced out of the hydraulic system, along with the air. to eliminate the possibility of spilling the fluid, use a hose connected from the bleeding valve to a canister to catch excess brake fluid.

3. Brake fluid is considered a toxic fluid. Always use rubber gloves so that the brake fluid does not get on your hands. If so, wash with soap and water immediately. Brake fluid can be absorbed into the skin. If a skin rash occurs, see a doctor immediately. Note that brake fluid will also cause certain paints to dissolve and be damaged.

4. Be careful not to breathe the dust particles left in a drum brake assembly when removing the brakes. The dust may contain asbestos, which can seriously injure your lungs and cause illness.

5. At times the brake pads or shoes may drag on the rotor or drum during driving. The friction causes the brake assembly to become very hot. Be careful not to burn your hands when servicing brake systems after running the street rod.

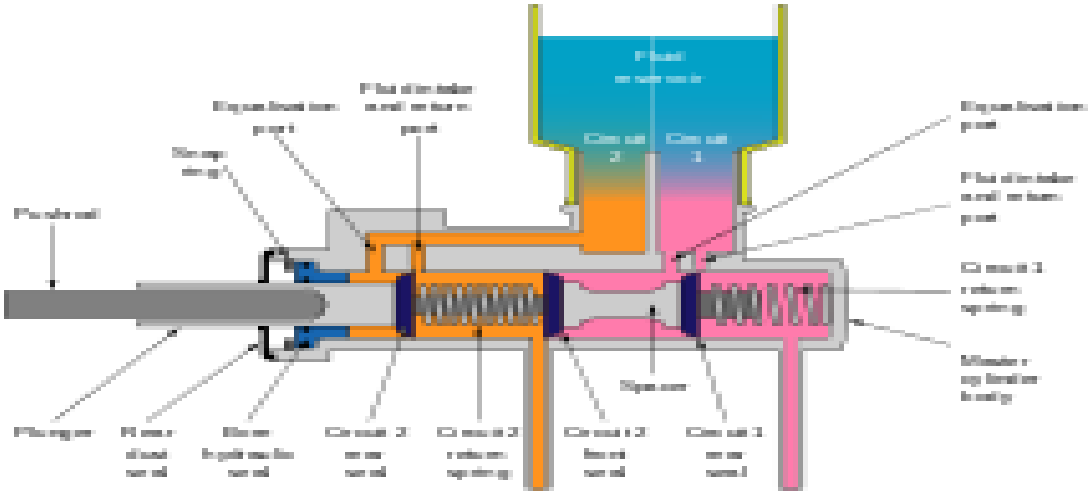
6. When removing a tire from its rim, remember to use the proper tools and procedure. There is high pressure on the tire sides and this pressure could cause serious injury during removal and installation.

7. When a tire is being inflated after it has been replaced on the rim, the bead will often pop into place. Keep your fingers away from the bead during inflation.

8. Be careful when handling a tire that has shredded during high speeds along a highway. There may be sharp metal wires protruding from inside the bead which could cut your hands.

Overhauling of master cylinder

Step 1: Remove the **master cylinder**.
Step 2: Remove the rubber boot.
Step 3: Remove the circlip.
Step 4: Take out the piston and spring.
Step 5: Check and clean the **cylinder**. ...
Step 6: Fit the new seals to the new piston.
Step 7: Fit the new spring



To remove the brake master cylinder, use the line wrench to loosen the brake lines and remove them. This tool will do a better job than a regular wrench. When you've done that, locate the bolts holding the master cylinder to the body of the vehicle. You'll need to use your socket wrench to loosen and remove these.

The most common necessary brake master cylinder repair is fixing a leak in the seals. This is typically a brake master cylinder repair that will become necessary after a few years when the seals wear out. It's not a difficult repair, although the details might vary depending on the make and model of your vehicle.

Step 1 - Prepare

Park your car on a flat surface. Make sure the vehicle is in park with the emergency brake on. Spread layers of old newspaper under the engine to catch any brake fluid that drips. Use a brake fluid removal tool to take out the fluid from the reservoir until it is empty. At this point, you're ready to actually begin your brake master cylinder repair. Unclip the sensor from the reservoir.

Step 2 - Remove the Master Cylinder

To remove the brake master cylinder, use the line wrench to loosen the brake lines and remove them. This tool will do a better job than a regular wrench. When you've done that, locate the bolts holding the master cylinder to the body of the vehicle.

You'll need to use your socket wrench to loosen and remove these. Lift the master cylinder out of the car, and plug the holes for the brake lines with clean cloths.

Step 3 - Disassemble

Take the brake master cylinder to your workbench for the rest of the brake master cylinder repair. You're going to need to remove the reservoir from the top of the cylinder first. For this you'll need to just snap it off with a screwdriver. Now, look at the rear of the master cylinder. You'll see a lock ring that keeps the pistons in place. Remove this with snap ring pliers. After that, take out the retaining ring that keeps the valve from the reservoir in place and remove the valve.

To access the pistons, valve assemblies and the seals for the brake master cylinder repair, tap the cylinder on your workbench and they will slide out. Keep them safe along with all the springs.

Step 4 - Assemble

Find the correct seals in the brake master cylinder kit. Replace them in the pistons, and carefully reassemble the pistons in the master cylinder, ensuring you put all the parts fit in correctly. Replace the retaining ring and then the lock ring before snapping the reservoir into place and putting the lock ring into place.

Now, sit the brake master cylinder back in place in the engine and replace the bolts to hold it firmly to the vehicle body. Reattach the brake lines and fill the master cylinder with brake fluid.

Step 5 - Bleed the Brakes

You haven't finished your brake master cylinder repair yet. The most important step is to bleed the brakes so they'll work well. You'll need help to do this properly, as you operate the brakes and someone else opens and closes the bleeder valves on each wheel until there's no more air in the system and the fluid is clear. After that, you'll fill up the reservoir again and check if the brake pedal operates normally before driving the vehicle.

5. 2.4. Process of removing trapped air

1. Begin at the corner furthest from the driver and proceed in order toward the driver. ...
2. Locate the bleeder screw at the rear of the caliper body (or drum **brake** wheel cylinder.) ...
3. Place the box-end wrench over the bleeder screw. ...
4. Place one end of the **clear** plastic hose over the nipple of the bleeder screw.

5.2.5. Process for servicing

1. Disc brake

The basic steps for disc brake service are as follows:

- Siphon two thirds of the brake fluid from the master cylinder. ...
- Remove the caliper guide pins that hold the caliper to the adapter. ...
- Lift the caliper off the adapter and away from the rotor. ...
- Remove old pads from the caliper and adapter

2. Parking brake

The service of this style of parking brake is similar to the service of a drum style rear brake assembly. A vehicle equipped with a parking brake mechanism integrated into the rear brake caliper is serviced with the replacement of the rear brake pads.

Typically, your brake warning light being on means your parking brake is engaged, but if you're still seeing the red (or orange) warning on your dash while the parking brake is disengaged, you're going to need to get your brakes inspected as soon as possible

Maintenance of suspension system

The sensible schedule for suspension maintenance: Every 1,000 to 3,000 miles, check tire inflation and check tread depth. At every oil change, check the power steering fluid; top off if necessary. ... Every 15,000 miles or at every alignment, check all suspension components for wear.

1. Clean Your Fork and Shock After Every Ride. Completely clean your fork and rear shock after each and every ride. ...
2. Turn Your Bike Upside Down. You can also turn your bike upside down now and then for about 20 minutes at a time. ...
3. Install a Mudguard. ...
4. Inspect Your Stanchions Regularly

Service and repair of leaf springs

They are installed on the front or rear axle of a vehicle and work by providing additional support that helps relieve the pressure placed on the axle by extra weight. In addition to supporting extra weight, leaf springs help keep tires in alignment and absorb shock resulting from driving over potholes, bumps and rough roads.

Work the brush vigorously along the sides of the spring, the under and upper surfaces and around any clips that may be fitted to hold the leaves together. Afterwards, wipe it clean with a rag. After cleaning the springs, lubricate them lightly with silicone lubricant, replace both wheels and their wheel nuts.

The frequency of leaf spring and coil spring repair or replacement can vary based on a number of factors. By conducting frequent inspections and scheduling service when needed, you can help keep your truck or trailer's suspension system and leaf springs in top condition.

Leaf spring repair is a multi-step process that can be difficult, especially if you don't have access to the appropriate equipment. Steps include jacking your truck, then safely removing the surrounding items before finally removing the springs. The repair process can be more complicated and even dangerous for semis and other large vehicles.

Having a repair shop replace your leaf springs can ensure that the correct spring is installed safely for your vehicle and load capacity. Installing the incorrect spring can result in premature wear that impacts the life expectancy of leaf springs and leads to more frequent replacement of the leaf springs and other suspension components.

Most leaf springs will last for several years, but factors such as cargo load and exposure to the elements can cause extra strain or corrosion that may increase the frequency at which they need to be replaced.

The signs that your leaf springs need repair or replacement occur while you are driving and can include one or more of the following symptoms:

- Difficulty steering or vehicle pulling to one side as you drive
- Feeling even small bumps as you drive down the road
- Your truck nose dives, leans back or rolls with momentum

Leaf spring bushings work in conjunction with leaf springs and other suspension system components to provide the support that gives your truck a smooth ride and proper handling. Like leaf springs, they help absorb shock and pressure caused by flexing leaf and coil springs, and will need to be replaced once they wear out.

The symptoms of bad leaf spring bushings also include feeling every bump on the road, your truck pulling to one side or diving or leaning with momentum. If you notice any of these symptoms you should have your leaf spring bushings immediately inspected by a leaf spring repair shop.

Because some of these signs might be quite subtle at first, it's always a good idea to have your leaf springs, leaf spring bushings, and other suspension components inspected on a regular basis, especially if you drive a semi or other truck that frequently hauls heavy loads.

IS IT SAFE TO DRIVE ON A BROKEN LEAF SPRING?

A broken leaf spring or leaf spring separation can both occur because of fatigue from general wear or overloading. If one of your leaf springs breaks or becomes separated, it's important to get your truck or trailer into a repair shop as soon as possible. If the broken leaf spring is not positioned on the rear axle, it may be safe to drive for a short distance, such as to your home or a nearby leaf spring repair shop.

Make sure you drive slowly and do not quickly swerve or make sharp turns, as your vehicle steering won't handle as it normally would, and your tires could lose their grip on the road. Driving with a broken leaf spring shackle or on damaged or fatigued leaf springs not only causes damage to your other suspension components but can be dangerous for you and other drivers.

WHAT CAUSES LEAF SPRINGS TO FAIL?

The life expectancy of leaf springs can vary depending on road conditions, how often you haul and the weight of the loads you are hauling. There are several factors that cause leaf springs to fail over a period of time. Some of the most common causes of leaf spring failure include:

LOOSE U-BOLTS

The U-bolts that attach leaf springs to the axle housing can become loose over time or issues can occur when the U-bolts are not tightened enough during installation. You can help prevent problems by checking your U-bolts every 500 or so miles to make sure they haven't loosened.

CORROSION FROM ROAD SALT AND GENERAL WEAR

Over time, leaf springs can corrode or become fatigued. The cause of fatigue is often a combination of exposure to elements and normal wear-and-tear from hauling heavy loads. The time it takes for leaf springs to corrode or fatigue varies depending on the type of weather you typically drive in, the frequency of your hauling, and the weight of your loads. You can help extend the life of your leaf springs by regularly washing your truck parts in the winter months and maintaining appropriate load sizes for your truck.

OVERLOADING YOUR TRUCK OR SEMI OR TRAILER

Overloading your vehicle or carrying uneven loads can also affect the life of your leaf springs. Always carry loads that are appropriate for your truck or trailer type to help prevent excess wear on your springs, or upgrade to leaf springs that can handle a higher load capacity. When attaching or welding accessories to the body of your truck or semi, be aware of weld splatter, which can cause damage to leaf springs. It is also important that you never attempt to weld on a leaf spring.

HOW TO CLEAN LEAF SPRINGS ON YOUR TRUCK

One thing you can do to extend the life expectancy of leaf springs is to regularly clean them. Cleaning leaf springs helps remove debris and grime that gets stuck between the leaves, preventing excess wear and corrosion. Leaf springs typically become caked with grease and grime, so cleaning them will require a wire bristle brush and a spray-able degreasing fluid. You will also need to wear gloves and goggles to provide protection from debris and cleaning agents.

To clean the springs, lightly spray degreasing fluid and scrub with the brush until all debris is removed. If there isn't a lot of debris to begin with, you can simply use the wire brush. As you are cleaning, inspect the springs for cracking, chipping or other signs of wear. After the leaf springs are clean you can apply a silicone lubricant, though this is not necessary.

Leaf spring cleaning requires jacking your tuck and removing the tires and axle stands to access the springs. If you do not have the appropriate equipment to safely perform the cleaning yourself, this service can easily be done at your local leaf spring repair shop. If you have additional questions abut leaf spring care, you can also contact your leaf spring manufacturer.

WHAT MATERIAL ARE LEAF SPRINGS MADE OUT OF?

Multi-leaf springs are constructed using several thin, carbon steel plates cut into sequential lengths. To create the spring, the steel plates are clamped together and formed into an arc shape. After being formed, the suspension leaf spring is heat treated to harden the steel, which increases its strength and load capacity.

Replacement of strut /shock absorber

Struts don't need to be replaced unless your vehicle is bouncing like it's on a pogo stick or bottoms out in potholes and over railroad tracks or unless a mechanic finds that they're leaking fluid or have been damaged. In some climates, they can also rust.

Shocks or struts are to be replaced because of the following reasons.

1. Bumpy ride

The most obvious sign of a problem with your shocks or struts is that your car is giving you a much more uncomfortable ride than normal. You'll feel bumps more, so the ride will feel rough. If you feel like you're about to lose control of your car when you drive over a bump or pothole, it's likely your shocks or struts need to be checked out.

2. Steering problems

Another telltale sign of a shock or strut problem is difficulty steering. Your steering wheel may feel stiff or hard to turn. And you may feel like your car is swaying or leaning when you take a turn or switch lanes.

3. Braking problems

Because struts are a structural part of your vehicle, faulty struts can result in other problems beyond just suspension issues. You may notice that your car feels unstable, takes a nose dive or lurches forward when you brake.

4. Fluid leaks

You may notice visible wear and tear to struts if you know where to look. But the most common visual clue that your shocks or struts may need repair is a fluid leak.

5. Unusual tire tread wear

When your suspension or wheel alignment is off, your tires will experience uneven tread wear, and it will usually look different than when your tires are just aging. Suspension damage can cause scalloped dips ("cups") to develop around the edge of the tread. And this problem is very dangerous. If you notice any such signs on your tires, see a mechanic right away.

6. Mileage

Cars need regular replacement of shocks or struts every 50,000 miles or so, depending on your car's make and model. Have your mechanic make a routine check of the shocks or struts every 50,000 miles, or however often your operating manual recommends it.

Always replace struts in pairs, never one at a time. Replace your struts if you notice any of these issues:

- They're leaking. A very light film of oil near the top of the strut is OK, but fluid leaking down the side of the strut means it's shot.
- You notice bounce, sway or front-end dive during braking.
- It's hard to keep your vehicle in its own lane on bumpy roads and curves.
- Your tires show evidence of 'cupping'-shallow craters caused by tire bounce.
- The strut boot is damaged or the strut body is dented.

Maintenance of wheels, tyres and tubes

Always maintain proper wheel alignment. Wheel alignment should be done after every 5,000 kms. or whenever any irregular wear on tyre is found. Always maintain proper wheel alignment. Wheel alignment should be done after every 5,000 kms. or whenever any irregular wear on tyre is found.

For optimum performance, tires must have the correct air pressure, tread depth, balance and the wheels of the vehicle must be properly aligned. Checking your tires on a regular basis is an important step in protecting your safety and your automotive investment. Ideally, tire inspections should be performed monthly.

Tyre Care and Maintenance Guide

1. Maintain proper inflation pressure in your tyres.
2. Maintain inflation pressure at the recommended level.
3. Don't spin your tyres excessively.
4. Check your tyres for wear.
5. Warning.
6. Never fit tyres with less load-carrying capacity than required by the vehicle's original equipment manufacturer.

How to Increase Life of Car Tyres?

1. Avoid Sudden Braking and Hard Acceleration. Hard acceleration or heavy braking takes a toll on the life of your car's tyres.
2. Using OEM-spec Wheels and Tyres.
3. Correct Air Pressure.
4. Regular Wheel Alignment.
5. Tyre Rotation.
6. Worn Out Tread.
7. Uneven Wear Pattern.
8. Damaged Sidewall.

By prioritizing safety, AAA maintains that tires should be replaced once the tread depth reaches 4/32”, when stopping distances have already begun to deteriorate significantly.

It's totally unnecessary. Having the alignment checked about every 40-50k miles (or more often if the car has hit a lot of potholes or curbs) is a good idea though.

Align your car when you get new tires-not when you rotate them. Also, balancing is not required either during rotation.

Tube type tyres

For the very first time, it could be a bit tough but that doesn't mean you would mess up. You need the right set of tools and a little effort. You will need a wheel nut spanner, tyre iron, chalk, pliers, rubber patch, file, foot pump and a rubber adhesive.

1. Try to locate the puncture on the tyre. Look for where the rubber has been pierced. Remove the nail or anything else that has pierced it. If you fail to find anything like that on the tyre, it is also possible that the puncture is because of a worn out tube which resulted into a cut or tear.

2. Unscrew the wheel nut using the spanner. Tap on the threaded side of the bolt to remove the bolt which will bring out the wheel with it. Put something like a block of wood or some bricks to keep the motorcycle level.

3. To take out the tube from the tyre, you will have to remove one side of the tyre from the rim. For this you need to use the tyre iron. Carefully slot it near the edge of rubber and push it gently. This would move the tyre outside the rim from one side. Then you can move it around to completely remove the tyre.

4. Remove the valve bolts so that the tube can be removed. Then put them on again and use the pump to inflate the tube. Immersing the tube in water would reveal the puncture area as bubbles will come out from there. Take out the tube and mark the spot so that you don't miss it.

5. Remove air from the tube and then rub the punctured area with the file. This smoothens it so that the patch would set right on it. Put the rubber adhesive on the punctured area and patch, spread it properly using your fingers and paste the patch over the area. Apply some pressure so that they stick properly and there is no air left in between.

6. Allow it to settle for a while and then check if the puncture has been sealed properly by immersing it in water again. Put it back inside the tyre, push the valve through the rim hole, put back the bolts and use the tyre iron to put the tyre back into the rim. Put the wheel back in its spot and tighten the wheel nut.

Tubeless tyres

These days tubeless tyres are found on a large number of motorcycles for obvious reasons. The cost isn't very steep, they perform better, won't immediately run out of air in case of puncture and punctures are easier to fix. As compared to tube type tyres, it is very easy and you won't even have to remove the wheel from its place to fix the puncture. You will need a tubeless puncture repair kit that has got pliers, smoothening tool, repair strips, strip insertion tool and a blade. Here is how you do it for tubeless tyres.

1. Spot the puncture on the wheel. Look for nails or other sharp objects piercing through the rubber.
2. Use the pliers to pull out the object that has damaged the rubber.

3. The smoothening tool has to be inserted in the puncture hole so that it is large enough for the strip to go in and then leave the tool there.

4. Put the strip halfway in the strip insertion tool. Gradually insert it into the puncture hole while you are pulling out the smoothening tool. If you see the strip protruding out too much, trim it with the blade.

Servicing of wheels

Wheel hub bearings may not be visible when you're scanning the outer body of a vehicle, but they play an important role in its safety and handling characteristics. Comprised of precision-manufactured bearings, seals and sensors in one pre-assembled unit, a wheel hub bearing unit is critical to a car's performance.

Although wheel bearings on late model vehicles are sealed and require no maintenance or adjustments, they won't last forever. Quite often, auto mechanics overlook hub bearing when working on brakes, suspension, or changing tires. But failing to ensure their integrity can have disastrous results!

When the wheel hub bearing unit degrades, the results can range from an annoying wheel vibration and noise – to a malfunction in the anti-lock brake system or a wheel that actually breaks off while the vehicle is in motion. Here are a few things to keep in mind when servicing wheel hubs and bearings:

First Signs of Trouble

Effective auto mechanic training teaches students to watch for key signs that hub wheel bearings need to be replaced. Usually located in the wheel's hub, rotor, or brake drum, bearings help the wheel rotate smoothly when the vehicle moves – so if the car owner reports hearing a whirring or humming noise while driving or the ABS light comes on, chances are the hub bearings need some attention. Other symptoms include a grinding noise while steering, steering wander, or possibly a pull to one side when braking.

Guide to Inspection

1. Wheel Balancing

Wheel balancing is one of the most overlooked services that you should have done to your car. It compensates for uneven wear, imperfection in your tires or rims and other minor damage that could occur to your wheels.

There are a number of reasons that wheel balancing may be necessary, but the most common include:

- Imperfections in the tire due to manufacturing – No tire is perfect. Some will have small imperfections that may be difficult to sense until you are going fast enough or putting enough torque on your tires to cause balance issues.
- Slipping of the tire on the rim – Sudden braking, improper lubrication used during the tire mounting process, and moderate wear are some reasons that a balanced tire can slip and spin on a rim. This results in an imbalanced tire that can cause vibrations while driving down the road.
- Uneven wear – Uneven wear can cause the tire to deform in ways that interact negatively with imperfections in the tire rim. This can cause vibrations and loss of grip due to excessive run out.

Wheel balancing, which effectively ensures that the wheels have minimal run out and proper rotation, can solve most of these issues.

On a minor note, it's worth noting that wheel balancing is incredibly important with reel-wheel drive cars such as the Nissan 370Z, BMW 2 Series and Chevrolet Camaro. This is because vibrations from unbalanced wheels are easier to feel due to the torque put on these wheels.

2. Tire Replacement

Tire replacement is another service that car owners tend to forgo. They do this because they erroneously think that their tires are still usable because they passed the local inspection this year, or because they have "enough" tread left on their 15-year-old tires.

As a general rule of thumb, tires should be inspected starting at 50,000 miles of wear or 5 years of use. This is because tires undergo chemical changes due to exposure to the heat, the sun and other elements that can cause warping, bubbling, uneven wear and other issues.

If your tires are nearing their tread indicators or showing signs of cracking at the walls, then those are two more signs that you should replace your tires sooner rather than later.

3. Wheel Bearing Replacement

Wheel bearings are intricate components that exist within the wheel hubs of your car's suspension. The best way to explain their job is to liken them to well-oiled gears that allow your wheels to spin freely without creating too much friction.

When these metal bearings become worn, they lose their ability to spin freely. This can result in play in your wheels, noise, vibrations and other problems that can lad to everything from a diminished driving experience to excessive wear on other suspension components like your car's struts.

While the procedure for replacing wheel bearings is relatively simple, it is both labor intensive and requires certain equipment to ensure that it is done properly. Our mechanics specialize in both of these departments, which ensures that your wheel bearings can be replaced reliably and affordably.

4. Suspension Issues

The last major area where wheel-related problems can develop isn't in the wheels but the suspension of your vehicle. Items like worn struts or springs, brittle bushings and damaged control arms can result in excessive wear that will lead to problems with the wheels of your car.

If you leave these components in disrepair, then this damage will inevitably recur no matter how many times you replace your tires or rims.

To check a wheel bearing, the auto technician should grasp the wheel at top and bottom and attempt to rock it. If there's any movement there, it means the bearings are loose and need to be replaced. Another option is to rotate the wheel by hand – any roughness or noise will tell you that the bearings are worn or damaged. If the vehicle has a lot of miles on it, and one wheel bearing has given out, be sure to check all of the others as well. Chances are, they are nearing the end of their lifecycle.

Hub greasing

Wheel Hub Repairs

There is no way to disassemble and repair a sealed hub assembly.

If something has gone wrong with the unit – like a failed internal ABS sensor or corroded ABS tone ring on the hub – the entire thing must be replaced. Mechanics will need to remove the wheel, hub nut and brakes to replace the unit. On the other hand, if you're working on an older vehicle, adjustable wheel bearings can be adjusted, cleaned and repacked with grease, and replaced if the bearings are bad. A leaky grease seal can also be corrected without having to replace the bearings, too.

Bearing play adjustment

The bearing is adjusted by tightening the hub nut if it is too loose, or loosening the nut if it is too tight. It should be done with the wheel on and raised on an axle stand. Rock the wheel from side-to-side and top-to-bottom to check for bearing wear.

Proper bearing adjustment is essential in maximizing bearing service life. Bearings should be adjusted to a setting range of 0.001 in. to 0.005 in. end play. To ensure proper end play, a dial indicator should always be used.

Rotating or Oscillating the Bearing

During adjustment, position the rollers tightly against the bearing cone (inner race) large rib. When tightening the adjusting nut or using a dial indicator to measure end play, always rotate or oscillate the rollers to be sure they are properly seated.

Improper bearing adjustment can negatively affect these other wheel end components:

- Anti-lock Braking System (ABS) and traction-control systems
- Brake components
- Camber and toe settings
- Spindles
- Tires
- Wheel seals
- Hubs

Types of Damage Caused by Poor Bearing Adjustment

Damage types caused by improper adjustment include:

- Worn spindles or hub – bearing setting too loose or too tight
- Leaky seals – bearing setting too loose or too tight
- Heating (bluing) of spindle or bearings – bearing setting too tight
- Wear on roller ends – bearing setting too loose or too tight

Advantages of Proper Bearing Adjustment

Incorporating proper bearing adjustment techniques into your maintenance routine helps standardize the practice among your technicians – improving accuracy and consistency. Proper bearing adjustment can also improve your driver's safety on the road.

Maintenance of tyres and tubes

Tyre Care and Maintenance Guide

1. Maintain proper inflation pressure in your tyres.
2. Maintain inflation pressure at the recommended level.
3. Don't spin your tyres excessively.
4. Check your tyres for wear.
5. Warning.
6. Never fit tyres with less load-carrying capacity than required by the vehicle's original equipment manufacturer.

How to prevent a tyre from bursting?

1. Well maintained tyres can save lives. ...
2. Maintain optimum air pressure. ...
3. Don't over speed, or for that matter get close to the tyres' speed rating.
4. Don't overload your car.
5. Maintain speed limits. ...
6. Don't buy poor quality tyres just to save some money

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Short answer question

1. What is the necessity of steering maintenance?
2. What is the importance of noise control in brakes?
3. Write the precautions taking during servicing of hydraulic brake.
4. Write the factors to increase tyre life.
5. What is the use of greasing?
6. What is the necessity of wheel balancing?

Long answer questions

1. Explain maintenance of adjustment of steering system.
2. Explain the procedure to inspect the steering linkage.
3. Explain power steering.
4. Explain overhauling of brakes.
5. Explain maintenance of wheels and tyres.

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6. Maintenance of Auto Electrical System

Introduction

The electrical system in your car not only powers the engine, but is also used to power the windows and door locks, defroster, headlights, radio, interior lights, clock, sun or moon roof, and more. That can put a lot of strain on an electrical system that isn't functioning properly. Here's how they all work together:

Battery – Your car battery provides the electrical current that's used to operate the ignition and fuel systems.

Starter – Current from the battery supplies a small amount of power to the starter. The starter then rotates the flywheel that turns the crankshaft. If the starter isn't working, the engine won't work.

Alternator – Without the alternator, your car battery wouldn't be charged.

Auto electrical maintenance

A few things you can do to properly care for your car battery, starter and alternator:

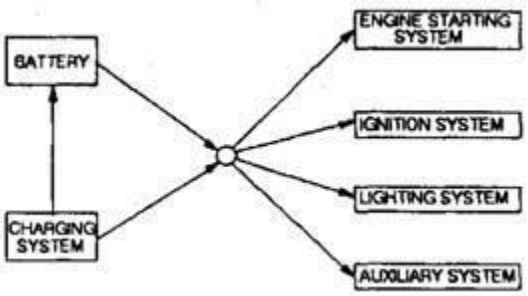
- **Regularly inspect and clean the battery and battery cables** Corrosion builds up on the posts and cables of your battery. It's a good idea to inspect the battery and cables once a month to make sure there's no corrosion build-up. If there is, you can clean the battery posts and cables by using a mixture of baking soda and water or a corrosion removal fluid made specifically for maintaining batteries. Here are the steps to cleaning the battery posts and cables (of course we can always do this for you):

1. Remove the battery cables from the battery posts.
2. Clean the posts and the cable ends using the fluid and a wire brush.
3. Rinse the battery cables and posts with water.
4. Re-connect the battery cables (positive side first).

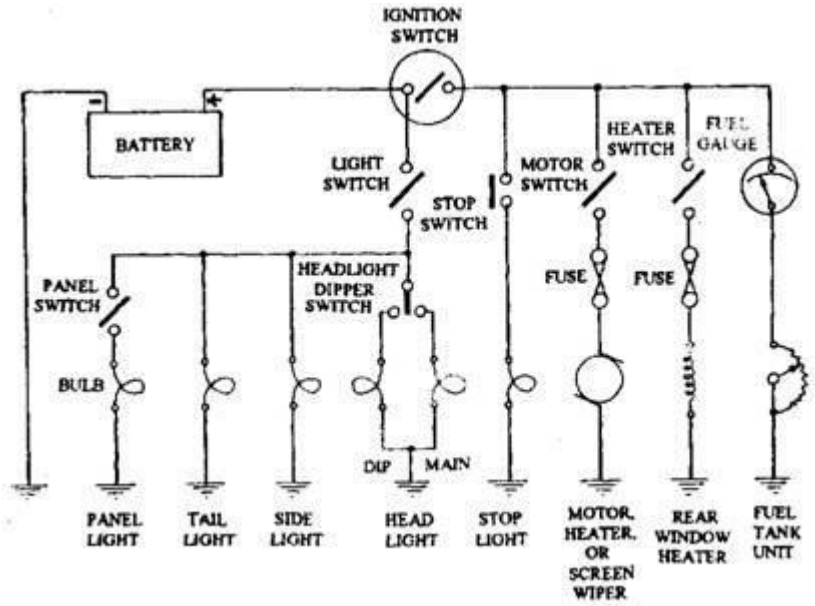
- **Inspect the Drive Belt once a month** – Open the hood and inspect the belt looking for cracks, dryness and/or glazing along its surface. You'll also want to check the tension of the belt. If you don't know how to do this or don't feel comfortable inspecting the belt, don't worry. We always perform a 27-point courtesy inspection on your vehicle when you bring it in for service. This is one of those areas that we'll be able to inspect and let you know when it's time to replace the belt.
- **If your car battery is nearing 4 to 5 years of age, replace it** – If you don't, your car battery will fail to start you car one morning and you'll be stuck waiting for a tow or service. If you're not sure your battery should be replaced, let us know. We can test it for you.

Circuit diagram cables, specification and colour code

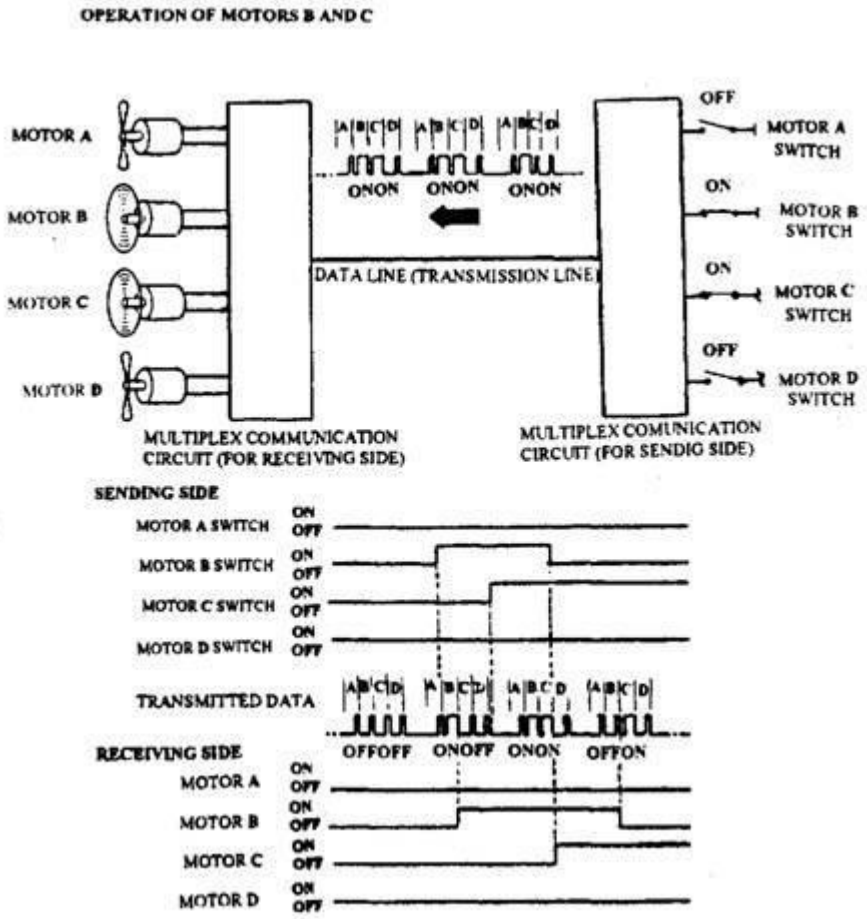
Vehicle electrical systems use up to the mid-1970s were relatively simple, containing just a few circuits for lighting, wiper and heater motors, and a points-type ignition system. The 1980s witnessed exceptional advances in electronics technology, which brought about a remarkable growth in the function of the electrical system so that a rapid increase in the number and complexity of electrical modules incorporated into vehicle resulted. As a consequence vehicle electrical wiring systems have become alarmingly complex, incorporating more and more connectors, terminals, relays and control units.



Battery circuit diagram



Ignition circuit diagram



Horn circuit diagram

Electrical test equipment

Multimeters are the most versatile of the electrical testers and, as the name implies, they are capable of many different testing functions. All professional electricians own one of these tools. Most Multimeters can provide precise readings of resistance, AC and DC voltage, continuity, capacitance, and frequency.

1. Non-contact voltage tester. Being able to measure voltage without test leads can save you time and keep you safer.
2. Insulated tools.
3. Clamp meter.
4. Maltimeter.
5. Insulation tester.
6. Fluorescent light tester.
7. Earth ground tester.

Kinds of Electrical Installation Testing

- Electrical Wiring Continuity Testing.
- Electrical Insulation Resistance Testing.
- Electrical Earth Continuity Path Testing.

- Electrical Testing of Non-linked Single Pole Switches.
- Electrical Earth Resistivity Testing.
- Electrical Performance Testing.

Battery and its maintenance

Use the following as a guide when examining your battery:

- Check the battery's state of charge.
- Ensure the battery top is clean, dry, free of dirt and grime.
- Inspect the terminals, screws, clamps and cables for breakage, damage or loose connections.

Refill flooded lead-acid batteries with distilled water every 2-4 weeks as needed. Regularly check battery state of charge. Apply an equalization charge to flooded batteries every 90 days. (Do not equalize sealed lead-acid or lithium batteries.)

Routinely test your battery to make sure it is correctly charged. This allows you to recharge your battery, if needed, to maintain its peak performance. It's important for your battery's health to get it tested twice a year to keep it at its optimal performance level.

Car Battery Care

Step 1: Clean the cables. Clean corrosion from the battery.

Step 2: Check the level of the electrolyte. Add water to fill holes, if necessary.

Step 3: Check the condition and charge of the battery.

Step 4: To drop in the new battery first remove the cables.

Step 5: Replace the battery.

Step 6: Reinstall the clamp and cables.

Checking of connections of lighting system

In a lamp unit fitted with a bulb, this is easy to check: remove the bulb, hold it up to the light and see if any filaments are broken. A halogen headlamp uses more power, but gives more than twice the illumination. If the bulb is of the halogen type, it should not be touched with the fingers.

How to test a light fitting?

1. Turn the power off to the socket.
2. Test the socket by attaching the clip of the continuity tester to the hot screw terminal, the black wire lead. Then, touch the probe to the metal tab in the bottom of the socket.
3. The tester should glow. If it doesn't, the socket is faulty and needs to be replaced.

Application and replacement of fuses

- Used to protect transformers,
- motors and power system from over-current conditions.
- In feeders, power transformers, and solar circuits.
- Electrical appliances and house distribution boards use **fuse** for domestic purposes.
- Used in automotive cars, electric vehicles, racing cars, rails.

Different Types of Fuses – Constriction, Working & Characteristics

- DC Fuses.
- AC Fuses.
- Cartridge Fuses.
- D – Type Cartridge Fuse.
- HRC (High Rupturing Capacity) Fuse or Link Type Cartridge Fuse.
- High Voltage Fuses.
- Automotive, Blade Type & Bolted Type Fuses.
- SMD Fuses (Surface Mount Fuse), Chip , Radial, and Lead Fuses.

Checking of charging system

If any of these symptoms are evident, then follow these five steps to pinpoint the issue:

1. Perform a visual inspection under the hood. Look at the belt tension and condition.
2. Visually inspect and test the batteries.
3. Measure system voltage.
4. Test alternator output.
5. Troubleshoot using the service manual.

Checking of starter system

1. Conduct a Visual Inspection Under the Hood. Inspect belt condition and tension.
2. Visually Inspect and Test the Batteries. Examine the batteries for any indication of physical damage, broken casing, unfastened terminals, or dripping fluid.
3. Perform a System Voltage Test.
4. Test Alternator Output.

Checking of ignition system

The only safe way to test for spark is to use a spark plug tester tool. If a coil problem is suspected, measure the coil's primary and secondary resistance with an ohmmeter. If either is out of specifications, the coil needs to be replaced. A coil can be easily bench tested with a digital 10 mega ohm impedance ohmmeter.

Method 2: Using a Multimeter

1. Take the ignition switch to Off status by turning the key.
2. Find the module's wire (power feed).
3. Back probe the wire by using the positive lead of the multimeter.
4. Put the multimeter negative lead into the good ground of the distributor base.
5. Turn the key and set it to the run position.

Servicing of electrical accessories

However, some simple initial steps can be taken as far as the economic and energy efficiency is concerned for maintenance of electrical equipment in buildings.

1. Standardization of Equipment.
2. Establishment of Records on Breakdown.
3. Frequency of Maintenance.
4. Economic of Routine Maintenance.
5. Upgrading to More Efficient Plant

Basic maintenance of electrical tools and equipment • clean out the **dust**. To make sure that your electric tools are ready to go when you are, keep them clean and free of **dust**. Spend some time to clean out the **dust** every once in a while on your tools while they are inactive in storage.
The handy list of the top tools every electrician needs.

- Multimeter.
- Voltage tester.
- Wire strippers.
- Circuit finder.
- Screwdrivers and nut drivers specific to electricians.
- Pliers.
- Fish tape.
- Tape measure.

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Short answer question

1. Write the advantages of auto electrical maintenance.
2. Draw the battery circuit diagram.
3. Write the electrical test equipment.
4. Write the types of fuses.
5. Write the tools used by electrician.

Long answer questions

1. Explain the checking of Ignition system.
2. Explain battery maintenance.
3. Explain servicing of electrical Accessories.

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7. Road safety and legal aspects motor vehicles

Road safety and importance

Road safety is of prime importance as road accidents are among the biggest causes of deaths in the country. With the number of vehicles on our roads increasing with every passing hour, it's of vital importance for everyone to have traffic awareness and understand and respect all the road safety rules in India.

The most obvious reason why road safety is so important is that many lives are at stake when you're on the road. The potential for death or a serious injury is always a prominent risk when someone is not focused while driving.

By providing proper road safety education, you will be able to protect your child away from dangers caused by road accidents. You can give them certain facts, show the possible dangers and risks involved, explain ways to keep them safe and develop their skills in understanding consequences.

Safe and responsible driving

Road Safety Starts With Proper Driver's Education

Everyone learns how to drive before they go to take their driver's test; they learn the rules of the road, how to operate their vehicle, what the signs mean, and how to maneuver in a number of circumstances, from heavy traffic to inclement weather.

Most of our driving habits are formed early on. That's why getting a high quality driver's education is so important, whether a driver is being taught by their parents or a professional driving instructor.

More and more states are recommending students sign up for online driver's education programs. These driver's ed courses are usually filled with interactive features and can be studied on a students own time.

Road signs

Yellow traffic signs are usually warning signs that stand for slowing down, driving with caution, or a general warning. It may be yellow, or yellow-green with black wording or symbols.

Traffic signs are divided into three categories: regulatory, warning, and guide signs.

Driving rules

- Never Drink & Drive.
- Always Wear Seat Belt.
- Keep a Safe Distance from the vehicle ahead.
- Always Avoid Distractions.
- Never Break Red Signal.
- Always Drive Within Speed Limit.
- Avoid the Drowsiness While Driving.
- Watch Out For Drivers On the Road.

Driving license

The Government of Andhra Pradesh is committed to provide Simple, Moral, Accountable, Responsive and Transparent (SMART) services to the people through the concept of Citizens' Charter. The Transport Department, as part of the implementation of this Citizens' Charter, has simplified the procedures to get a Driving License.

As per Motor Vehicle Act 1988, a valid Driving License is necessary to drive any motor vehicle on public roads.

Where do you get it?

At the Regional Transport Office or Motor Vehicles Inspector's Office, having jurisdiction over your residential area.

When do you get it?

After completion of 16 years of age, for driving motor cycles with engine capacity not exceeding 50cc with the consent of the parent / guardian. After completion of 18 years of age, motor cycles with engine capacity exceeding 50cc and light motor vehicle. After completion of 20 years of age, for an endorsement to drive transport vehicles.

How to get a Driving License? There are two stages to get a Permanent Driving License.

STAGE I	OBTAINING A LEARNER'S License
STAGE II	OBTAINING A PERMANENT License

Do you need to produce a Medical Certificate?

Applicants for the Non-Transport Licenses, under the age of 50 years do not require a Medical Certificate. However, those applicants who are over 50 years of age must produce a Medical Certificate. All applicants for Transport Vehicle License must produce a Medical Certificate, irrespective of their age.

»	RENEWAL OF DRIVING License
»	ISSUE OF DUPLICATE DRIVING License
»	INTERNATIONAL DRIVING PERMIT
»	CHANGE OF ADDRESS
»	ADDITION OF ANOTHER CLASS OF VEHICLE TO DRIVE

»	FORMS
»	FAQs / QUESTIONNAIRE
»	TRAFFIC SIGNS

Vehicle registration

Necessity for Registration ? No person shall drive any Motor Vehicle and no owner of Motor Vehicle shall cause or permit the vehicle to be driven in any public.

Necessity for Registration ?

No person shall drive any Motor Vehicle and no owner of Motor Vehicle shall cause or permit the vehicle to be driven in any public place or any other place, unless the vehicle is Registered in accordance with Chapter 4 of IMV Act 1988.

Registration where to be made ?

Every owner of Motor Vehicle shall cause the Vehicle to be Registered by a Registration Authority in whose Jurisdiction he has residence or place of business where the vehicle is normally kept.

Registration, how to be made?

- TEMPORARY REGISTRATION
- PERMANENT REGISTRATION
- RENEWAL OF CERTIFICATE OF REGISTRATION
- ISSUE OF DUPLICATE CERTIFICATE OF REGISTRATION
- TRANSFER OF OWNERSHIP

Motor insurance

Motor insurance is a vehicle insurance policy that is mandatory for vehicles like trucks, cars, jeeps, bikes, scooters, etc. This policy offers coverage to the vehicle owner/driver against financial losses that may occur due to accidents or other kinds of damages.12-Feb-2021

No Claim Bonus: Up to 50%
PA Cover: Up to Rs. 15 lakhs
Claims Process: Digital - Within 20 minutes

Motor insurance is an insurance policy that covers the policyholder in case of financial losses – resulting from an accident or other damages – sustained by the insured vehicle. A comprehensive motor insurance policy covers damages to third-party and third-party property along with compensating for own losses as well.

Motor Insurance deals with the insurance covers for the loss or damage caused to the automobile or its parts due to natural and man-made calamities. ... It provides accident cover for individual owners of the vehicles while driving and also for passengers and third-party legal liability

Fitness certificate

A Regional Transport Office (RTO) Vehicle Fitness Certificate is issued to vehicles used for commercial purposes. After making an online application for a fitness certificate, the applicant can visit the RTO for the inspection process.
How do I download a Vahan fitness certificate?

https://vahan.parivahan.gov.in/vahanservice/vahan/ui/statevalidation/homepage.xhtml

1. For To Go to Above Link And Enter Your Vehicle Registration Number like for Example GJ-02-KK-2222.
2. After Applicant Enter the "Vehicle Registration number" to avail “Application for fitness certificate” service.

Different policies and claim settlements.

Types of Insurance Claims

- Burglary and Theft. Burglary and theft are the most common commercial insurance claims filed by businesses.

- Water and Freezing Damage.
- Wind and Hail Damage.
- Fire.
- Slips and Falls by Customers.
- Customer Injury and Property Damage.
- Product Liability.
- Struck by an Object.

Claim settlement is one of the most important services that an insurance company can provide to its customers. Insurance companies have an obligation to settle claims promptly. ... Most claims are settled by issuing a cheque within 7 days from the time they receive the documents.

Which insurance company has best claim settlement ratio?
Max Life Insurance has the highest claim settlement ratio in terms of number of claims with 99.22%.
This is followed by HDFC Life Insurance and Tata AIA Life Insurance with 99.07% and 99.06%, respectively.
Out of the top 10 life insurers, nine have a claim settlement ratio of more than 98%.

Can I claim on multiple insurance policies?

If the claim amount is higher than the sum insured under the policy on which you first made the claim, you can claim the balance bill amount on the second policy. Remember that while buying health insurance, you are required to fill proposal forms wherein the insurer asks for disclosure of any existing policy.

What is the first step in any claim settlement process?
Step by Step Claim Settlement Process of a Term Insurance Plan

1. Inform the Insurer About the Claim.
2. Important Documents to Keep Handy.
3. Submission of the Required Documents for the Claim Processing.
4. Settlement of Claim.
5. Important Exclusions and Inclusions.

Tyre pressure and wear

Air pressure in tires is measured in pounds per square inch, or PSI; usually, the recommended pressure ranges between 30 and 35 PSI. To learn what your tire pressure should be, look for your manufacturer's recommendation, which is printed on a label inside the car
After knowing the proper tire pressure of your vehicle recommended by the manufacturer, you should check your tire pressure regularly to make sure that you are in good shape.

You can check your tire pressure in auto part stores, the mechanics, gas stations, and at home. To check tire pressure at home, you need:

- A Tire Pressure Gauge(Digital or Regular)
- Air Compressor
- Pen and paper / your phone

Step 1: Test with cold tires

As tire pressure changes with the temperature a lot, and recommended tire pressures are cold inflation pressure, you should start with cold tires if possible. We mostly check the tire pressure after one night's rest to avoid the heat from the friction of the last drive, and before the temperature goes up.

Step 2: Check the tire pressure with the gauge

Unscrew the valve cap and press the tire gauge onto the valve stem hard enough until the hissing sound disappears. There should be a reading as long as the gauge is well connected to the tire.

Step 3: Note down the readings

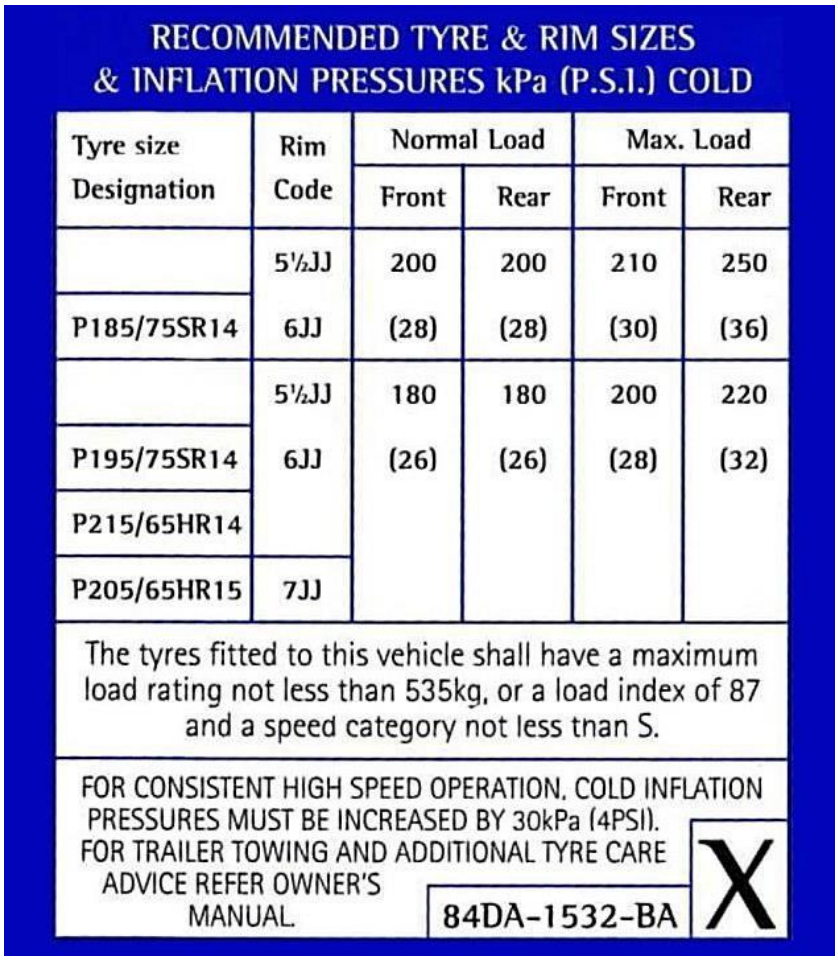
You can then note down the tire pressure of each tire, and compare them with the ideal psi you read from inside your driver’s door or in the owner’s manual. Make sure you read in detail, as for some vehicles, front and rear tires have different recommended psi.

Step 4: Fill your tires to the recommended psi

If you find a tire underinflated, use the air compressor to fill your tires. You can either buy an air compressor in the auto parts store or use one in a gas station. Remember to rest your tires for at least half an hour to make sure they’re cold and the reading is accurate. If you have to fill your tires when the tires are hot, inflate them 3~4 psi above the recommended psi, and check again with your gauge when they are cold. It’s ok to overinflate a bit when filling the tires, as you can let the air out with the gauge.

Step 5: Check the tire pressure again

After filling the tires, use your tire pressure gauge to check the tire pressure again and make sure they are in a good range. Let the air out a bit if they are over-inflated by pressing the gauge harder on the valve stem.



RECOMMENDED TYRE & RIM SIZES
& INFLATION PRESSURES kPa (P.S.I.) COLD

Tyre size Designation	Rim Code	Normal Load		Max. Load	
		Front	Rear	Front	Rear
	5½JJ	200	200	210	250
P185/75SR14	6JJ	(28)	(28)	(30)	(36)
	5½JJ	180	180	200	220
P195/75SR14	6JJ	(26)	(26)	(28)	(32)
P215/65HR14					
P205/65HR15	7JJ				

The tyres fitted to this vehicle shall have a maximum load rating not less than 535kg, or a load index of 87 and a speed category not less than S.

FOR CONSISTENT HIGH SPEED OPERATION, COLD INFLATION PRESSURES MUST BE INCREASED BY 30kPa (4PSI).
FOR TRAILER TOWING AND ADDITIONAL TYRE CARE ADVICE REFER OWNER'S MANUAL.

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Causes of Tyre wear

- Under-inflation: This will cause the tyre to wear on the outer edges of the tread, leaving the central tread area far less worn.
- Over-inflation
- Wheel misalignment
- Illegal Wear
- End of Life
- Emergency Braking
- Cuts
- Impact and Sidewall damage

Tyre rotation

Tyre rotation is the process of changing the position of the tyres on your vehicle, often done by swapping front and rear car tyres. If you choose to fit two new tyres at any time, put the new ones on the rear axle. There are various ways you can rotate your tyres, usually dependant on the vehicle.
Tire rotation is routinely repositioning your vehicle's tires in specific patterns from front to back or side to side, is an important element of tire upkeep and safety. Additionally, rotating your tires may also be required to keep your tires covered under warranty.

Tyre vulcanizing and retreading

The tread patterns that give a tire its traction are added by running it through a curing machine. The heat that this process generates also serves to fuse the tire's various components together. This is what's known as vulcanizing.
Tyre vulcanization is the process of adding new raw rubber to a damaged area of a tyre to create a repair suitable for the rest of the tyres road life. The damaged tyre will be prepared and new rubber moulded into the damaged area then put into a tyre vulcanising machine to cook the raw rubber at high temperature.

Retreading is a process through which we can use our old tyres. In this method, a worn casing of a tyre that has a good structural quality is taken off and put through a process in which it gets a completely renewed tread and sidewall rubber. After that, the revamped tyre is taken forward for a curing process in which the new rubber is vulcanized to the original casing and hence, the tyre gets a newly made tread pattern.
A retreaded tyre commences its life as a worn out tyre. There is a need for retreading when you find out that the tread is down to 2-3 mm or if it has been re-grooved earlier, or if the tyre has puntures and needs a repair. In these cases, take the tyre to an experienced technician who will check and inspect the tyre to see whether it is in a condition to get retreaded. If the expert finds it alright, then retreading of tyre can be done.

Wheel Balancing

Every time a wheel is first mounted onto a vehicle with a new tire, it has to be balanced. The goal is to make sure the weight is evenly distributed throughout each of the wheels and tires on a vehicle. This process evens out heavy and light spots in a wheel, so that it rotates smoothly.
The common symptoms of out-of-balance tires are uneven and faster tread wear, poor fuel economy, and vibration in the steering wheel, the floorboard or the seat that gets worse at faster speeds. When all areas of the wheel-tire unit are as equal in weight as possible, the tire will roll smoothly.

Wheel balancing is the process of balancing the weight of a tire and wheel assembly so that it travels evenly at high speeds. Balancing requires putting a mounted wheel and tire on a balancer, which centers the wheel and spins it to determine where the weights should go. Every time a wheel is first mounted onto a vehicle with a new tire, it has to be balanced.

The goal is to make sure the weight is evenly distributed throughout each of the wheels and tires on a vehicle. This process evens out heavy and light spots in a wheel, so that it rotates smoothly. If there is even a slight difference in weight in the wheels, it will cause enough momentum to create a vibration in the car.

In fact, wheels and tires are never exactly the same weight all around. The wheel's valve stem hole will usually subtract a small amount of weight from that side of the wheel. Tires will also have slight weight imbalances, whether from a joining point of the cap plies or a slight deviation from perfectly round. At high speeds, even a tiny imbalance in weight can become a large imbalance in outward force, which could cause the wheel and tire assembly to spin in a heavy and uneven motion. This usually turns into a vibration in the car as well that could cause uneven and damaging wear on the tires.

Tubeless tyre

Tubeless tyres, as the name suggests, are tyres without a tube. The tyre is built in such a way that it can contain air by itself. The tyre has a halo or chloro-butyl lining on its inside which is airtight.

Tubeless tyre Advantages

No silly punctures A normal tyre usually getspunctured when the tube gets pinched between the tyre wall and the rim. It may sound silly, but happens more often than you would expect.

Ability to run at lower pressure Air changes its pressure inside the tube and makes it common for tyres to run at lower pressures. This further increases the chances of the tube getting pinched with the wheel as mentioned before. This will not the case with tubeless tyres.

Liquid sealant Tubeless tyres can be filled with liquid sealants. If a sharp object puts a hole in a tubeless tyre, the liquid sealant immediately oozes out and dries up; thus sealing the hole. This enables you to travel longer without having to worry about a puncture.

Lightweight Tubeless tyres are lighter compared to tubed tyres and in turn, affect the mileage of the vehicle. Heavy vehicle components will demand more power from the engine and this requires more fuel.

No unwanted friction While driving at high speeds, a tubed tyre will have friction within itself. This increases the tube temperature and there can even be chances of the tube exploding. A tyre/tube explosion at high speeds calls for disaster. Tubeless tyres do not pose this risk.

Stability Since air is contained within the tubeless tyre itself, and not in a separate tube, high-speed stability will be better. With a tube, there are chances of uneven pressure and can make the car wobble at high speeds. Also, since a tubed tyre has more components (tyre, tube, rim) compared to a tubeless tyre (just tyre and rim), performance and efficiency are better with a tubeless tyre.

Disadvantages of tubeless tyres:

- More expensive.
- Fitting is messier and more time consuming.
- Removal often requires good grip strength.
- Air and sealant can escape ('burping') if the **tyre** bead comes away from the rim due to a sudden impact or extreme cornering force.
- Sealants that coagulate need topping up every six months.

Procedure for Tubeless tyre repair

Tubeless tyres can be repaired if they have a butyl or latex lining. If the tyre is having a proper lining then you use a inner tube patch and vulcanising rubber glue to seal the inside of the tyre. For tyres without a lining the tyre is to be superglued again to get the patch to stick.

The tubeless tyre puncture repair kit has following tools and accessories

- A Spiral Probe to clean and expand the punctured hole

- A Split-Eye Insertion Tool to insert the Tyre Repair Strip
- A small tube of Rubber Cement
- A packet of Tyre Repair Strips
- Remove the nail and insert the Spiral probe in the puncture hole
- Rotate the Spiral probe in each direction to clean and expand the hole
- Take a Repair Strip from the pack and insert in the eye of the Split-eye Insertion tool. You can see picture of the split-eye of the tool above
- Pull the Repair Strip through the eye so that both sides of the strip are equal in length

- Apply little amount of Rubber cement Solution over the Spiral probe and insert into the tyre to cover the hole
- Now remove the Spiral Probe and immediately insert 2/3rd of the Repair Strip into the hole with the help of Split-Eye Insertion Tool
- Twist the Insertion tools 360 degrees and pull out. The Repair Strip will plug the puncture hole and the tool will come out clean
- With a knife, the excess length of Strip protruding out is to be trimmed.

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Short answer question

1. Write the importance of road safety.
2. Draw any two road signals.
3. Write the driving rules.
4. Write the types of Insurance claims.

Long answer questions

1. Explain procedure for getting driving license.
2. Explain necessity of vehicle Registration.
3. Explain

a). Motor insurance

b). Fitness certificate of vehicle

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