TPCT's

College of Engineering, Osmanabad

Laboratory Manual

AUTOMOBILE ENGINEERING

For

Final Year Students

Manual Prepared by

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TPCT's

College of Engineering
Solapur Road, Osmanabad
Department of Mechanical engineering

Vision of the Department:

To impart strong foundation in Mechanical Engineering Fundamentals, so that students will be competent professionals to meet the global challenges

Mission of the Department:

To promote scientific & educational activities for facing problems of global competition and prepare engineering students for successful carriers.

College of Engineering

Technical Document

This technical document is a series of Laboratory manuals of Mechanical engineering Department and is a certified document of College of engineering, Osmanabad. The care has been taken to make the document error-free. But still if any error is found, kindly bring it to the notice of subject teacher and HOD.

Recommended by,

HOD

Approved by,

Principal

FOREWORD

It is my great pleasure to present this laboratory manual for final year engineering students for the subject of Automobile Engineering. To understand and visualize the basic concepts of automobile and their parts like clutch, gear box, suspension system, steering system, differential, braking system, etc. The subject gives the knowledge about the power transfer from engine to rear wheel and safety precautions while driving the vehicle. This lab manual provides a guideline to the students for understanding the working of clutch, gear box, suspension system, steering system, differential, braking system, etc.

H.O.D.
Mech. Dept

LABORATORY MANUAL CONTENTS

This manual is intended for the Final Year students of Mechanical branch in the subject of Automobile Engineering. This manual typically contains practical/ Lab Sessions related to Automobile Engineering covering basic aspects related to the subject.

Students are advised to thoroughly go through this manual rather than only topics mentioned in the syllabus as practical aspects are the key to understanding and conceptual visualization of theoretical aspects covered in the book.

SUBJECT INDEX:

1. Do's & Don'ts in Laboratory.

2. Lab Exercises

   1. Layout of the automobiles ,front in line ,cross engine ,rear engine,2W and 4W drives.
   2. Construction and working of Petrol & Diesel Engines used in Automobiles. Study of MPFI & CRDI.
   3. Study and construction of clutches used in automobile.
   4. Study of construction and working of four wheeler, manual shift gear box used in Automobile.
   5. Construction and working of Rigid Axle and Independent Suspension system used in Automobile.
   6. Construction and Working of Steering Assembly used in Automobile
   7. To study the construction and working of differential used in the Automobile .
   8. Construction and assembly of the braking systems used in the automobile. Study of tandem master cylinder, slave cylinder.

3.Quiz

4.Conduction of viva voce examination

5. Evaluation & marking scheme

Dos and Don’ts in Laboratory :-

1. Do not handle any model before reading the instructions.
2. Observe type of sockets of equipment power to avoid mechanical damage.
3. Be as neat as possible. Keep the work area and work bench clear of items not used in experiments.
4. Strictly observe the instructions given by the Teacher/ Lab Instructor.

Instruction for Laboratory Teachers:-

1. Submission related to whatever lab work has been completed should be done during the next lab session.
2. Students should be instructed to switch on the power supply after getting the checked by the lab assistant / teacher. After the experiment is over, the students must hand over the model of equipment to the lab assistant/teacher.
3. The promptness of submission should be encouraged by way of marking and evaluation patterns that will benefit the sincere students.

EXPERIMENT NO-1

TITLE: Layout of the automobiles ,front in line ,cross engine ,rear engine,2W and 4drives.

Aim: To study different Layout of Automobile.

INTRODUCTION

Automobile is a self-propagating vehicle which transmits motion.Present age is called age of automobile. Vehicle producing power within itself for its propulsion is self-propelled vehicle.eg. moped,scooter,motorcycle, etc.Germany is the birthplace of automobile.The first automobile powered by steam engine was built in France by Nicholas joseph caugnot in 1769. It was three-wheel vehicle with speed 2.5 miles per hour.

Layout

1) FRONT ENGINE REAR WHEEL DRIVE

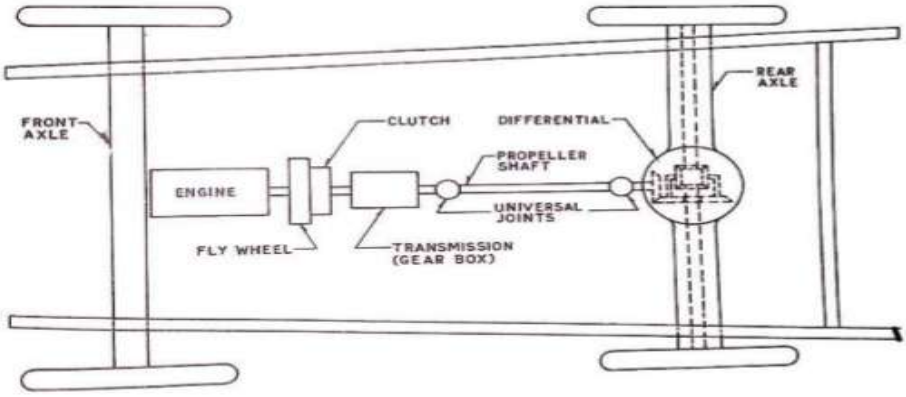
In this drive the engine is mounted on the front side i.e. front engine unit drives a beam type rear wheel supported on leaf springs through a propeller shaft with two universal joints. Coil springs, the front wheels are independently sprung. This is one of the oldest layout.

ADVANTAGES

a] balanced weight distribution.
b]easy front wheel steering movement.
c]large luggage space is provided at rear.
d] maintenance is easy.

DISADVANTAGES

a] long propeller shaft is needed
b] more noise, wear is more



Layout of complete system of Automobile

2) **REAR ENGINE REAR WHEEL DRIVE**

The propeller shaft is eliminated. The clutch engine gearbox drive with the single unit. engine is at the rear end. Power is completely transmitted to the rear wheel. there is no adjustment in propeller shaft.

ADVANTAGE

a] excellent traction is available while climbing the wheel.
b] larger passenger space is available
c] compact , accessible power ,transmission assembly is provided.
d] avoid noise .

DISADVANTAGES

a] no natural cooling
b] unbalanced layout .
c]vehicle can oversteer .
d] Power requirement is more .

3)FRONT ENGINE FRONT WHEEL DRIVE

It provides optimum passenger space . propeller shaft length is reduced . good grip to road surface due to engine weight at front .The chance of skidding is reduced . natural air cooling of radiator . power for cooling is reduced .

ADVANTAGES

a] no need to decrease interior space for driven shaft.
b] cost is less .
c] low weight,means better mileage .
d] Improves drive train assembly .
e] better cross wind assembly .

DISADVANTAGES

a] limits the acc^{n} of the of front wheel drive vehicle .
b] in less traction conditions front drive wheel loose traction first making seeing ineffective.
c] Centre of gravity of vehicle is forward .

4) FOUR WHEEL DRIVE

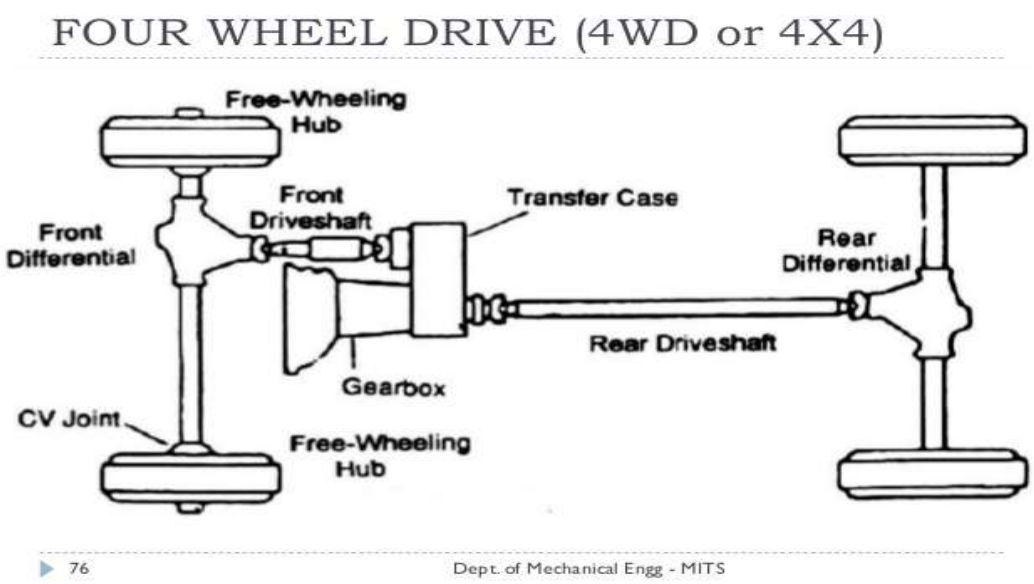
All four wheels are driven by engine making entire weight available for traction .these are very useful on hill station if one of the wheel skidding then other wheel transmit the tractive force to the vehicle . The steering of four wheel drive is hard .when front wheel fall into ditch they can be driven out higher initial and running cost because of extra fuel consumption .used in jeep ,military vehicles .

ADVANTAGES

a] better traction
b] excellent load handling capacity .
c] can be used in uneven road surfaces.
d] equal power distribution to all 4 wheels.
e] avoid skidding .

DISADVANTAGES

a] complex in construction
b] extra part is needed like transfer gear box.
c] more effort is required to driver .
d] maintenance cost of four wheel is more .



Conclusion:

Possess the working knowledge of the different layout used in automobile and understand the different engine positions.

EXPERIMENT NO-2

TITLE: Construction and working of Petrol & Diesel Engines used in Automobiles. Study of MPFI & CRDI .

Aim: To study the Petrol Engine, Diesel Engine, MPFI and CRDI systems.

Introduction

A heat engine is a machine, which converts heat energy into mechanical energy. The combustion of fuel such as coal, petrol, diesel generates heat. This heat is supplied to a working substance at high temperature. By the expansion of this substance in suitable machines, heat energy is converted into useful work. Heat engines can be further divided into two types:

3. External combustion and
4. Internal combustion.

In a steam engine the combustion of fuel takes place outside the engine and the steam

thus formed is used to run the engine. Thus, it is known as *external combustion engine.* In the case of *internal combustion engine,* the combustion of fuel takes place inside the engine cylinder itself.

Spark Ignition (Carburettor Type) IC Engine

In this engine liquid fuel is atomised, vaporized and mixed with air in correct proportion before being taken to the engine cylinder through the intake manifolds. The ignition of the mixture is caused by an electric spark and is known as spark ignition.

Compression Ignition (Diesel Type) IC Engine

In this only the liquid fuel is injected in the cylinder under high pressure.

CONSTRUCTIONAL FEATURES OF IC ENGINE:

The cross section of IC engine is shown in Fig. 1. A brief description of these parts is given below.

Cylinder:

The cylinder of an IC engine constitutes the basic and supporting portion of the engine power unit. Its major function is to provide space in which the piston can operate to draw in the fuel mixture or air (depending upon spark ignition or compression ignition), compress it, allow it to expand and thus generate power. The cylinder is usually made of high-grade cast iron. In some cases, to give greater strength and wear resistance with less weight, chromium, nickel and molybdenum are added to the cast iron

Piston:

The piston of an engine is the first part to begin movement and to transmit power to the crankshaft as a result of the pressure and energy generated by the combustion of the fuel. The piston is closed at one end and open on the other end to permit direct attachment of the connecting rod and its free action.

The materials used for pistons are grey cast iron, cast steel and aluminium alloy. However, the modern trend is to use only aluminium alloy pistons in the tractor engine.

Piston Rings:

These are made of cast iron on account of their ability to retain bearing qualities and elasticity indefinitely. The primary function of the piston rings is to retain compression and at the same time reduce the cylinder wall and piston wall contact area to a minimum, thus reducing friction losses and excessive wear. The other

important functions of piston rings are the control of the lubricating oil, cylinder lubrication, and transmission of heat away from the piston and from the cylinder walls. Piston rings are classed as compression rings and oil rings depending on their function and location on the piston.

Piston Pin:

The connecting rod is connected to the piston through the piston pin. It is made of case hardened alloy steel with precision finish. There are three different methods to connect the piston to the connecting rod.

Connecting Rod:

This is the connection between the piston and crankshaft. The end connecting the piston is known as *small end* and the other end is known as big *end.* The big end has two halves of a bearing bolted together. The connecting rod is made of drop forged steel and the section is of the I-beam type.

Crankshaft:

This is connected to the piston through the connecting rod and converts the linear motion of the piston into the rotational motion of the flywheel. The journals of the crankshaft are supported on main bearings, housed in the crankcase. Counter-weights and the flywheel bolted to the crankshaft help in the smooth running of the engine.

Engine Bearings:

The crankshaft and camshaft are supported on anti-friction bearings. These bearings must be capable of with standing high speed, heavy load and high temperatures. Normally, cadmium, silver or copper lead is coated on a steel back to give the above characteristics. For single cylinder vertical/horizontal engines, the present trend is to use ball bearings in place of main bearings of the thin shell type.

Valves:

To allow the air to *enter into* the cylinder or the exhaust, gases to escape from the cylinder, valves are provided, known as *inlet* and *exhaust* valves respectively. The valves are mounted *either on* the cylinder head or on the cylinder block.

Camshaft:

The valves are operated by the action of the camshaft, which has separate cams for the inlet, and exhaust valves. The cam lifts the valve against the pressure of the spring and as soon as it changes position the spring closes the valve. The cam gets drive through *either the* gear or sprocket and chain system from the crankshaft. It rotates at half the speed of the camshaft.

Flywheel

This is usually made of cast iron and its primary function is to maintain uniform engine speed by carrying the crankshaft through the intervals when it is not receiving power from a piston. The size of the *flywheel varies* with the number of cylinders and the type and size of the engine. It also helps in balancing rotating masses.

PRINCIPLES OF OPERATION OF IC ENGINES:

FOUR-STROKE CYCLE DIESEL ENGINE

In four-stroke cycle engines there are four strokes completing two revolutions of the crankshaft. These are respectively, the suction, compression, power and exhaust strokes. In Fig. 3, the piston is shown descending on its suction stroke. Only pure air is drawn into the cylinder during this stroke through the inlet valve,

whereas, the exhaust valve is closed. These valves can be operated by the cam, push rod and rocker arm. The next stroke is the compression stroke in which the piston moves up with both the valves remaining closed.

The air, which has been drawn into the cylinder during the suction stroke, is progressively com-pressed as the piston ascends. The compression ratio usually varies from 14:1 to 22:1. The pressure at the end of the compression stroke ranges from 30 to 45 kg/cm^2. As the air is progressively compressed in the cylinder, its temperature increases, until when near the end

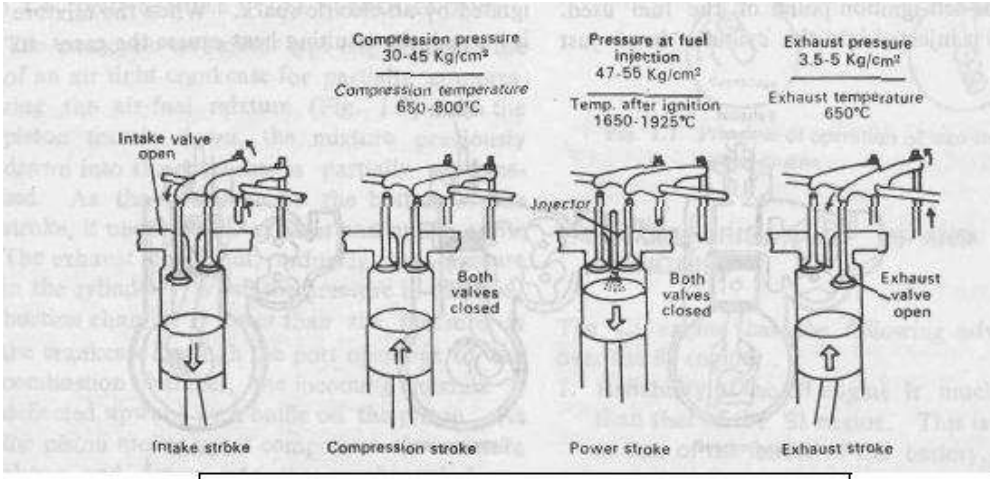
of the compression stroke, it becomes sufficiently high (650-80O ^{o}C) to instantly ignite any fuel that is injected into the cylinder. When the piston is near the top of its compression stroke, a liquid hydrocarbon fuel, such as diesel oil, is sprayed into the combustion chamber **under high pressure (140-160 kg/cm^2)**, higher than that existing in the cylinder itself. This fuel then ignites, being burnt with the oxygen of the highly compressed air.

During the fuel injection period, the piston reaches the end of its compression stroke and commences to return on its third consecutive stroke, viz., **power stroke**. During this stroke the hot products of combustion consisting chiefly of carbon dioxide, together with the nitrogen left from the compressed air expand, thus forcing the piston downward. This is only the working stroke of the cylinder.

During the power stroke the pressure falls from its maximum combustion value **(47-55 kg/cm^2),** which is usually higher than the greater value of the compression pressure (45 kg/cm^2), to about **3.5-5 kg/cm^2** near the end of the stroke. The exhaust valve then opens, usually a little earlier than when the piston reaches its lowest point of travel. The exhaust gases are swept out on the following upward stroke of the piston. The exhaust valve remains open throughout the whole stroke and closes at the top of the stroke.

The reciprocating motion of the piston is converted into the rotary motion of the crankshaft by means of a connecting rod and crankshaft. The crankshaft rotates in the main bearings, which are set in the crankcase. The flywheel is fitted on the crankshaft in order to smoothen out the uneven torque that is generated in the reciprocating engine.

Principle of four-stroke engine



TWO-STROKE CYCLE DIESEL ENGINE:

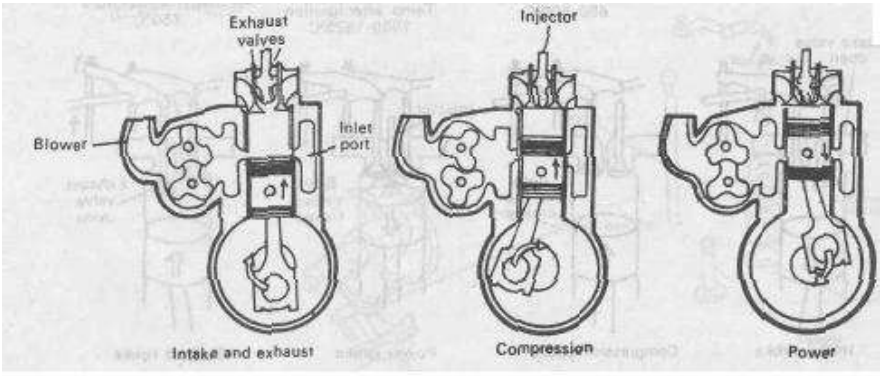
The cycle of the four-stroke of the piston (the suction, compression, power and exhaust strokes) is completed only in two strokes in the case of a two-stroke engine. The air is drawn into the crankcase due to the suction created by the upward stroke of the piston. On the down stroke of the piston it is compressed in the crankcase, The compression pressure is usually very low, being just sufficient to enable the air to flow into the cylinder through the transfer port when the piston reaches near the bottom of its down stroke.

The air thus flows into the cylinder, where the piston compresses it as it ascends, till the piston is nearly at the top of its stroke. The compression pressure is increased sufficiently

high to raise the temperature of the air above the self-ignition point of the fuel used. The fuel is injected into the cylinder head just before the completion of the compression stroke and only for a short period. The burnt gases expand during the next downward stroke of the piston. These gases escape into the exhaust pipe to the atmosphere through the piston uncovering the exhaust port.

Modern Two-Stroke Cycle Diesel Engine

The crankcase method of air compression is unsatisfactory, as the exhaust gases do not escape the cylinder during port opening. Also there is a loss of air through the exhaust ports during the cylinder charging process. To overcome these disadvantages blowers are used to pre-compress the air. This pre-compressed air enters the cylinder through the port. An exhaust valve is also provided which opens mechanically just before the opening of the inlet ports.

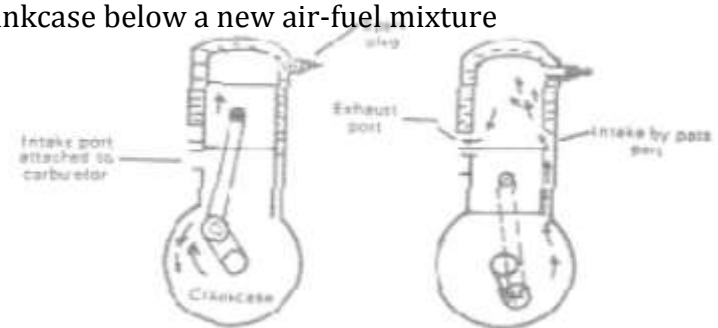


FOUR-STROKE SPARK IGNITION ENGINE

In this gasoline is mixed with air, broken up into a mist and partially vaporized in a carburettor (Fig. 5). The mixture is then sucked into the cylinder. There it is compressed by the upward movement of the piston and is ignited by an electric spark. When the mixture is burned, the resulting heat causes the gases to expand. The expanding gases exert a pressure on the piston (power stroke). The exhaust gases escape in the next upward movement of the piston. The strokes are similar to those discussed under four-stroke diesel engines. The various temperatures and pressures are shown in Fig. 6. The compression ratio varies from 4:1 to 8:1 and the air-fuel mixture from 10:1 to 20:1.

TWO-STROKE CYCLE PETROL ENGINE

The two-cycle carburettor type engine makes use of an airtight crankcase for partially compressing the air-fuel mixture (Fig. 6). As the piston travels down, the mixture previously drawn into the crankcase is partially compressed. As the piston nears the bottom of the stroke, it uncovers the exhaust and intake ports. The exhaust flows out, reducing the pressure in the cylinder. When the pressure in the combustion chamber is lower than the pressure in the crankcase through the port openings to the combustion chamber, the incoming mixture is deflected upward by a baffle on the piston. As the piston moves up, it compresses the mixture above and draws into the crankcase below a new air-fuel mixture



COMPARISON OF CI AND SI ENGINES

The CI engine has the following advantages over the SI engine.

1. Reliability of the CI engine is much higher than that of the SI engine. This is because in case of the failure of the battery, ignition or carburettor system, the SI engine cannot operate, whereas the CI engine, with a separate fuel injector for each cylinder, has less risk of failure.
2. The distribution of fuel to each cylinder is uniform as each of them has a separate injector, whereas in the SI engine the distribution of fuel mixture is not uniform, owing to the design of the single carburettor and the intake manifold.
3. Since the servicing period of the fuel injection system of CI engine is longer, its maintenance cost is less than that of the SI engine.
4. The expansion ratio of the CI engine is higher than that of the SI engine; therefore, the heat loss to the cylinder walls is less in the CI engine than that of the SI engine. Consequently, the cooling system of the CI engine can be of smaller dimensions.
5. The torque characteristics of the CI engine are more uniform which results in better top gear performance.
6. The CI engine can be switched over from part load to full load soon after starting from cold, whereas the SI engine requires warming up.
7. The fuel (diesel) for the CI engine is cheaper than the fuel (petrol) for SI engine.
8. The fire risk in the CI engine is minimised due to the absence of the ignition system.
9. On part load, the specific fuel consumption of the CI engine is low.

ADVANTAGES AND DISADVANTAGES OF TWO-STROKE CYCLE OVER FOUR-STROKE CYCLE ENGINES

Advantages:

1. The two-stroke cycle engine gives one working stroke for each revolution of the crankshaft. Hence theoretically the power developed for the same engine speed and cylinder volume is twice that of the four-stroke cycle engine, which gives only one working stroke for every two revolutions of the crankshaft. However, in practice, because of poor scavenging, only 50-60% extra power is developed.
2. Due to one working stroke for each revolution of the crankshaft, the turning moment on the crankshaft is more uniform. Therefore, a two-stroke engine requires a lighter flywheel.
3. The two-stroke engine is simpler in construction. The design of its ports is much simpler and their maintenance easier than that of the valve mechanism.
4. The power required to overcome frictional resistance of the suction and exhaust strokes is saved, resulting in some economy of fuel.
5. Owing to the absence of the cam, camshaft, rockers, etc. of the valve mechanism, the mechanical efficiency is higher.
6. The two-stroke engine gives fewer oscillations.
7. For the same power, a two-stroke engine is more compact and requires less space than a four-stroke cycle engine. This makes it more suitable for use in small machines and motorcycles.
8. A two-stroke engine is lighter in weight for the same power and speed especially when the crankcase compression is used.
9. Due to its simpler design, it requires fewer spare parts.
10. A two-stroke cycle engine can be easily reversed if it is of the valve less type.

Disadvantages:

1. The scavenging being not very efficient in a two-stroke engine, the dilution of the charges takes place which results in poor thermal efficiency.
2. The two-stroke spark ignition engines do not have a separate lubrication system and normally, lubricating oil is mixed with the fuel. This is not as efrective as the
3. lubrication of a four-stroke engine. Therefore, the parts of the two-stroke engine are subjected to greater wear and tear.
4. In a spark ignition two-stroke engine, some of the fuel passes directly to the exhaust. Hence, the fuel consumption per horsepower is comparatively higher.

5. With heavy loads a two-stroke engine gets heated up due to the excessive heat produced. At the same time the running of the engine is riot very smooth at light loads.
6. It consumes more lubricating oil because of the greater amount of heat generated.
7. Since the ports remain open during the upward stroke, the actual compression starts only after both the inlet and exhaust ports have been closed. Hence, the compression ratio of this engine is lower than that of a four-stroke engine of the same dimensions. As the efficiency of an engine is directly proportional to its compression ratio, the efficiency of a two-stroke cycle engine is lower than that of a four-stroke cycle engine of the same size.

CRDI SYSTEM

CRDI stands for Common Rail Direct Injection meaning direct injection of fuel into the cylinders of a diesel engine via a single common line called the common rail which is connected to all fuel injectors. Where as ordinary diesel direct fuel injection systems have to build up pressure a new for each and every injection cycle , the new common rail (line) engines maintain constant pressure regardless of the injection sequence. This pressure then remains permanently available throughout the fuel line. The engines electronic timing regulates injection pressure according to engine speed and load. The electronic control unit ECU modifies injection pressure precisely and as needed,based on data obtained from sensors on the cam and crank shafts. In other words,compression and injection occur independently of each other. This technique allows fuel to be injected as neede, saving fuel and lowering emissions.

MPFI SYSTEM

We will be familiar with the words MPFI and CRDI in the advertisement of some vehicles. But how many of us know what MPFI exactly is? The term MPFI is generally used to specify an engine variant used in the petrol vehicles. A small computerized system is used to control the engine of the car. A petrol car will have more than three fuel burning chambers or simply cylinders. The MPFI engine is abbreviated as the Multi point fuel injection engine. The MPFI engine got this name because of the reason that each cylinder is having a fuel injector installed near them. That is why they are called as the **Multi point fuel injection** engine.

Principle behind MPFI

The power is produced in a petrol engine is by burning the fuel. In petrol engine, the petrol is ignited. At first, the petrol is allowed to mix with air. It is then ignited in a cylinder called as the **combustion chamber**. This combustion of the petrol produces a sufficient energy to run the engine. The Carburetor is being used in the earlier days before the invention of MPFI engine. It is the duty of the carburetor to mix the fuel and air in a fixed air-fuel ratio. The fuel thus mixed in the carburetor is then given to the combustion chamber where this mixture gets ignited. The power thus obtained from the ignition of gas is used to drive the engine. The main disadvantage of the Carburetor is that the mixing of fuel and air is not in the proper ratio which leads to the wastage of fuel and the pollution is high. Since the emission rate is high in carburetor engine, the MPFI engine is being introduced.

Working of MPFI engine

The MPFI is an advanced version of carburetor engine. As we said earlier the MPFI engine is having a fuel injector for each cylinder. A computer is used to control each and every fuel injector individually. The computerized system of the car consists of a microcontroller. This microcontroller monitors each **fuel injectors** and keeps on telling each injector about the amount of fuel to be injected to the cylinder so that the fuel wastage can be reduced. Since there is a controlled fuel usage, the engine is known for its fuel efficiency

Conclusion

From the above study, we have acquired the knowledge of petrol and diesel engines used in Automobile. These engines are used in cars, truck, buses, jeeps.

EXPERIMENT NO-3

TITLE: STUDY AND CONSTRUCTION OF CLUTHES USED IN AUTOMOBILE

AIM: To study construction and working of Clutches .

INTRODUCTION

The motion of the crankshaft is transmitted through the clutch the gear box or transmission, which consists of set of gears to change the speed. From gear box, the motion is transmitted to the propeller shaft through the universal joint and then to the differential through another universal joint. Universal joint is used where the two rotating shafts are connected at an angle for power transmission. Finally the power is transmitted to the rear wheels through the rear axles. The differential provides the relative motion to the two rear wheels while the vehicle taking a turn. Thus, the power developed inside the cylinder is transmitted to the rear wheels through a system of transmission.

The vehicles which have front wheel drives in addition to the rear wheel drives include a second set of propeller shafts, universal joints, final drives and differentials for the front units.

CLUTCH AND ITS FUNCTION

Clutch is a device used in the transmission system of motor vehicle to engage and disengage the engine to transmission. Thus the clutch is located between the engine and the transmission. When the clutch is engaged, the power flows from the engine to the rear wheels through the transmission system and the vehicle moves. When the clutch is disengaged, the power is not transmitted to the rear wheels and the vehicle stops while the engine steel running, when shifting the gears, when stopping the vehicle and idling the engine. The clutch is engaged only when the vehicle is to move and is kept engaged when the vehicle is moving. The clutch also permits the gradual taking up of the load. When properly operated, it prevents jerky motion of the vehicle and thus avoids putting undue strain on the remaining parts of the power transmission system.

REQUIREMENTS OF CLUTCH

1.Torque transmission. The clutch should be able to transmit maximum torque of the engine.

2.Gradual engagement. The clutch should engage gradually to avoid sudden jerks.

3.heat dissipation . The clutch should be able to dissipate large amount of heat which is generated during clutch operation due to friction.

4.Dynamic balancing. The clutch should be dynamically balanced. This is particularly required in the case of high speed engine clutches.

5.Vibration damping. The clutch should have suitable mechanism to damp vibrations and to eliminate noise produced during the power transmission.

6.Size. The clutch should be as small as possible in size so that it will occupy minimum space.

7.Free pedal play. The clutch should have free pedal play in order to reduce effective clamping load on the carbon trust bearing and wear on it.

8.Easy in operation. The clutch should be easy to operate requiring as little exertion as possible on the part of the driver.

9.Lightness. The driven member of the clutch should be made as light as possible so that it will not continue to rotate for any length of time after the clutch has been disengaged.

TYPES OF CLUTCHES

a. Single plate clutch
b. Multiplate clutch
c. cone clutch.

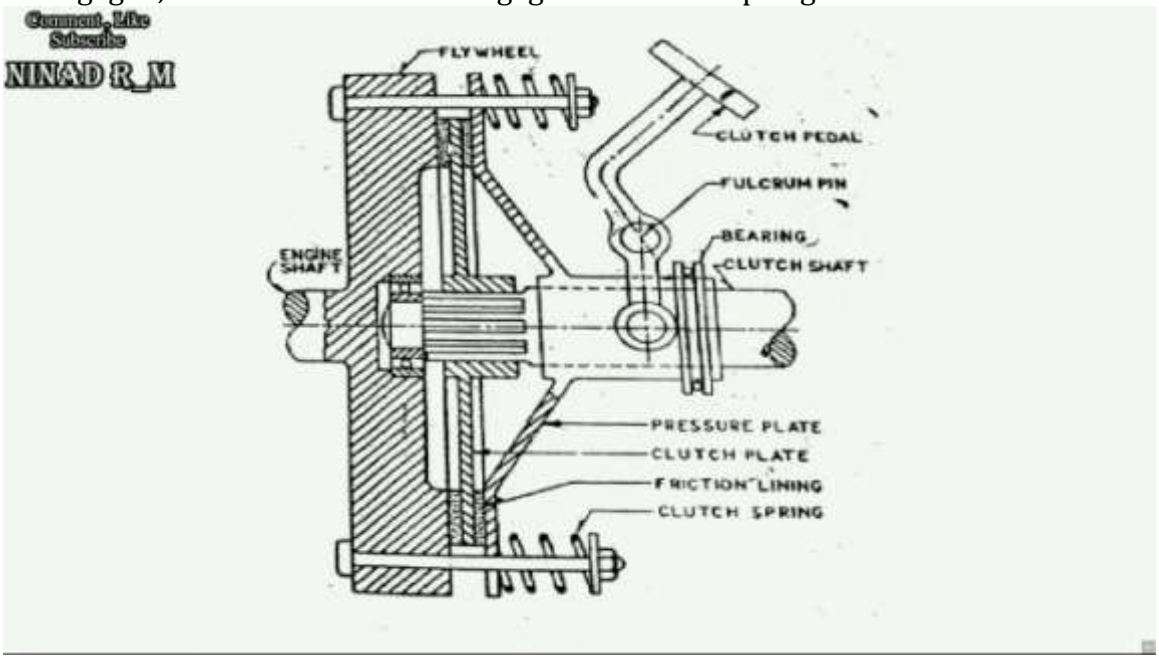
2. Centrifugal clutch.
3.Semi-centrifugal clutch.
4.Conical spring clutch or Diaphragm clutch:
5..Electro-magnetic clutch.
6.Vaccum clutch.

A)SINGLE PLATE CLUTCH

It is most common type of clutch used in motor vehicles. Basically, it consists of only one clutch plate, mounted on splines of the clutch shaft, as shown in fig. The flywheel is mounted on the engine crankshaft and rotates with it. The pressure plate is bolted to the flywheel through clutch springs, and is free to slide on the clutch shaft when the clutch pedal is operated. When the clutch is

engaged, the clutch plate is gripped between the flywheel and the pressure plate. The friction linings are on both the sides of the clutch plate. Due to the friction between the flywheel, clutch plate and pressure plate, the clutch plate revolves with the flywheel. As the clutch plate revolves, the clutch shaft also revolves. Clutch shaft is connected to the transmission. Thus, the engine power is transmitted to the crankshaft to the clutch shaft.

When the clutch pedal is pressed, the pressure plate moves back against the force of the springs, and the clutch plate becomes free between the flywheel and the pressure plate. Thus, the flywheels remain rotating as long as the engine is running and the clutch shaft speed reduces solely and finally it stops rotating. As soon as the clutch pedal is pressed, the clutch is said to the disengaged; otherwise it remains engaged due to the spring forces.

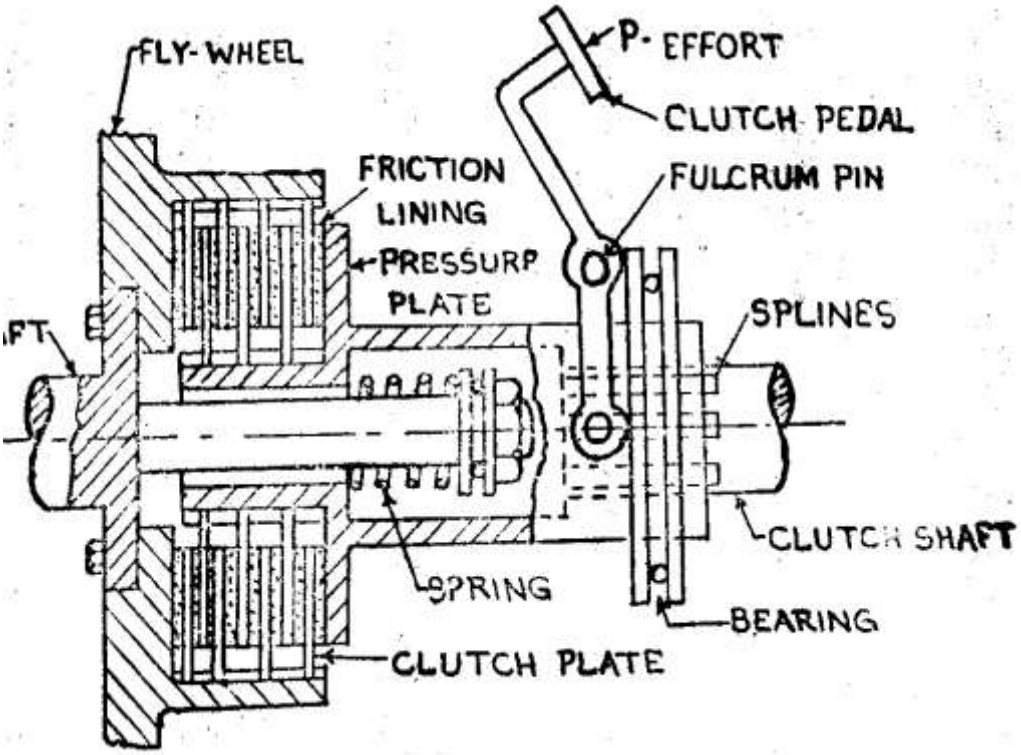


B)MULTIPLATE CLUTCH

Multiplate clutch consists of a number of clutch plates, instead of only one clutch plate as in the case of single plate clutch. As the number of clutch plates is increased, the friction surface also increases. The increased number of friction surfaces obviously increases the capacity of the clutch to transmit torque. The plates are alternately fitted to the engine shaft and gear box shaft. They are firmly passed by strong coil springs and assembled in drum. Each alternate plate slides in grooves on the flywheel and the other slides on splines on the pressure plate. Thus, each alternate plate has inner and outer splines.

The multiple clutch works in the same way as the single plate clutch, by operating the clutch pedal. The multiplate clutch works in the same way as the single plate clutch, by operating the clutch pedal. The multiplate clutches are used in heavy commercial vehicles, racing cars and motors cycles for transmitting high torque.

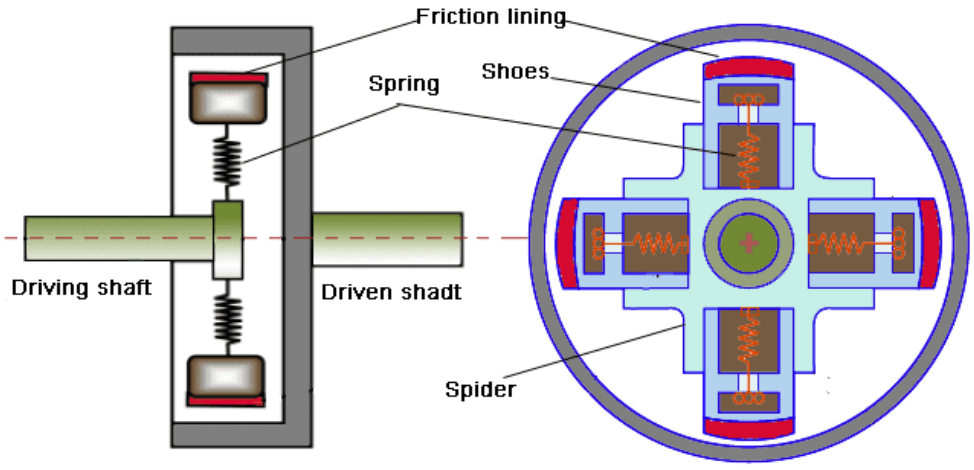
The multiplate clutches may be dry or wet. When the clutch is operated in an oil bath, it is called a wet clutch. When the clutch is operated in an oil bath, it is called a wet clutch. When the clutch is operated dry, it is called dry clutch. The wet clutch are generally used in conjunction with, or as a part of the automatic transmission.



C) CENTRIFUGAL CLUTH

The centrifugal clutch uses centrifugal forces, instead of spring force for keeping it in engaged position. Also, it does not require clutch pedal for operating the clutch. The clutch is operated automatically depending upon the engine speed. The vehicle can be stopped in gear without stalling the engine. Similarly, the vehicle can be stared in any gear by passing the accelerator pedal.

Fig shoes a centrifugal clutch. It consists of weights A pivoted at B. When the engine speed increases the weights fly off due to the centrifugal force, operating the bell crack levers, which press the plate C. The movement of the plate C presses the spring E, which ultimately presses the clutch plate D on the flywheel against the spring G. this makes the clutch engaged. The spring G keeps the clutch disengaged at low speeds at about 500 rpm. The stop H limits the movement of weights due to centrifugal force.



Centrifugal Clutch

Conclusion:

Hence students understand the detail working of clutch and its application such as Single Plate clutch used in heavy duty vehicles where as multiplate clutch used in two wheelers and centrifugal clutch used in moped vehicles.

EXPERIMENT NO.4

TITLE- Study of construction and working of four wheeler, manual shift gear box used in Automobile.

Aim: To study the different types manual shifting Gear boxes used in Automobile.

INTRODUCTION

The word transmission means the mechanism which transmits the power from engine crankshaft to rear wheels. It also means that a mechanism which provides us with suitable variation of engine torque at road wheels whenever required. This may be a gear box (manual transmission) and automatic transmission.

1. FUNCTIONS OF TRANSMISSION

A] at low speeds the torque produced by IC engine is very small which increases as speed increases, peaks at optimum speed, and start decreasing beyond that.

i) if engine is directly connected to the road drive it may not have tractive effort to start the vehicle from rest.

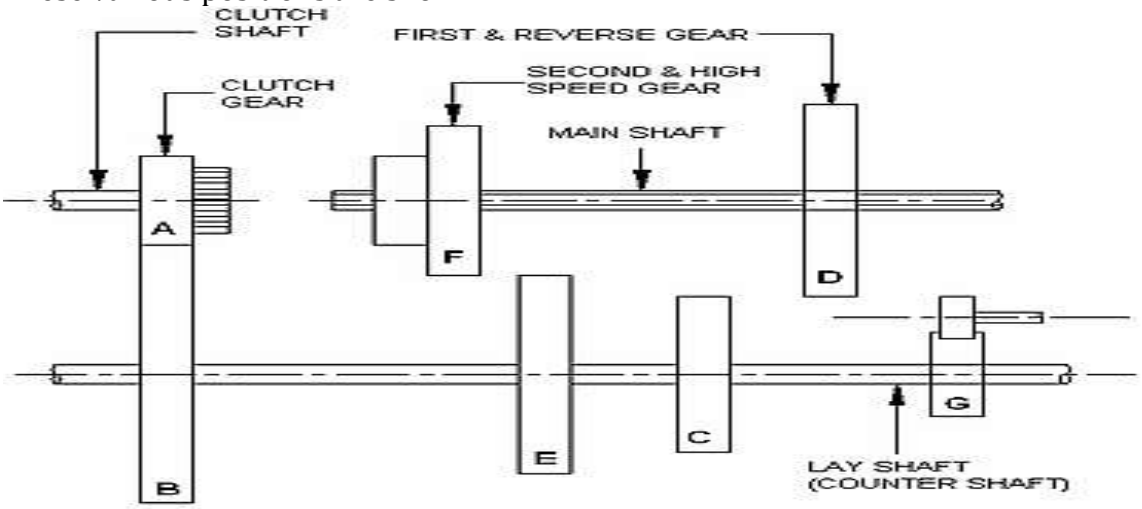
ii) the practical considerations for the automobile under different conditions demands a large variation of torque at road wheels means it's not always possible to run the engine at optimum speed besides the bigger engine requires to cater to the torque requirement under most difficult conditions. Thus, transmission provides the means to vary the torque ratio between the engine and road wheels.

B] it also provides a neutral position so that engine and road wheels are disconnected even with the clutch in the engage position.

C] a means to back the car by reversing the direction of rotation of drive is also provided by the transmission.

2. SLIDING MESH TYPE OF GEAR BOX

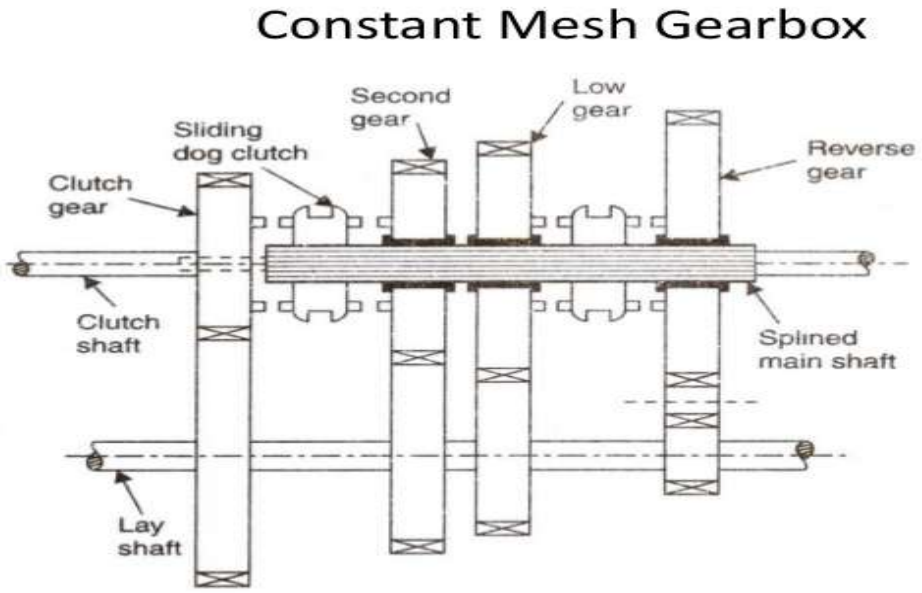
This is the simplest gear box. The power comes from the engine to clutch shaft then to cutch gear which is always in mesh with gear on layshaft. All the gear on the layshaft are fixed to it and as such they are all the time rotating when engine is running and the clutch is engaged. Three direct and one reverse speed are attained suitably moving the gear on main shaft by means of selector mechanism. These various positions are shown.



2.CONSTANT MESH GEAR BOX

All the gears are in mesh with gears on layshaft. The gears on main shaft which is splined are free. The dog clutches are provided which are free to slide on the main shaft.

When the left dog clutch is slide to left by selectormechanism, its teeth are engaged with those on clutch gears and we get three direct gear the same dog clutch when slide to right makes contact with second gear. Similarly, movement of right dog clutch to the left results in low gear and towards right in reverse gear.



2.1 DOUBLE DECLUTCHING

In the constant mesh box smooth engagement of dog clutch is necessary that the speed of main shaft gear must be increased. This is done by double declutching.

The clutch is disengaged and the gear is brought to neutral. Then the clutch is engaged and accelerator pedal pressed to increase the speed of main shaft gears after this the clutch is again disengaged and the gear moved to the required lower gear and the clutch is again engaged. As clutch is disengaged twice in this process it is called double declutching.

For changing to higher gear reverse effect is desired i.e. the driver has to wait with gear in neutral till the main shaft speed is decreased sufficiently for smooth engagement of gear.

2.2 ADVANTAGES

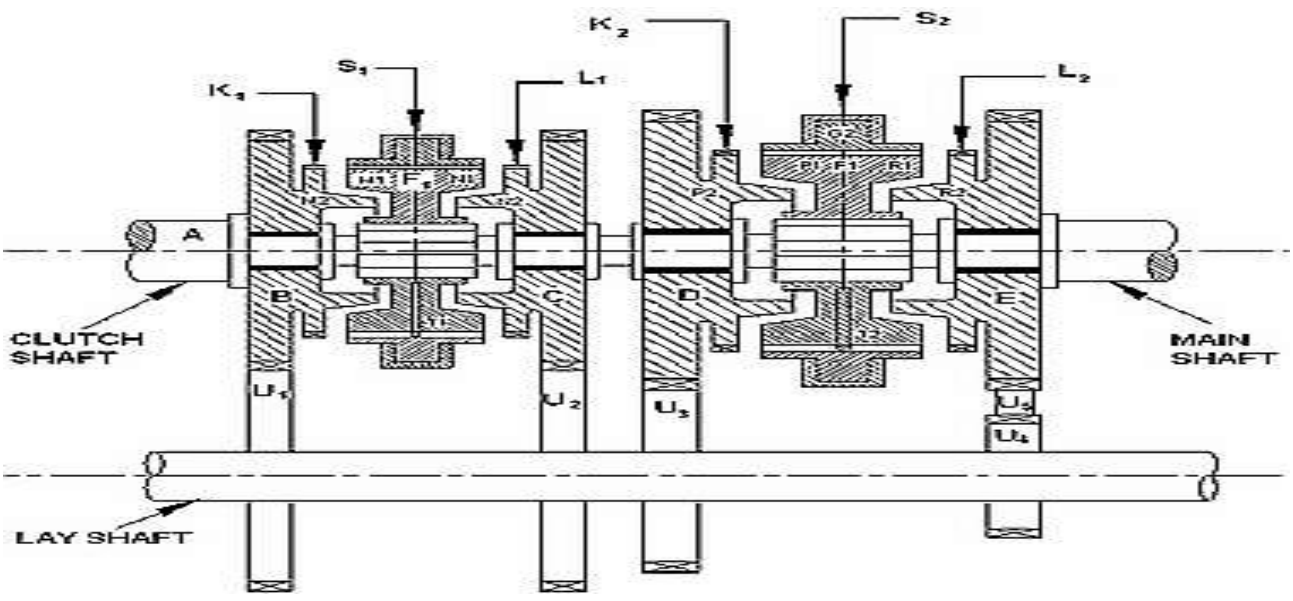
A] As the gears are always remain in mesh no necessity to use spur gears, helical can be used for quieter running.

B] wear of dog teeth on account on engaging and disengaging is reduced because all teeth of dog clutches are involved compared to 2-3 incase of sliding mesh.

3. SYNCHROMESH GEAR BOX

Similar to constant mesh type. Its working is also similar to constant mesh type, but in the former, there is improvement over the latter. This is the provision of synchromesh device which avoids double declutching. the parts which are to be engaged are brought into frictional contact which equalizes the speed, after which this may be engaged smoothly.

In most of the cars synchromesh devices are not fitted to all gears. They are fitted on high gears and on the low and reverse gears ordinary dog clutches are provided to reduce the cost.



Conclusion

Hence we studied various manual shifting gear boxes used in automobile .

EXPERIMENT NO-5

TITLE: Construction and working of Rigid Axle and Independent Suspension system used in Automobile.

AIM: To study construction and working of Independent Suspension system

INTRODUCTION

The automobile chassis is mounted on the axles, not direct but through some form of springs. This is done to isolate the vehicle body from the road shocks which may be in the form of bounce, pitch, roll or sway. These tendencies give rise to an uncomfortable ride and also cause additional stress in the automobile frame and body. All the parts which perform the function of isolating the automobile from the road shocks are collectively called a suspension system. It includes the springing device used and various mountings for the same.

OBJECTS OF SUSPENSION

1. To prevent the road shocks from being transmitted to the vehicle components.
2. To safeguard the occupants from road shocks.
3. To preserve the stability of the vehicle in pitching or rolling, while in motion.

FUNCTION OF SUSPENSION SPRINGS

Springs are placed between the road wheels and the body. When the wheel comes across a bump on the road, it rises and deflects the spring, thereby storing energy therein. On releasing, due to the elasticity of the spring material, it rebounds there by expending the stored energy. In this way the spring starts vibrating, of course, with amplitude decreasing gradually on account of internal friction of the spring material and friction of the suspension joints, till vibrations die down.

TYPES OF SUSPENSION SPRINGS

The various suspension springs may be classified as follows :

1. Steel springs
   a) Leaf spring
   b) Tapered leaf spring
   c) Coil spring
   d) Torsion bar
2. Rubber sprigs
   a) Compression spring
   b) Compression-Shear spring
   c) Steel- reinforced spring
   d) Progressive spring
   e) Face-shear spring
   f) Torsional shear spring
3. Plastic spring
4. Air spring
5. Hydraulic spring

LEAF SPRINGS

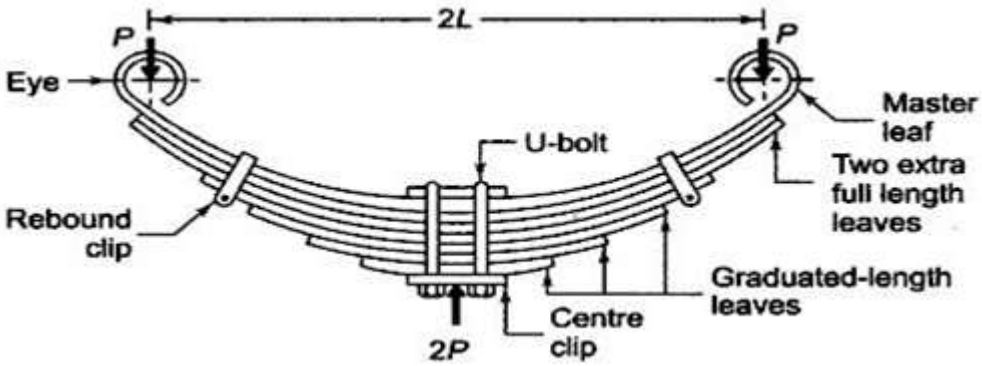
Semi-elliptic leaf springs are almost universally used for suspension in light and heavy commercial vehicles. For cars also, these are widely used for suspension.

CONSTRUCTION

fig. gives a rear axle leaf spring of semi-elliptic type. The spring consists of a number of leaves called blades. The blades vary in length as shown. The composite spring is based upon the theory of a beam of uniform strength. The lengthiest blade has eyes on its ends. This blade is called master leaf. All the blades are bound together by means of steel straps as shown.

The spring is supported on the axle, front or rear by means of a U-bolt. One end of the spring is mounted on the frame with a simple pin, while on the other end, connection is made with a shackle. When the vehicle comes across a projection on the road surface, the wheel moves up, deflecting the spring. This changes the length between the spring eyes. If both the ends are

fixed, the spring will not be able to accommodate this change of length. This is provided for by means of a shackle at one end which gives a flexible connection.



SHOCK ABSORBERS

Telescopic type shock absorber:

A 'telescopic' shock absorber drives its name from the tubular shape of early telescopes used in ancient times. These are of two types, viz., the mono-tube type and the twin-tube type. Referring to fig. wherein a twin-tube type shock absorber is shown, rod G is attached to the two-way valve A, while another similar two-way valve B is attached at the lower end of cylinder C. There is a fluid in the space below valve assembly A, below B and also in the annular space between cylinder C and tube D, which is connected to the space below the valve assembly B as shown. H is gland in the head J and any fluid scrapped off by rod G is brought down into the annular space through the inclined passage shown in the head. The eye is connected to the axle, while the eye F is attached to the chassis frame. The fluid generally used in shock absorbers is a mixture of 60 percent turbine oil.

To understand the action of the shock absorber, consider that the vehicle has come across a bump. Then eye E would move up and thereby the fluid will pass from the lower side of valve assembly A to its upper side. But since the volume of the space above A is less by the volume of the rod G, the fluid will also exerts its pressure on valve assembly B and go to the underside of valve B. this passing of the fluid through valve openings provides the damping. Similarly for downward motion of the eye E during rebound, the fluid will pass from the upper side of the valve assembly A to the lower side and also from the lower side of valve assembly B to its upper side.

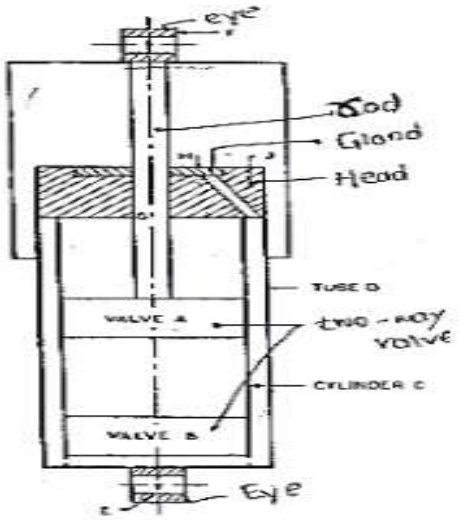
The construction of valve assembly A is shown in fig. a) and pf valve assembly B in fig. b). when the pressure on the upper side becomes greater, the valve 'c' opens against the force of the spring 'd' and thereby allows the fluid to come down to the lower side. However, when the pressure on the lower side becomes greater, the valve 'a' is lifted against the force of star-shaped spring 'b' and the fluid passes up through the various openings.

Tube D is not full of fluid. There is air above the fluid. As the fluid is forced to flow through the holes in the valves into the tube D, it has turbulence, which causes air in the tube to mix with the fluid. This aeration decreases the effective fluid viscosity which reduces the shock absorber control. On smooth road, this phenomenon is not very significant because shock absorbers operate relatively less and the air gets time to escape from the fluid. However, significant reduction of shock absorber control may occur on rough roads. To prevent this gas-charged shock absorbers have been developed, wherein an inert gas, nitrogen, is used. These may be of low pressure type (gas pressure 2.5 to 5 bar) orhigh pressure type (gas pressure 25 to 30 bar).

Modern shock absorbers are velocity-sensitive, i.e., the faster the suspension moves, the more resistance to the shock absorber provides. This results in shock absorber adjusting to road conditions and controlling all the unwanted motions that occur in a moving vehicle, e.g., bounce, sway, brake drip, acceleration squat, etc.

A telescopic shock absorber installed in position on a vehicle front axle is shown in fig.

Inflatable shock absorbers are very similar to the standard shock absorber, except that these have an air chamber bladder shown black in fig. high pressure air in the bladder forces apart the upper and the lower sections of the shock absorber, which increases the distance between the axle and the vehicle body, thereby helping the body to level. Theair being compressible, does not have any significant effect on the overall performance of the shock absorber. In case of failure of the air circuit, it behaves only as an ordinary shock absorber.



Telescopic Shock Absorber

FRONT WHEEL (DEAD AXLE) INDEPENDENT SUSPENSION

Independent suspension has become almost universal in the case of front axle, due to the simplicity of construction of such a suspension system.

Five types of independent suspension are in use for front axle:

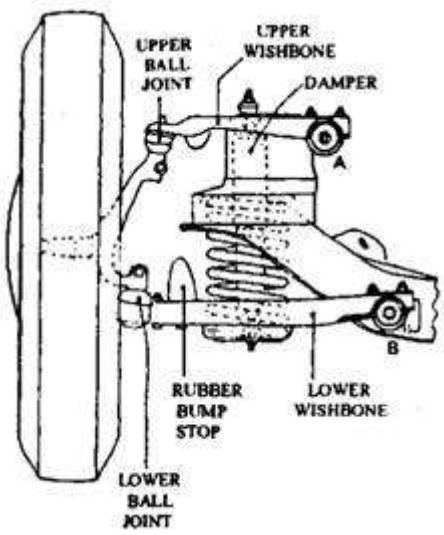
1. Wishbone type or parallel link type
2. Mac Pherson strut type
3. Vertical guide type
4. Trailing link type
5. Swinging half-axle type

WISHBONE TYPE SUSPENSION

Fig. shows a diagrammatic sketch of wishbone type suspension with coil springs. The use of coil springs in the front axle suspension of cars is now almost universal.

It consists of upper and the lower wishbone arms pivoted to the frame member. These arms resemble letter 'A' of the roman alphabet due to which these are also referred to as 'A-arms'. The spring is placed in between the lower wishbone and the underside of the cross-member. The vehicle weight is transmitted from the body and the cross-member to the coil spring through which it goes to the lower wishbone member. A shock absorber is placed inside the coil spring and is attached to the cross-member and to lower wishbone member.

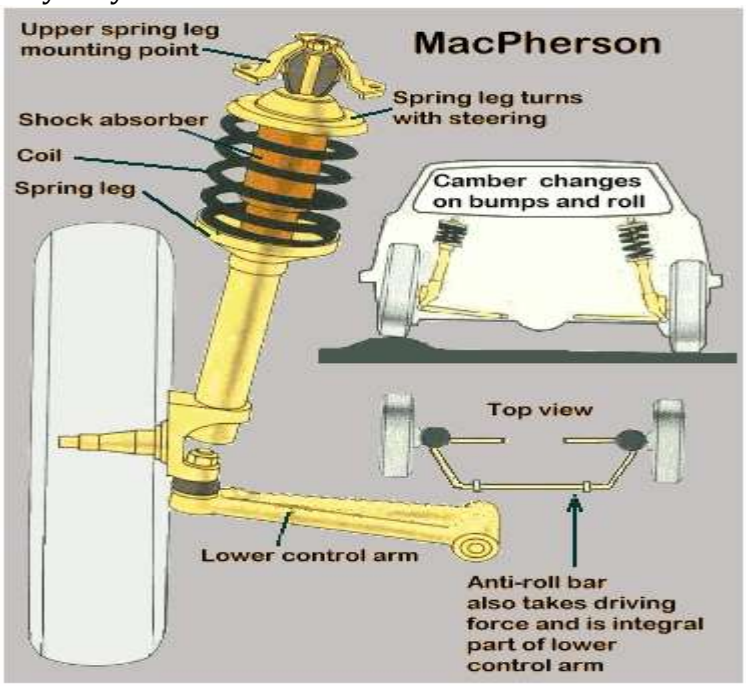
The wishbone arms are like the chicken wishbone or letter V in shape, because of which the system is so called. Because of this V-shape, the wishbones not only position the wheels and transmit the vehicle load to the springs, but these also resist acceleration, braking and cornering (side) forces. The upper arms are shorter in length then the lower ones. This helps to keep the wheel track constant, thereby avoiding the tyre scrub thus minimising tyre wear. However, a small change in the camber angle does occur with such an arrangement.



MAC PHERSON STRUT TYPE OF SUSPENSION

In this layout, only lower wishbones are used. A strut containing shock absorber and the spring carries also the stub axle on which the wheel is mounted. The wishbone is hinged to the cross member and positions the wheel as well as resists accelerating, braking and side forces. This system is simpler than double wishbone type described above and is also lighter, keeping the unsprung weight lower. Further, the camber also does not change when the wheel moves up and down. This type of suspension system gives the maximum room in the engine compartment and is, therefore, commonly used on front wheel drive cars.

Mac Pherson strut was developed by Earle S. Mac Pherson of general motors in 1947. In India this system was first used in Maruti (Suzuki) 800 cars. This type of suspension with anti-roll bar as employed in Volkswagen Jatta and Passat cars is shown in fig. this is claimed to provide increased road safety, improve ride comfort and light and self-stabilizing steering which means that car continues along its chosen line of travel when the brakes are applied even though the roadsurface may vary.



3

AIR SUSPENSION

Air suspension systems are coming into prominence because of certain advantages they posses over the conventional metal springs. These advantages are:

1. A variable space for wheel deflection is put to optimum use by virtue of the automatic control devices.
2. Because the vehicle attitude is also constant, changes in head lamp alignment due to varying loads are avoided.
3. The spring rate varies much less between the laden and unladen conditions, s compared with that of conventional steel springs. This reduces the dynamic loading.

4. The improved standard of ride comfort and noise reduction attained with air springs reduces both driver and passenger fatigue.
   Two generally used types of air springs are given in fig. a) shows a bellow type spring, while fig. b) indicates a piston type spring. Both have been shown employed in a wishbone type independent suspension system. Internal volume of the bellows is reduced during jounce, which means that the air pressure inside the spring is increased as it is compressed, i.e., the spring becomes stiffer. Due to this the optimally comfortable ride is provided under all conditions. A vehicle with electronic air suspension can provide about three times softer ride as provided by conventional coil springs, simultaneously absorbing bumps and protecting against bottoming, due to variable spring rate. The layout of an air suspension system has been shown in fig. the four air springs, which may be either the bellows type or the piston type as discussed above, are mounted on the same position where generally the coil springs are mounted. An air compressor takes the atmospheric air through a filter and compresses it to a pressure of about 240 MPa, at which pressure the air in the accumulator tank is maintained, which is also provided with a safety relief valve. This high pressure air goes through the lift control valve and the levelling valves, to the air springs as shown. The lift control valve is operated manually by means of a handle on the control panel, through a cable running from the valve to the handle.

Conclusion

Hence we have studied the different suspension systems used in automobile, like leaf spring used in heavy vehicles,(TATA 407) wishbone suspension system used in Maruti Ciaz, Macpherson in Maruti 800.

EXPERIMENT NO-6

TITLE: Construction and Working of Steering Assembly used in Automobile.

Aim:To study Steering assembly .

Introduction

The main function of a steering system is to convert the rotary motion of the steering wheel into angular displacement of the front wheels. The system must also maintain the straight-ahead motion of the vehicle while it encounters pot holes and road bumps and must operate with minimum effort.

While travelling straight, both the front wheels must be parallel with each other. During a turn, each wheel must roll on an arc and these arcs should hav a common centre. Tyre wear and slip is reduced to a minimum with such a condition.

Steering is effected by moving the axes of rotation of the front wheels with respect to the chassis frame. To satisfy this condition, the inner wheel must turn through a greater angle than the outer one. If not, tyre wear is greatly increased.

STEERING SYSTEM FUNCTIONS

The functions of a good steering system are as follows.

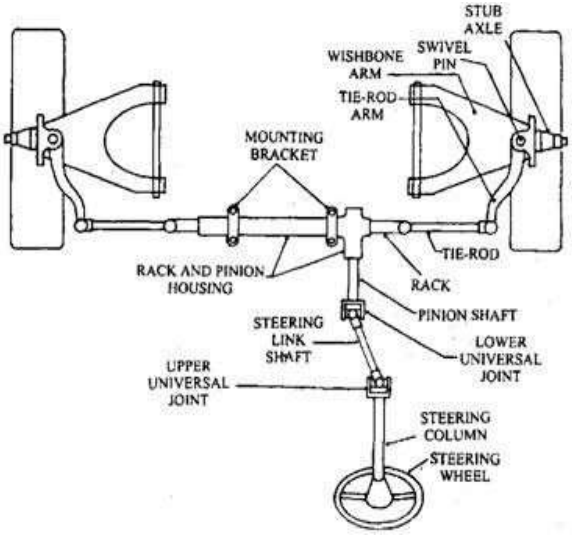
1. To turn the vehicle at the will of the driver
2. To control the wear and tear of tyres
3. To convert the rotary motion of the steering wheel into angular displacement of the front wheels
4. To multiply the effort of the driver for easy operation
5. To provide directional stability and rolling action of the wheels on the road surface
6. To achieve the self-rightening effect
7. To absorb road shocks and to prevent them from reaching the driver

ARRANGEMENT OF STEERING SYSTEM

The steering linkage of a rigid axle suspension system shown in comprises a steering wheel, steering shaft, steering gear box, drop arm, drag link, steering arm, track or tie rod, track arm, stub axles and king pin assembly or steering knuckles.

When the steering wheel is turned, motion is transmitted to the steering box by the steering shaft rotating in a hollow steering column. A drop or pitman arm is splined to the steering gear box rocker arm on one end and the other end is connected to the drag link by a ball joint. The drag link gives motion to the steering arm and to the steering knuckle. The other wheel is turned by a track rod. It is attached to the steering arms by the help of ball joints.

The front wheel independent suspension may have steering linkages as shown in. In the parallelogram-type steering linkage, there are two tie rods which get their motion from a relay rod. Such an arrangement is suitable with parallel-arm independent suspension. The other types are shown in.



TYPES OF STEERING GEARS

The steering box enables the driver to exert a large force on the road wheel with minimum effort applied at the steering wheel. It also changes the rotary motion of the steering wheel into lateral movement of the tie rod.

Steering gear ratios vary from 12 : 1 on cars to 35 : 1 on heavy commercial vehicles. Steering gear box efficiency should be such that the gears should be reversible, i.e. motion can be transmitted from steering wheel to the drag link and vice versa. This helps the driver to 'know' the road wheels without transmission of shock loads due to road imperfections.

The following are the main designs of steering box in common use.

1. Worm and sector
2. Rack and pinion
3. Recirculating ball

Worm and Sector

It is a modification of worm and worm wheel steering box. The worm wheel has been replaced by a sector which has greatly reduced the size and weight of the mechanism.

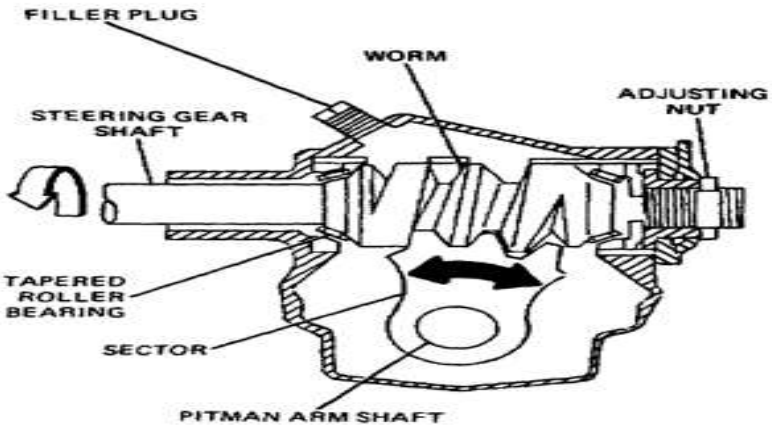
The steering gear box as shown in has component parts such as rocker shaft, gear sector, drop arm, worm wheel, taper roller bearings, steering shaft, malleable iron or light alloy casing with an oil filler plug and screws, shims for backlash adjustment.

The case-hardened steel integral worm and steering shaft is housed in the casing by radial ball thrust bearings, one at each end of the worm. An oil seal with retainer is located in the casing above the upper bearing. The bearings are press fit on the worm shaft.

The case-hardened steel helical tooth sector is fixed to the rocker shaft. The centre line of the worm wheel is off-set to the toothed sector. The rocker shaft is placed inside the casing and is supported on two or three lead-bronze steel backed bushes. The outer end of the rocker shaft has a rubber or cork oil seal with a retainer.

The sector and worm teeth backlash is set by an adjusting screw in the gear cover. The drop arm is screwed to the rocker shaft by a nut and lockwasher.

The steering shaft is enclosed in a steering column on nylatron bearings situated at the top of the column. The upper end of this shaft is serrated and fixed to the steering wheel by a plain washer and nut.



Rack and Pinion Steering Gear

This steering gear is widely used in cars with independent front suspension. Ambassador and Maruti-800 make use of this mechanism.

It comprises (i) a rack, (ii) tie rods, (iii) pinion, (iv) ball joints (v) universal joint, (vi) rubber boot and (vii) spring pads.

The steering gear used in Ambassador cars. The steel case hardened pinion is attached at the end of the steering shaft. A universal joint is provided at the bottom end of the steering shaft to mount the steering box centrally and to provide more leg space.

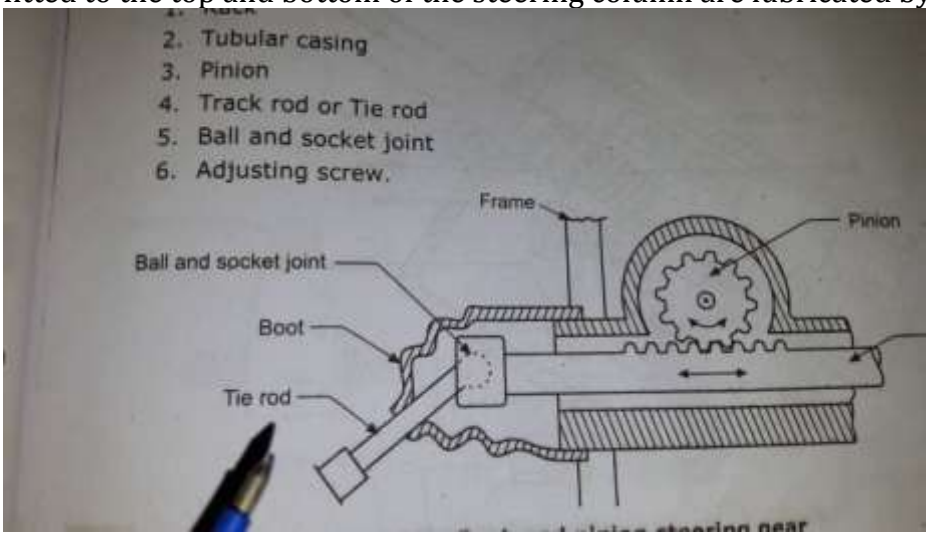
The casing made of malleable iron houses the pinion on bearings, sometimes it houses a nylon yoke type damper also.

The pinion engages with a rack which moves sideways to give lateral movement to the front wheels. The tie rods are attached to this rack by ball joints enclosed in bellow type rubber boots. The ball joints allow for rise and fall of the wheels. Spring pads on the underside of the rack tend to reduce the backlash between gears to a minimum.

The rack backlash is adjusted by adding shims to the damper cover plate. The pinion endplay is adjusted by adding shims to the damper cover plate. The pinion endplay is adjusted by adding shims to the bearing cover plate.

The gear ratios obtained are 17.5 : 1 in the case of Maruti-800.

The box or casing is filled with hypoid SAE-90 oil up to the required level. The felt bearings fitted to the top and bottom of the steering column are lubricated by graphite oil.



Recirculating Ball Type

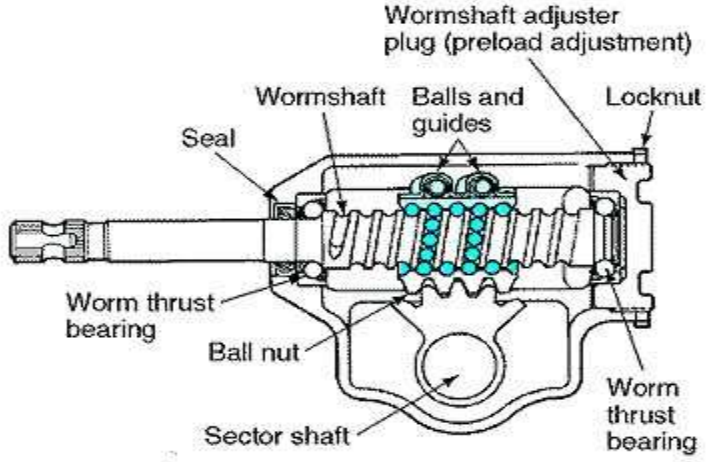
This type of steering gear is used in heavy commercial vehicles such as Tata and Ashok Leyland Viking trucks manufactured in India.

In such a steering gear, the worm at the end of the steering shaft has a nut having recirculating steel balls in between grooves of worm and nut. The balls greatly reduce the friction, increasing the efficiency of the mechanism o 90 %. Teeth formed on the outside of the nut are in mesh with a toothed wheel sector. The drop arm attached to this sector steers the front wheels through the link rod and the steering arms.

As the driver turns the steering wheel, the two steel ball races roll in the grooves and the nut travels along the length of the worm. The wheel sector gets its motion from the nut which, in turn, moves the drop arm to displace the front wheels. The ball guides recirculate the steel balls in the worm grooves.

The backlash between the sector and the external teeth on the nut is adjusted by turning a screw till the required adjustment is effectet.

The worm shaft end-play is adjusted with the help of adjuster nut or with addition and subtraction of shims at its end. The steering shaft endplay is adjusted by shims.



The balls are recirculated through the ball guides.

POWER STEERING

The prupose of power steering is to reduce the driver's effort at the steering wheel. Such a system is used in big cars and heavy commercial vehicles whose unladen weight is more than 1500 kgs.

It is useful while driving on rough roads at low speeds and while reversing the vehicle for parking purposes.

Power steering mechanism employs electrical devices, compressed air and hydraulic pressure. We shall explain the system, employs electrical devices, compressed air and hydraulic pressure. We shall explain the system, employing hydraulic pressure being widely used. The two

types of power steering system forms part of the steering gear whereas in the latter, it forms part of the steering linkage.

The hydraulic power assisted steering system comprises of (i) a fluid reservoir, (ii) hydraulic pump, (iii) hydraulic ram with a fixed length piston rod, (iv) hydraulic control valve, (v) steering shaft, (vi) steering box and (vii) steering wheel.

The engine driven hydraulic pump feeds the fluid under pressure from the fluid reservoir to the hydraulic feed lines. A hydraulic control valve situated below the steering senses the input pressure at the steering wheel and converts it into pressure changes into the hydraulic ram.

When the steering wheel is at rest, the fluid exerts the same pressure on both sides of the hydraulic ram piston keeping the hydraulic ram at rest.

As soon as the driver turns the steering wheel, the steering arm moves the control valve such that one of the ports closes whilst the other opens. High pressure fluid from the pump flows to one side of the hydraulic ram piston moving it towards one side as shown in Fig. 15.9. the movement of the piston causes the steering linkage to move in the required direction.

The following are the advantages of such a system.

1. The driver's effort is substantially reduced while he can easily get the 'feel' of the road.
2. When the vehicle suddenly meets a bump or the front tyre bursts, there is no 'coming back' of the steering wheel as in the case of conventional steering. The driver can easily control the vehicle.
3. Even if the hydraulic power system fails, the vehicle can be maneuvered easily by the help of manual steering.

Conclusion:

Hence students understand the detail working of steering system and steering gears which are used in various vehicle like cars (TATA Indica, Mini Door).

Experiment No. 7

TITLE: To study the construction and working of differential used in the Automobile .

Aim: To study the differential .

Necessity of differential :

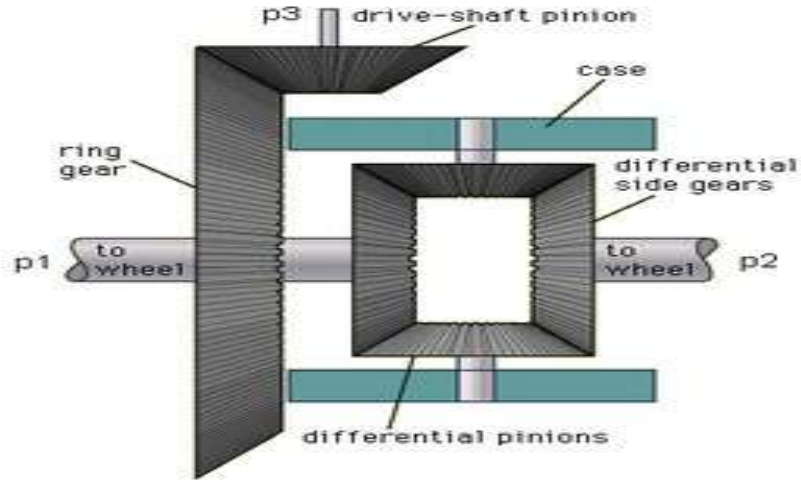
When a vehicle is taking a turn, the outer wheels will have to travel greater distance as compared to the inner wheels in the same time . If therefore ,the vehicle has a solid rear axle only there will be tendency for the wheels to skid. Hence if the wheels skidding is to be avoided , some mechanism should be provided in the rear axle. The mechanism which reduce the speed of the inner wheels and increases the speed of outer wheels when taking turns , it should at same time keep the speeds of all the wheels same when going straight ahead. Such a device which serves the above function is called a differential.

Construction and working of differential :

The following are the main parts of differential :

- Differential housing
- Crown wheel or crown pinion
- Sun pinion or sun gears
- Start pinion or start gears
- Axle half shaft
- Final drive

The sun gears are mounted on the inner end of each half shaft of the drive axle. The crown wheel is attached in the differential cage to which the power is transmitted from gear box through propeller shaft and final drive bevel pinion when the differential unit rotates , both the sun gears rotate and thus both wheels turn which are attached to the half shafts .Suppose one wheel is held stationary the gears of star pinions carry rotary motion to the outer axle causing it to rotate. Therefore , when one rear wheel run more rapidly than other ,while car taking a turn ,the star gears spin on the shaft transmitting more rotary motion to the outer wheel .This causes faster rotating of outer wheel than the inner .



Differential lock :

The torque transmitted by the bevel gear differential to each of the rear wheels remains equal even when they are rotating at different speeds .Due to this reason if one wheel is on a slippery surface ,lose dirt or sand the wheel on the solid ground will not be driven while the other spins around idly .when the differential action is stopped and the whole torque is then applied to the wheel which is gripping on the road .

Self locking differential :

A self locking differential consists of two clutches one on each side, to lock the side gears and axles to the differential cage, when the differential, action is not desired . The mechanism consists of four differential pinion gears mounted on two cross shafts at right angles to each other . when the differential cage is driven by the rear axle gears , the turning resistance causes the cross shafts to move up the ramps and push the shafts apart . This action forces the

pinion on each shaft to bear against the side gear rings in order to apply the clutch which locks both axle shafts and forces them to turn at the same speed .

Conclusion:

Students will learn the necessity and importance of differential while taking turn.

EXPERIMENT NO-8

TITLE: Construction and assembly of the braking systems used in the automobile. Study of tandem master cylinder, slave cylinder.

Aim: To study various braking system and their components used in Automobile.

Introduction

A moving vehicle possesses kinetic energy which is converted into heat energy on the application of brakes. This heat is transferred to the surrounding air. In the simpleast form, a brake comprises a stationary brake shoe with a friction lining on it and a brake drum. The driver applies force on the brake pedal which gets amplified and pushes the stationary shoe to make contact with the brake drum and stops its rotation due to frictional resistance. The heat generated due to braking action is proportional to the force which brings the shoe in contact with the drum.

REQUIREMENTS

Brakes, in general, are required to slow, stop or hold the vehicle and convert the kinetic energy of motion into heat and then to dissipate this heat

1. Application of brakes should bring the vehicle to a relatively quick stop on any type of road-wet, even, uneven, uphill or downhill.
   The vehicle may be at any speed, laden or unladen.
2. A separate mechanical brake is required to hold the vehicle in position on a gradient.
3. The braking system components must require minimum maintenance.
4. The pedal effort required to produce maximum deceleration should be negligible and should not vary with the condition of the road.
5. The braking system should allow minimum time between application of pedal effort and actual braking effect on the drums.
6. The braking action should not involve any noise, or drift the vehicle away from its desired path.
7. Provisions for quick heat dissipation must be incorporated.
8. A secondary braking system must be incorporated, should the primary braking system fail.

CLASSIFICATIONS

Broadly, brakes are classified as (i) drum brakes and (ii) disc brakes. The operating systems for such brakes can be of many types:

① Mechanical, ② hydraulic, ③ pneumatic, ④ vacuum, ⑤ electrical, ⑥ combined vacuum and hydraulic.

DRUM BRAKES

These may be (1) Internal expanding and (2) external expanding.

Internal expanding brakes have brake shoes contained within the brake drums and expand outwards to make contact with the rotating brake drum, whereas external expanding brakes contract to make contact with the rotating drum.

Construction

Drum brakes have the following working parts

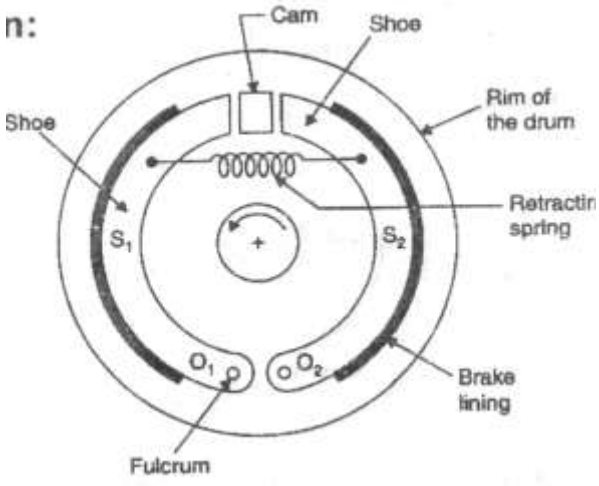
1. Brake back plate is mounted on the stationary part of the axle. Attached to it is the brake shoe actuating device- a cam, hydraulic wheel cylinder, etc. The shoes are held to it by two long bolts. Anchor pins or manual shoe adjusters are fixed at the lower end. The steel back plate withstands the stresses caused due to braking torque. The outer periphery of the back plate is lipped and fits over the brake drum. This design keeps water and dirt away.
2. Brake shoes are in “T” section made of sheet steel or cast aluminium alloy. Aluminium alloy transfers heat fast and has low weight. The tip of the shoe is made flat to touch the cam surface in the case of mechanical brakes or else it abuts against the end of the wheel cylinder in the case of hydraulic brakes. The heel of the shoe is fixed either on anchor pins and locked or attached to adjusters. Holes are provided in the shoes for retracting springs. Brake linings are fixed to the shoes by a special adhesive in the case of scooters, mopeds and motor cycles and by brass or aluminium rivets in the case of cars and trucks. The linings have to withstand high temperatures of about 350 ˚C without distortion and are made of asbestos based materials having high coefficient of friction. The different lining

materials are (i) moulded pulp (ii) compressed fabric, (iii) woven and (iv) impregnated asbestos sheet.

3. Brake drums are made of nickel-iron casting, this metal gives optimum rate of heat transfer and provides good anti-wear qualities. Scooter and motor cycle brake drums are made of cast aluminium with a bonded cast iron liner. These run cooler and transfer heat fast and have ribs on its outer surface to provide the necessary strength.

   The brake back plate is fixed to the stationary axle casing whereas the drum is fixed to the rotating axle and road wheel.

4. The retracting springs bring back the shoes to their original positions when the brake pedal is released.



Disc Brakes

Figure shows the construction and working of a disc brake. It consists of the following parts:

❶ Connecting tube ❷ Cylinder ❸ Piston ❹ Friction pad
❺ Hydraulic fluid ❻ Brake disc ❼ From master cylinder ❽ Calliper

Disc

It is made of high-grade of grey cast iron having pearlitic structure to give better wear resistance property. The surface finish of the disc should be smooth with a runout not more than 0.10 mm or else vibrations would occur at the pedal. This disc which rotates with the car wheel is efficiently cooled as most of its area lies exposed. Ventilated discs have two discs linked by internal ribbings instead of one thick disc. Air can flow through ventilations from all directions to make cooling faster.

Calipers

These are of V-shaped type and are in two halves. Each half has a pad bonded to a steel plate, a steel piston and a brake cylindrical housing bolted together. Both these halves are hydraulically linked so that equal pressure may be applied on the pad through floating pistons. Hydraulic pressure is applied only on one side of the piston. Nipples are provided with calipers for bleeding purposes. Sometimes 4-piston calipers are used for effective braking.

Friction pads

These are made of asbestos fibre and metal oxide fillers bonded with organic compounds. Each pad is fixed to a steel backing plate which has to take torque reaction during braking on to the caliper.

Two retaining pins passing through holes in the calipers and the back plates hold the pads in radial position. Spring clips keep the retaining pins in position and shims are used to keep the pad assembly in position. The pads may be of square, rectangular, oval or segmental in shape. The size of the piston is made the same as that of pads to avoid noise during braking. Rubber sealing rings prevent dust and moisture to enter the piston housings.

Working

When the driver applies pressure on the brake pedal, hydraulic pressure pushes the pistons out from their housing. The pistons, in turn, press the brake pads against the moving disc faces, causing friction and hence slowing it down. Hydraulic pressure is equally applied by the hydraulic fluid to the floating pistons on either side. When the driver takes his foot off the brake pedal, hydraulic pressure on the friction pads is released, the pistons move inwards and break their contact with the disc.

Advantages of disc brakes over Drum Brakes:

1. Disc brakes provide better stability since these have uniform pressure distribution over the pads than that of the brake linings in the case of drum brakes.
2. Increased temperature does not affect the disc pads much compared to the brake linings of the drum brakes.
3. The design of the brake adjusters becomes simple because when hot, the discs expand towards the pads causing no loss in pedal travel
4. The application of brakes causes lesser bearing load since the overhang is lesser over the adjacent bearing
5. Maintenance and repairs of disc brakes is easy

Disadvantages

1. Disc brake assemblies are costlier than drum brakes
2. The pads wear off fast compared to brake shoe linings of drum brakes. Disc brakes have higher brake pressures
3. Complete protection to the disc from road debris is provided with great difficulty
4. The high temperature operation of disc brakes causes evaporation of the brake fluid and deterioration of seals
5. In the case of cars fitted with disc brakes, an external servo mechanism is required because these have no self energizing effect. Such an arrangement is not required in cars having drum brakes
6. Handbrakes can be installed on drum brakes because these have self energizing effect. Disc brakes offer difficulty in installing hand brakes.

MECHANICAL BRAKES

Mechanical brakes have been outdated in cars but are mostly used as 'parking brakes'. Scooters, motor cycles and mopeds use such type of brakes.

Mechanical brakes are simply drum brakes consisting of (i) brake drum, and (ii) brake shoes with brake linings-there are two shoes called leading and trailing, (iii) cam or toggle lever, (iv) retractor spring, (v) a brake lever for the driver (a wire or rod connects this lever to the cam) and (vi) brake back plate.

The leading shoe is the first shoe after the cam in the direction of rotation. The friction between the shoe and the drum pushes the tip of the leading shoe harder in contact with the drum and pushes it off at its toe, whereas the trailing shoe tip is thrown away off the brake drum, as the drum rotates against it.

The braking effort by the leading shoe is four times that of the trailing shoe and hence it wears faster. The leading shoe has a self-applying effect called the 'self-servo effect'.

HYDRAULIC BRAKES

These types of brakes consist of master cylinder, which contains hydraulic brake fluid. Master cylinder is operated by the brake pedal and is further connected to the wheel cylinder in each wheel through pipelines, unions and flexible lines. The system is so designed that even when the brakes are in the released position, a small pressure of about 50kpa is maintained in the pipelines to ensure that the cups of the wheel cylinder are kept expanded. This prevents the air entering the wheel cylinders when the brakes are released. Besides this pressure also serves the following purposes:

1. It keeps the free travel of the pedal minimum by opposing the brake shoe retraction springs.
2. During bleeding, it does not allow the fluid pumped into the line to return, thus quickly purging air from the system.

MASTER CYLINDER:

It consists of fluid reservoir and compression chamber in which piston operates. The fluid in the reservoir compensates for any change in the fluid volume in the pipelines due to temperature variations and to some extent due to leakage. To prevent leakage there are rubber seals on both sides of the piston in the compression chamber. The fluid always surrounds the reduced diameter region of the piston. A rubber boot covers the push rod and of the master cylinder to prevent the dirt entering inside. Towards the brake lines side of the compression chamber, there is fluid check valve

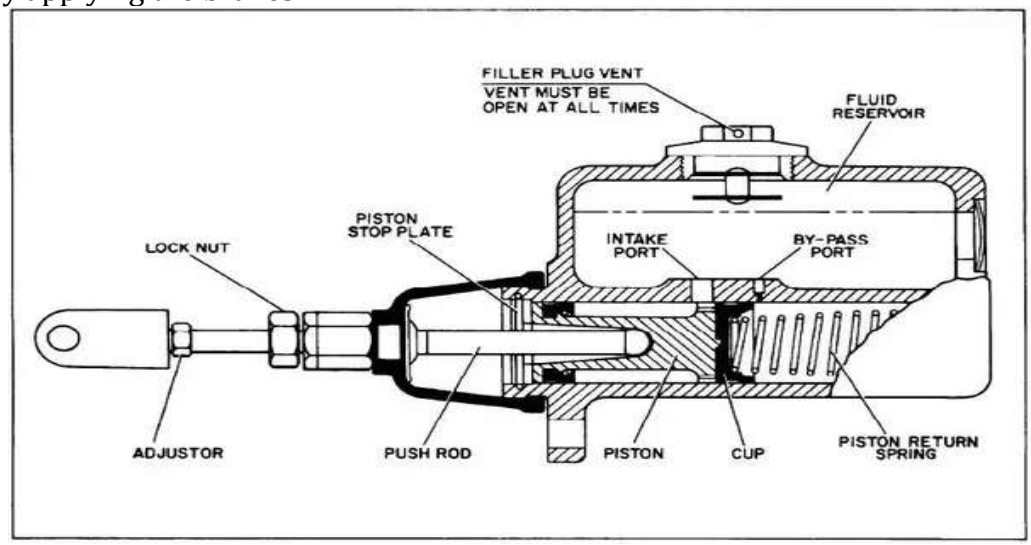
with a rubber cup inside. It serves to retain the residual pressure in the brake lines even when the brakes released.

There are a number of holes in the piston head on the primary (high pressure) seal side. Two holes connect at the reservoir to the compression chamber. The smaller one out of these is about 0.7 mm diameter and is called the bypass or compression port. The second hole is called the intake or recuperation port. Besides, there is a vent in the cap, to keep the brake fluid always at atmospheric pressure.

The push rod is operated with the foot brake pedal through the linkage. As the pedal is pressed, push rod moves to left against the force of the spring, till it covers the bypass port. Further movement of the push rod causes building up of pressure in the compression chamber. Finally, when sufficient pressure has built up, the inner rubber cup of the fluid check valve is deflected, forcing the fluid under pressure in the lines. This fluid enters the wheel cylinder or the caliper and moves the pistons thereby applying the brakes.

When the brakes are released, the spring pressure in the master cylinder moves the piston to the right extreme position. This same force of the spring keeps the fluid check valve pressed on its seat for sometime and thereby delays the return of fluid from the lines into the compression chamber again. Some delay is also caused by the inertia of the fluid in the lines. This produces a vacuum in the compression chamber and unless this is destroyed immediately, there are all chances of air leakage into the system. Even a very small amount of air will render the brakes unless, the air being compressible. Having intake port as shown in figure solves this problem. As soon as some vacuum is formed, the atmospheric pressure in the fluid reservoir forces the fluid through intake port and holes in the piston, which deflects the rubber, cup and enters the compression chamber, destroying the vacuum.

But by the time, the vacuum is destroyed; the fluid from the lines comes back into the reservoir by lifting the fluid check valve off its seat. This extra fluid now has to be accommodated somehow, because compression chamber is already full. If this is not done, the pressure in the lines will not be relieved fully and there are chances of brake shoe rubbing with the drum. Once this happens, there will be more heat generated at the drum, which when transmitted to the wheel cylinders would cause the fluid to expand and exert still more pressure, causing the shoes to move still further towards the drum. In this way, a vicious circle will start, causing the brakes to jam ultimately. This is avoided by means of bypass port. The extra fluid coming from the lines passes to the fluid reservoir, where pressure is maintained atmospheric by providing an air vent. Wheel Cylinder: The construction is very simple. The brake fluid under pressure forces the piston apart, thereby applying the brakes.



AIR BRAKE SYSTEM:

In drum brakes, a brake drum is attached concentrating to the stub axle hub whereas on the axle

casing is mounted on a back plate. The back plate is made of pressed steel sheet and is ribbed to increase rigidity and to provide support for the expander, anchor and brake shoes. It also protects the drum and shoe assembly from mud and dust. Moreover, it absorbs the complete torque reaction of the shoes due to which reason it is sometimes also called torque plate. Two brake shoes are anchored on the back plate. One or two retractor springs are used which serve to keep the brake shoes away from the drum when the brakes are not applied. The brake shoes are anchored at one

end, whereas on the other ends force F is applied by means of some brake actuating mechanism, which forces the brake shoe against the revolving drum, thereby applying the brakes. An adjuster is also provided to compensate for wear of friction lining with use. Sometimes, in smaller cars a single pin anchor is employed.

ANTILOCK BRAKING:

The most efficient braking takes place when the wheels are still moving. If the brakes lock the wheels so that the tires skid, kinetic friction results, and braking is much less effective. To prevent skidding and provide maximum effective braking, several antilock devices have been developed. Some provide skid control at the rear wheels only. Others provide control at all four wheels. Control means that as long as the wheels are rotating, the antilock device permits normal application of the brakes. But if the brakes are applied so hard that the wheels tend to stop turning and a skid starts to develop, the device comes into operation. It partly releases the brakes so that the wheels continue to rotate. However, braking continues, but it is held to just below the point where a skid would start. The result is maximum braking

The hydraulic operating system has the following advantages over the mechanical operating system.

1. It gives higher efficiency than any other system
2. It applies equal pressure on all the four wheels
3. It consists of minimum component parts making maintenance easy
4. It allows smooth and easy application of brakes.
5. Brake shoe thrust can be altered by changing the piston area of the wheel cylinder
6. It suits vehicles having independent suspension system

Construction

The hydraulic operating system comprises (i) master cylinder, (ii) wheel cylinder, (iii) brake drum, (iv) brake shoes and (v) brake fluid brake lines and hoses.

Principle

A hydraulic fluid transmits pressure equally to all brake shoes based on Pascal's Law which states that When any part of a confined fluid is subjected to pressure, the pressure is transmitted equally and undiminished to every portion of the inner surface of that container.

Brake Fluid

It is a special type of fluid named SAE-1703J and must meet the following requirements

1. It must have a high boiling point and low freezing point
2. It must be chemically stable
3. It must remain fluid at low temperatures but must retain good film strength at high temperatures
4. It must have good lubricating properties
5. It must be non-corrosive and must not attack rubber or metallic parts

These fluids are based on glycol or polyglycols with additives like castor oil in alcohol with a suitable neutralizer to neutralizer to neutralize the effect of acids in alcohol.

Brake Lines and Hoses

The connections between the master cylinder and wheel cylinders are made of copper coated, tin plated, annealed, steel tubings and flexible hoses. A flexible hoses is made up of alternate layers of rubber and fabric sheets wound over each other. These are used to connect the steering front wheels.

Working of Hydraulic Brakes

Brakes Pressed on

When the driver applies force on the brake pedal, the master cylinder piston moves forward, closing the fluid supply from the reservoir. The fluid is compressed and force is transmitted equally to the brake shoes through the wheel cylinder pistons. The wheel cylinder pistons move outwards and allow contact between the brakedrum and brake shoes.

Brakes Released

The fluid slowly returns from the wheel cylinder into the master cylinder by opening the check valve. The spring now closes the check valve. The slow return of the fluid causes vacuum in the compression chamber. Fluid in the reservoir being at atmospheric pressure, flows to the compression chamber through the feed holes. Meanwhile, with the destruction of vacuum, more fluid

returns back into the compression chamber. This extra fluid is allowed to pass into the reservoir through the by-pass port.

Conclusion:
Students will learn necessity and working of braking system used in Automobile.

3.Quiz on the subject:-

4. Conduction of Viva-Voce Examinations:

Professor should conduct oral examination of the students on whole subject. To make it meaningful, the questions should be such that practical knowledge of the students in the subject is tested. Oral examinations are to be conducted in cordial environment amongst the teachers taking the examination. Teachers taking such examinations should not have ill thoughts about each other and courtesies should be offered to each other in case of difference of opinion, which should be critically suppressed in front of the students.

5. Evaluation and marking system:

Basic honesty in the evaluation and marking system is absolutely essential and in the process impartial nature of the evaluator is required in the examination. It is a primary responsibility of the teacher to see that right students who are really putting up lot of hard work with right kind of intelligence are correctly awarded.

The marking patterns should be justifiable to the students without any ambiguity and teacher should see that students are faced with just circumstances.