AUTOMOBILE ENGINEERING LAB MANUAL

For B.E. (Mechanical)

Compiled By

D.S.DABHADE

Mechanical Engineering Department,
MGM'S Jawaharlal Nehru Engineering College, Aurangabad

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Mission and vision of the Department

Vision of Mechanical Department

To establish the state of the art learning center in Mechanical Engineering which will impart global competence, enterprising skills, professional attitude and human values in the student.

Mission of Mechanical Department

1. To impart quality technical education to the students.
2. To develop comprehensive competence in the students through various modes of learning.
3. To enable students for higher studies and competitive examinations.
4. To facilitate students and industry professionals for continuous improvement and innovation.

Program Educational Objectives:

[1] Use core competence acquired in various areas of Mechanical Engineering to solve techno-managerial issues for creating innovative products that lead to better livelihoods & economy of resources.

[2] To establish themselves as effective collaborators and innovators to address technical, managerial and social challenges.

[3]To equip students for their professional development through lifelong learning and career advancement along with organizational growth.

[4] Serve as a driving force for proactive change in industry, society and nation.

PROGRAM SPECIFIC OUTCOMES

Student should have

1) An ability to work professionally in mechanical systems including design, analysis, production, measurement and quality control.

2) An ability to work on diverse disciplinary tasks including manufacturing, materials, thermal, automobile, robotics, mechatronics, engineering software tools, automation and computational fluid dynamics.

---------- LIST OF EXPERIMENTS ----------

1) Study and demonstration of Layout of an Automobile

2) Study and Demonstration of Differential

3) Study and Demonstration of Clutches

4) Study and Demonstration of Brakes

5) Study and Demonstration of Gear box

6) Study and Demonstration of Steering Mechanism

7) Study and Demonstration of Suspension System

8) Study and Demonstration of Internal Combustion Engine

EXPERIMENT NO. 01

OBJECTIVE: Study and Demonstration of Layout of an Automobile.

EQUIPMENT: A working or non working model of Layout of an Automobile.

THEORY –

Components of an Automobile

1) BASIC STRUCTURE – This is the unit on which are to be built the remainder of the units to turn it in to a power operated vehicle. It consist of frame, suspension system, axles, wheels and tyres

Frame – There are two distinct forms of construction

1. The conventional pressed steel frame to which all the mechanical units are attached and on which the body is superimposed.

2. The integral or frameless construction, in which the body structure is so designed as to combine the functions of body and frame, the units normally attached to the frame being attached directly to the body. Frameless construction is possible only in case of a closed car, since the roof, screen pillars, door pillars and rear panel are essential load taking parts of structure.

Suspension System – Functions of suspension systems are

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

There are two types of suspension systems

1. The conventional system, in which the springs are attached to a rigid beam axle
2. The independent system, in which there is no rigid axle beam and each wheel, is free to move vertically without any reaction on the other wheel.

Axles – The weight carrying portions of the axles , whether it may be front or rear ,may be considered as beam supported at the ends , loaded at two intermediate points and subjected to following loads

1. The vertical load at the spring centers due to which the weight of the vehicle.

2. A fore and aft load at the wheel centre due to driving or braking effort

3. Torque reactions due to the drive or brakes.

4. A side thrust at the radius of the tyre due to centrifugal force when rounding a curve.

Wheels – Wire spoked wheels have been used mainly on sports cars, primarily on account of their light weight and quickness in changing the wheel .However the pressed steel wheel has displaced these all ordinary purposes. Such a wheel consist of a central flanged disc pressed in to a rolled section rim retained I n position by welding. Light alloy wheels are currently used in case of luxury and sport cars.

2) POWER PLANT-

The power plant provides the motive power for all the various functions which the vehicle or any part of it, may be called upon to perform. The power plant generally consists of an internal combustion engine which may be either of spark-ignition, or of compression ignition type.

3) TRANSMISSION SYSTEM –

Functions of transmission system are

1) To disconnect the engine from the road wheels when desired
2) To connect the engine to driving wheels without shock
3) To vary the leverage between the engine and the driving wheels
4) To reduce the speed permanently in a fixed ratio
5) To turn drive through a right angle
6) To make a provision such that the driving wheels may rotate at different speeds while taking turns.

Clutch – Its purpose is to enable the driver to disconnect the drive from the road wheels instantaneously and to engage drive from the engine to the road wheels gradually while moving the vehicle from rest.

Gear Box (Transmission) – The gear box or transmission provides the necessary leverage variation between the engine and road wheels.

Bevel pinion and crown wheel –

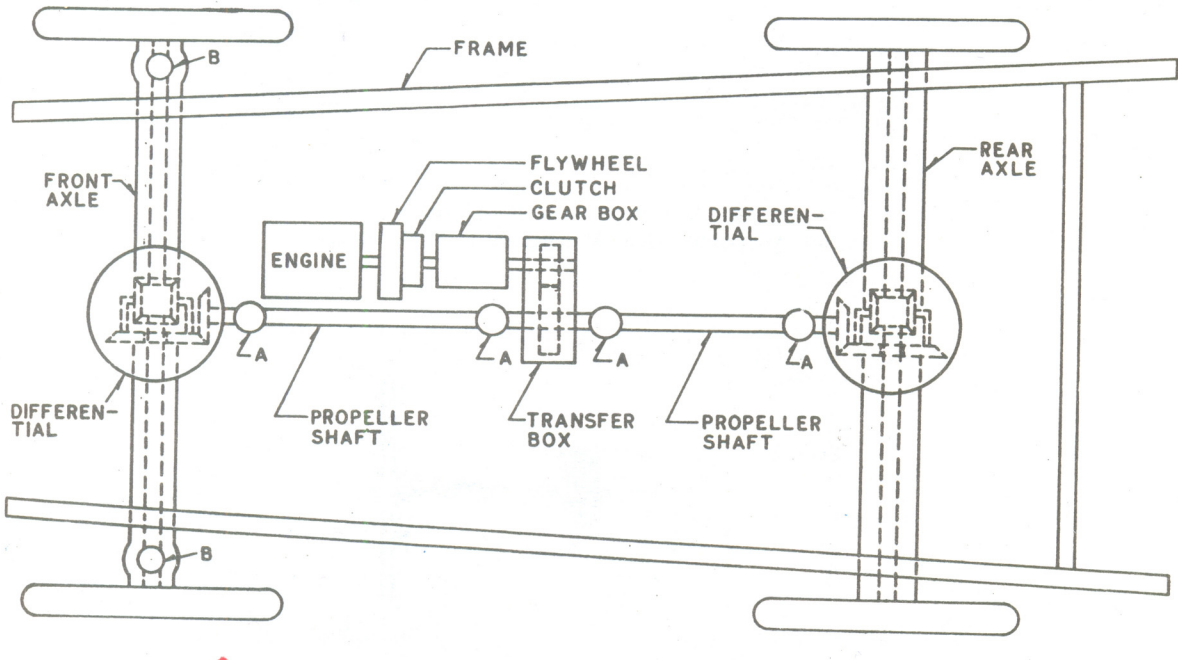
They turn the drive through 90 and also provide a permanent reduction in speed .The permanent reduction is necessitated because of the fact that speed of engine has to be maintained at optimum level at all times, yet a minimum value of torque has to be made available at the road wheels.

Universal joint-

They provide for the relative movement between the engine and the driving wheels due to flexing of road springs.

Differential –

While taking turns, the driving wheels must run at different speeds. This is done with the help of differential. Instead of using the long propeller shafts and transmitting the power from engine to the rear axle , a number of alternative methods have been used.


FRAME
B
FRONT AXLE
FLYWHEEL
CLUTCH
GEAR BOX
ENGINE
DIFFEREN-TIAL
REAR AXLE
A
A
A
A
DIFFEREN-TIAL
PROPELLER SHAFT
TRANSFER BOX
PROPELLER SHAFT
B

EXPERIMENT NO.-02

OBJECTIVE: Study of differential gear mechanism of rear axle.

EQUIPMENT: A working or non working model of differential gear mechanism of any vehicle.

THEORY: The purpose of the differential assembly is to allow the two drive wheels to turn at different speeds when the car goes around a corner. This is necessary because when cornering, the wheel on the inside of the turn goes through a smaller arc or corner than the wheels on the outside. If the wheels were not allowed to turn at different speeds, they would tend to skip around the corner and steering would be very difficult.

Differentials are used in:

i) The rear drive axle of front engine, rear wheel drives vehicles.
ii) The transaxles of front engine, front wheel drive and rear engine, rear wheel drive vehicles.
iii) The front drive axle and rear drive axle of four wheel drive vehicles.
iv) The transfer case of some four wheel drive vehicles.

Both the front drive and rear drive differential have the same job to do. They also have many of the same parts. The basic difference is the way in which engine torque is delivered to the differential assembly.

Power enters the rear axle assembly from the final drive which consists of bevel pinion connected through a rear universal yoke to the propeller shaft. The bevel pinion is meshed with the crown wheel, which is bolted to the case. This arrangement allows the bevel pinion to turn the crown wheel.

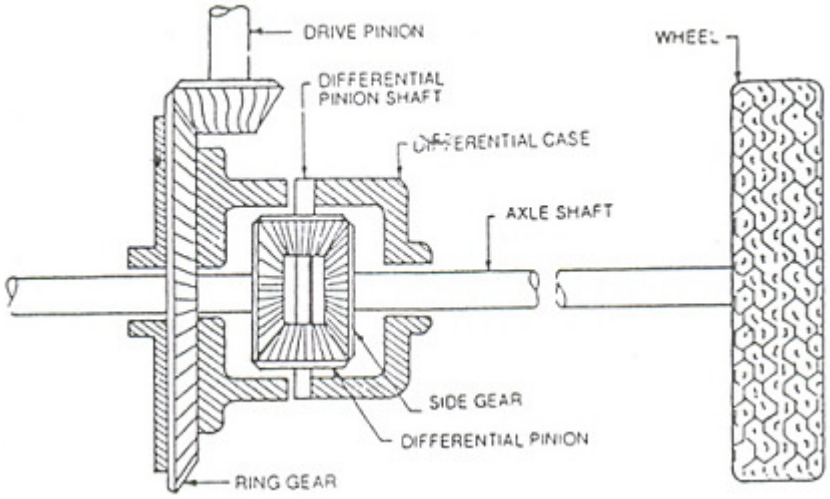
As the crown wheel turns, the case attached to it also turns. A shaft through the case also goes through the middle of two small pinion gears. As the case turns, this shaft turns the small pinion gears, each of which meshes with a side gear. Each side gear is attached to a shaft called an axle, which on a rear drive system runs through housing to one of the rear wheels.

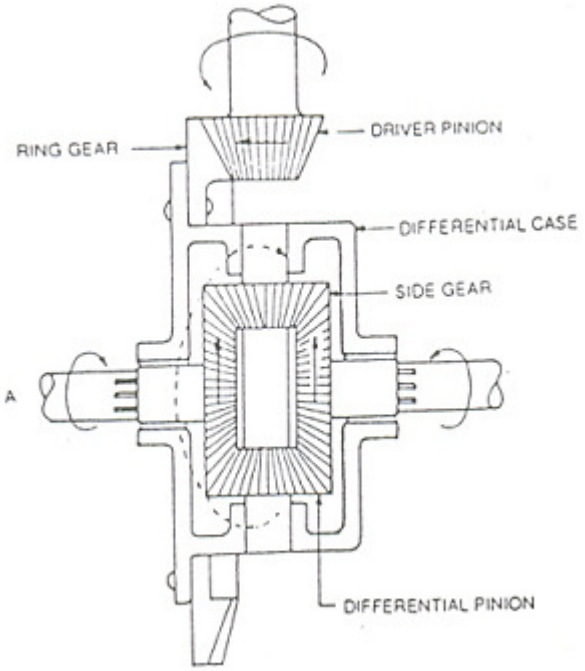
When the automobile is travelling in a straight line, the power flow through the system is fairly simple. The crown wheel turns the case. The case, through its shaft and pinion gears, turns each of the side gears at the same speed. The axles or drive shafts turn the drive wheels, which drive the vehicle.

When the vehicle makes a turn, however, the power flow becomes more complicated. If the automobile is making a left turn, the left drive wheel must go through a sharper corner or travel through a shorter distance than the right drive wheel. The crown wheel turns the case. Since the left wheel is going through a sharp corner, the left axle is slowed or stopped

momentarily. The pinion gears in the case still turn with the case but they also rotate on the case shaft. Thus they can walk around the slowed or stopped left side gear and provide all the power to the right side gear so the right wheel will turn faster than the left wheel.

During a right turn there is more resistance on the right axle, because the right wheel must turn through a sharper corner than the left. The pinions in the case walk around the right side gear and drive the left axle gear.





EXPERIMENT NO.-03

OBJECTIVE: Study and Demonstration of Clutches

EQUIPMENT – Models of clutches

THEORY –

Introduction-

The power developed by the engines is delivered to the driving wheels of the automobile by the power train. The transmission is the major part of the power train. In the manual transmission, clutch is a device used to connect and disconnect engine power flow to the transmission the will of the driver. The driver operates the clutch via a clutch pedal inside the vehicle.

When the clutch pedal is depressed, the three main clutch assembly components – flywheel, friction disc and pressure plate are disengaged, interruption of the power flows. As the clutch is release, the pressure plate moves closer to the clutch disc.

Functions of Clutch –

1. To permit the engagement or disengagement of a gear when the vehicle is stationary and engine is running.

2. To transmit the engine power to the road wheels smoothly without shock / jerk to the transmission system.

3. To permit the engaging of gears when the vehicle is in motion without damaging the gear wheels.

WORKING PRINCIPLE –

The working principle of clutch is based on friction .When the two friction surfaces re brought in contact with each other and pressed they are united due to friction between them .If now one is resolved ,the other will also resolve. One surface is considered as a driving member and other as driven member. The driving member is kept rotating .When the driven member is brought in contact with the driving member, it is also starts rotating .When the driven member is separated from the driving member, and it stops revolving. The driving member of clutch is the flywheel mounted on crankshaft, the driven member is a pressure plate mounted on the transmission shaft.

1) SINGLE PLATE CLUTCH

This is the common type of clutch used in automobile. It consists of two member flywheel and pressure plate. The flywheel is mounted on 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. Single plates clutch has only one clutch plate, mounted on the splines of the clutch shaft. The clutch pedal is used to engage or disengage the clutch

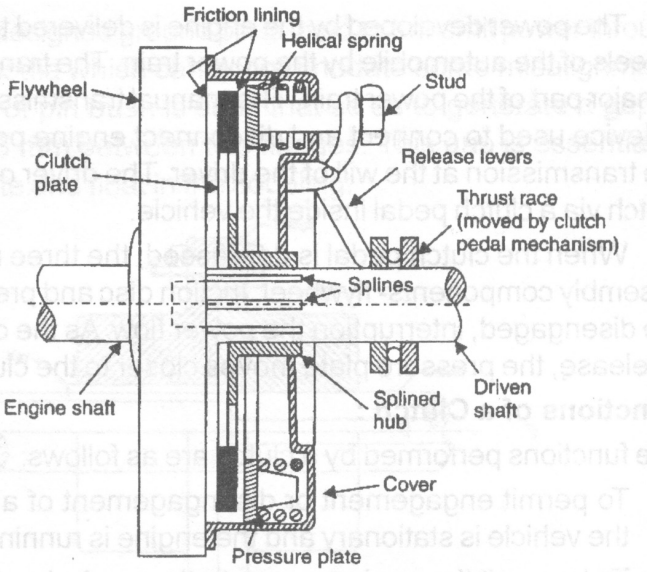


Fig. Single Plate Clutch

When the clutch is engaged, the clutch plate is gripped between the flywheel and pressure plate. The friction linings are provided on both sides of the clutch plate. Due to 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, which is connected to the transmission. Hence, the engine power is transmitted through 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 flywheel keeps rotating as long as the engine is running. As soon as the clutch pedal is pressed, the clutch is said to be disengaged, otherwise it remains engaged due to the spring forces.

Advantages:

1. Gear changing is easy.
2. It is mire reliable.

Disadvantage:

It requires more force by the driver to disengage since the springs are very stiff.

2. MULTIPLE CLUTCHES:

A multiplate clutch consists of more than one clutch plate. As the numbers of clutch plates are increased, the friction surface also increases. The increased number of friction surfaces 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 pressed by the strong coil springs and assembled. Each of the alternate plate slides on splines on the pressure plate.

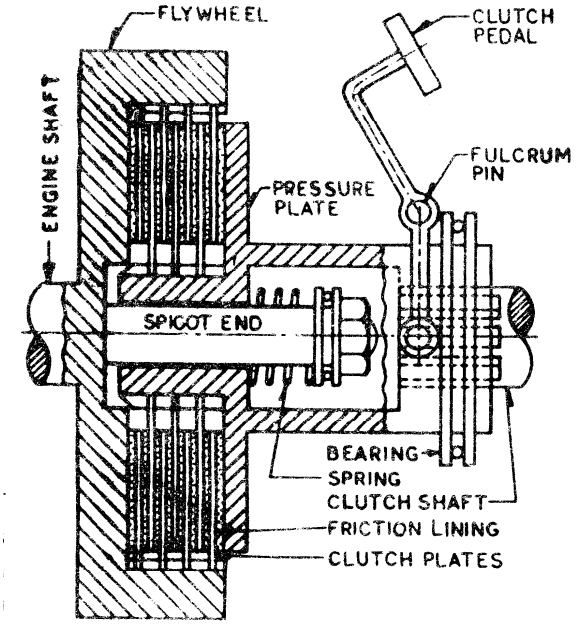


Fig. 3.21 Multiplate Clutch.

A multiplate clutch works in the same way as a single plate clutch while the flywheel is rotating, the pressure plate rotate and press against the friction plate. This causes the clutch plate to rotate, which in turn rotate the clutch shaft. When the pedal is pressed, the flywheel continues to rotate but the clutch plate is released. This happens because they are not fully pressed by the pressure plates. Thus the clutch shaft also stops rotating.

A multiplate clutch may be dry or wet. When the clutch is operated in an oil bath, it is called as a wet clutch. When the clutch is operated dry, it is called dry clutch.

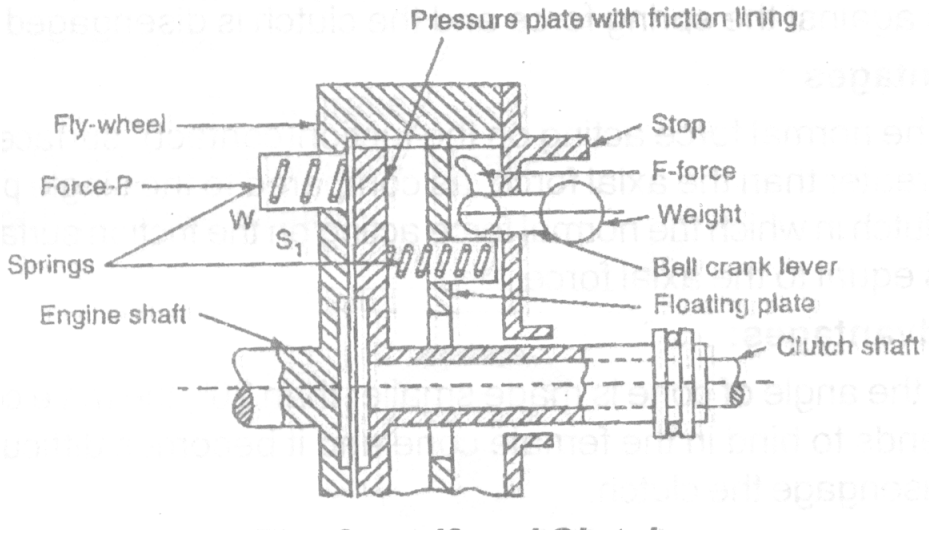
Advantages:

1. The number of friction surfaces increases the capacity of the clutch to transmit torque. Therefore, considering the same torque transmission the overall diameter of the multiplate clutch is reduced when compared to a single plate clutch.

2. It is used in scooters, motorcycles, where there is space problem.
3. As it can transmit more torque, it can be used in heavy vehicles and racing cars.

3) CENTRIFUGAL CLUTCH:

This clutch is centrifugal force instead of spring force for keeping the clutch in engaged position. It does not require clutch pedal to operate the clutch. The clutch is operated automatically depending upon the engine speed.

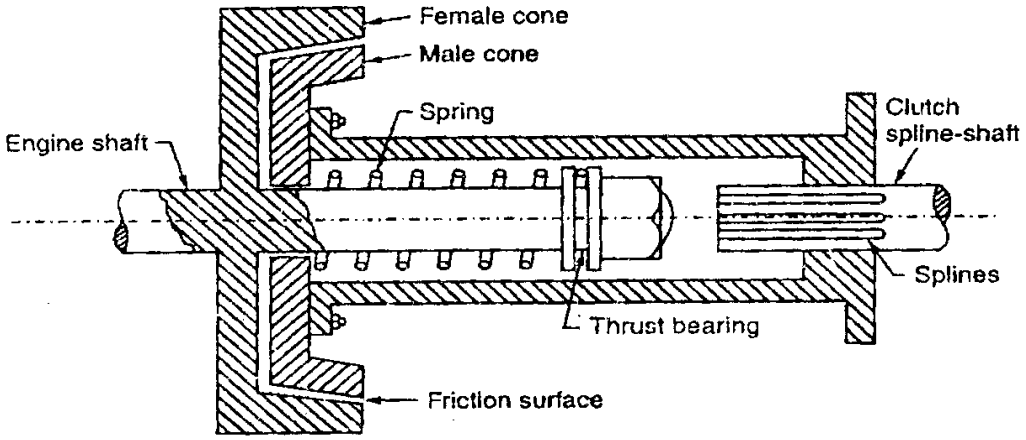


It consists of weight which flies off due to centrifugal force when the speed increases. It operates the bell crank lever which presses the floating plate. The movement of the spring which then presses the clutch plate on the flywheel against the spring thus engaging the clutch. The spring keeps the clutch disengaged at low speed of about 500 rpm. The stop above the weight, limits the amount of the centrifugal force.

Advantages-

1. No clutch pedal is required to operate the clutch
2. It is operated automatically depending upon the engine speed.

4) CONE CLUTCH



A cone clutch consists of friction surfaces in the form of cones. A female cone is mounted on the engine shaft while a male cone is mounted on the splined clutch shaft as shown in figure. The male cone has friction surface on the conical portion and it can slide on the clutch shfaft.When the clutch is engaged the friction surfaces of the male cone are in contact with that of the female cone due to the forced of spring .When the pedal is pressed against the spring force and the clutch is disengaged .

Advantages-

The normal force acting on the friction (contact) 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

Disadvantages –

1. If the angle of cone is made smaller than 20°, the male cone tends to bind in the female cone and it becomes difficult to disengage the clutch.
2. A small amount of wear on the cone surfaces results in a considerable amount of axial movement of the male cone which it will be difficult to allow.

EXPERIMENT NO.-04

OBJECTIVE: Study and Demonstration of Braking System

EQUIPMENT: A working or a non working model of Braking system.

THEORY:

Functions of Brake:

There are two distinct functions of the brake:

1. To stop or slow down the vehicle in the shortest possible distances in emergencies.
2. To control the vehicle to be retained when descending a hill.

Classification of brakes:

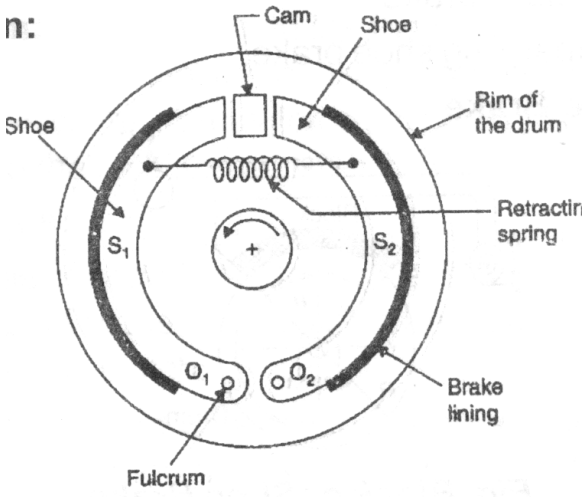
I. From construction point of view

(a) Drum brakes (b) Disc brakes

II. By method of actuation

(a) Mechanical brakes (b) Hydraulic brakes (c) Electric brakes (d) Vacuum brakes (e) Air brakes

DRUM BRAKES:



In this type of brakes, a brake drum is anchored concentric to the axle hub whereas on the axle casing is mounted a back plate. In case of front axle, the back plate is bolted to the steering knuckle. 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. Friction linings are mounted on the brake shoes. 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 as 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. The relative braking torque obtained at the shoes for the same force applied at the pedal varies depending upon whether the expander (cam or toggle lever) is fixed to the back plate or it is floating; whether the anchor is fixed or floating and whether the shoes are leading or trailing.

DISC BRAKES:

The disc brake has a metal disc instead of a drum. It has a flat shoe, or pad, located on each side of the disc. To slow or stop the car, these two flat shoes are forced tightly against the rotating disc or rotor. The shoes grip the disc. Fluid pressure from the master cylinder forces the pistons to move in. This action pushes the friction pads of the brake shoes tightly against the disc. The friction between the shoes and the disc slows and stops the disc.

Theory of braking:

Braking total torque

μ_f =Coefficient of friction between drum and shoe.

K=Effective radius

Dual brake system:

The dual brake system uses two master cylinders. One brake line from the master cylinder goes to one set of wheel brakes. The other brake line from the master cylinder goes to the other set of wheel brakes.

Parking brake:

The parking brake holds the vehicle stationary while it is parked. Since the parking brake is independent of the service brakes, it can be used as an emergency brake if the service brakes fail. When the parking brake is operated by a hand lever, some manufacturers call it the hand brake.

Material:

The brake linings are either of solid woven type or molded type. The asbestos base non-metallic linings have an average coefficient of friction of 0.4 up to about 260°C. Their maximum temperature

resistance is about 350°C. Zinc wire lining have better resistance to wear than the non-metallic type. Also zinc serves to conduct some heat away from the working surface. Molded type linings are prepared directly from the mix which contains asbestos fibers, together with resin powders and fillers. These linings have good wear resistance. Their maximum temperature resistance is about 450°C. The average coefficient of friction is 0.4.

The brake linings are attached with the brake shoes either by riveting or by synthetic resin adhesives. The second method is preferable, due to the absence of riveting holes, more contact surface, free from scoring action and more effective wearing thickness.

HYDRAULIC BRAKE SYSTEM:

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.

Vacuum assisted system:

With vacuum assisted brakes, only a relatively light pedal force is required to brake the vehicle. When the brake pedal is pushed down, a vacuum operated booster takes over and furnishes most of the force for pushing the pistons into the master cylinder. The hydraulic booster is operated by oil pressure from the power steering pump. The vacuum comes from the engine intake manifold. The system includes a cylinder in which a tight-fitted piston can move. When vacuum is applied to one side of piston, atmospheric pressure causes the piston to be pushed to the right. This movement pushes the piston rod into the master cylinder.

In the vacuum assisted brake system, the bake pedal does not act directly on the master cylinder. Instead, brake pedal movement operates a vacuum valve, which then admits vacuum to the power cylinder.

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

EXPERIMENT NO.-05

OBJECTIVE: Study and Demonstration of gear box.

EQUIPMENT: A working or a non working model of any gear box such as constant mesh, sliding mesh, synchromesh, semiautomatic or automatic.

THEORY: There are three reasons to have a transmission (gear box and its associated units) in the power train or drive train. These are:

i) The transmission provides the torque needed to move the vehicle under a variety of road and load conditions. It does this by changing the gear ratio between the engine crankshaft and vehicle drive wheels.

ii) It can be shifted into reverse so the vehicle can move backward.

iii) It can be shifted into neutral for starting the engine and running it without turning the drive wheels.

There are two basic types of transmissions: manual and automatic. Manual transmissions are shifted manually by hand. Automatic transmission shift automatically, with no help from the driver.

SLIDING MESH GEAR BOX:

It is the simplest type of gear box. The arrangement of gears is shown in fig. in neutral position. The gear housing and bearings are not shown. The clutch gear is rigidly fixed to the clutch shaft. It remains always connected to the drive gear of the countershaft. Three other gears are also rigidly fixed to the countershaft (lay shaft). They are the second speed gear, first speed gear and reverse speed gear. Two gears are mounted on the splined main shaft which can be slided by the slider yoke when the shaft lever is operated. These gears are the second speed gear and first and reverse speed gear. They can be connected to the corresponding gears of the countershaft. A reverse idler gear is mounted on another shaft and always remains connected to the reverse gear of the countershaft.

Constant Mesh Gear Box:

Fig shows a constant mesh gear box. It consists of a clutch shaft, a countershaft and a main shaft. Gears(2), (3), (5) ,(7) and (9) are fixed to the main countershaft but do not slide alone it. Gear wheels(4),(6) and (8) are not fixed to the main shaft. Therefore these gears can revolve freely around it. Gear (4) of the main shaft is in constant mesh with gear (3) of the counter shaft. Similarly, gear (6) is in constant mesh with gear (5), and gear (8) with gear (7). All the gears are shown in neutral position.

Synchromesh Gear Box:

The modern cars use helical gears and synchromesh devises in the gear boxes, that synchronize the rotation of gears that are about to be meshed. This eliminates clashing of the gears and make gear shifting easier. The synchromesh gear box is similar to the constant mesh gear box, but this gear box is provided with a synchromesh device by which two gears to be engaged are first brought into frictional contact which equalizes their speed after which they are engaged smoothly. In most of the cars, the synchromesh devices are not fitted to all the gears. They are fitted only on the top gears. Reverse gears and in some cases the first gear, do not have synchromesh device, since they are intended to be engaged when the vehicle is stationary.

EXPERIMENT NO.06

OBJECTIVE: Study and Demonstration of Steering Mechanism.

EQUIPMENT: A working or a non working model of steering mechanism.

THEORY: The steering system allows the driver to control the direction of the automobile by means of two major components. : the steering gears, which multiply the driver's effort at the steering wheel; and the steering linkage, which connects the gear box to the front wheels. How well the system works depends on proper alignment of the front wheels for directional control and ease of steering.

1. To convert rotary movement of the steering wheel into angular motion of the front road wheels.
2. To provide directional stability to the vehicle.
3. To minimize wear of tyres.
4. To turn vehicle at driver's will.
5. To provide perfect rolling motion of the road wheels at all times.
6. To multiply the effort of the driver by leverage so that turning of wheels is easy.

7. To facilitate straight ahead recovery after completing a turn.
8. To absorb road shocks thus preventing them to get transmitted to the hands of the driver.
9. To swing the wheels to the left or right.

   To achieve correct steering, two types of steering mechanisms are used.

   i) Davis Steering Mechanism

   ii) Ackermann Steering Mechanism

   The main difference between these two is that the Davis mechanism has sliding pairs, whereas the Ackermann mechanism has only turning pairs. The sliding pair has more friction than the turning pair and hence Davis mechanism will wear out after certain time. Therefore Ackermann mechanism is preferred to the Davis mechanism.

Fig. shows the Ackermann mechanism. It consists of a track rod AB connected to the links KA and LB, which are integral with the stub axles. When the vehicle is in straight ahead position these links make equal angles with the centre line of the car.

Ackermann Principle: In order to achieve the instantaneous centre, the inner wheel must turn through a greater angle than the outer. This difference in movement of the inner and outer wheels is obtained by inclining the links KA and LB. The effect of this will be clear from fig. If the track rod AB moves, say through x distance, measured parallel to the axle beam, link KA will move through a greater angle than link LB. The inclination of these links is such that lines drawn through them will intersect theoretically at the centre line of the car. This arrangement is known as Ackermann principle or linkage and can also be applied if the track rod is placed in front of the axle.

Let l = length of track rod AB

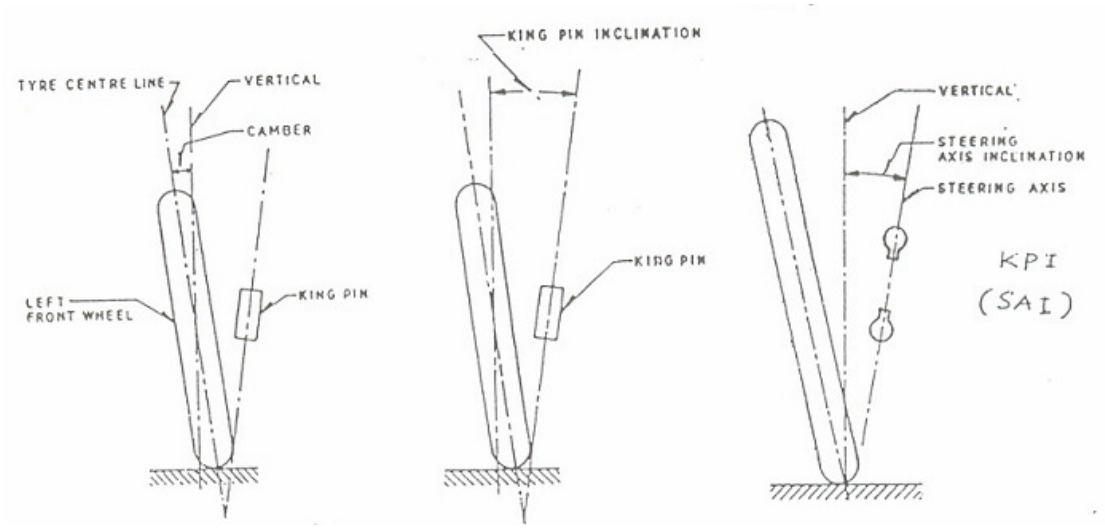
r = length of links KA and LB

Then,

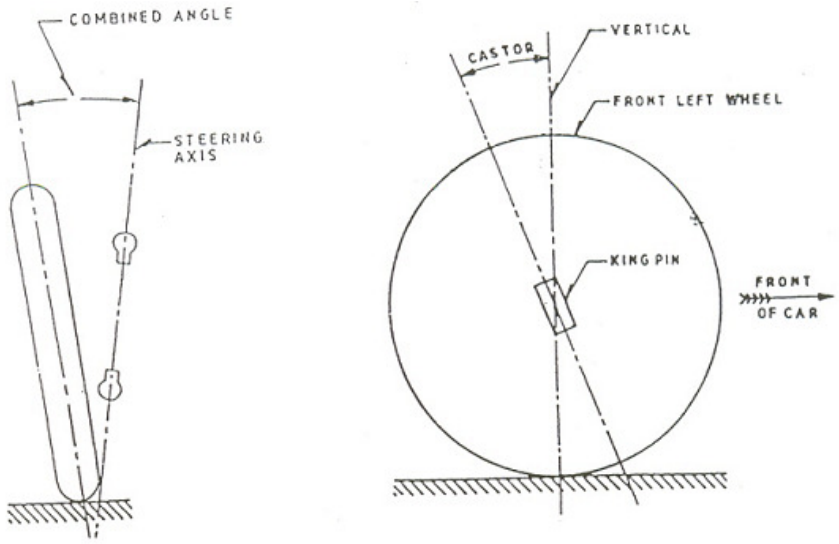
sin(

STEERING GEOMETRY PARAMETERS:

1. Camber: Tilt of the wheel plane from the longitudinal plane.



2. Castor: Tilt of the king pin with reference to the transverse vertical plane.



Combined angle Castor

3. Kingpin Inclination: King Pin inclination is the tilt of the king pin from the longitudinal vertical plane.

4. Toe in or toe out - Toe in is the amount by which the front wheels are set closer together at the front than at the rear when the vehicle is stationary

On the other hand, the wheel may be set closer at the rear than at the front in which case the difference of the distances between the front wheels at the front and at the rear is called toe out.

Steering Gear box:

The steering gear converts the rotary motion of the steering wheel into straight line motion of the linkage. There are two basic types of steering gears, the pitman-arm type and the rack and pinion type. Either type can be used in a manual steering system or a power steering system. The pitman type has a gear box at the lower end of the steering shaft. The rack and pinion type has a small gear (a pinion) at the lower end of the steering shaft. The action is the same in either system. When the steering wheel and shaft are turned by the driver, the rotary motion is changed into straight line motion. This causes the front wheels to pivot or swing from one side to the other to steer the car.

One job of the steering gear is to provide mechanical advantage. In a machine or manual device, this is the ratio of the output force to the input force applied to it. This means that a relatively small applied force can produce a much greater force at the other end of the device.

1. Worm and Wheel
2. Cam and Double Roller
3. Worm and Nut
4. Recirculating Ball type
5. Rack and Pinion

EXPERIMENT NO. - 07

OBJECTIVE: Study and experiment on Suspension system.

EQUIPMENT: A model of suspension system.

THEORY :

Need of suspension system:

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.

Types of suspension:

1.) Leaf spring suspension system 2.) Coil Spring Suspension system

3.) Mc-Persion strut suspension system (4.) Torsion bar suspension system

Suspension springs:

1. Steel springs

(a) Leaf spring (b) tapered leaf spring (c) Coil spring (d) torsion bar

2. Rubber springs

(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

Constructional details and characteristics of leaf spring:

The most commonly used leaf spring is the semi-elliptic type, consisting of one main leaf, which usually has its ends formed into eyes for connection with the spring brackets, and a number of shorter leaves, the length of which gradually and uniformly decreases from the main leaf. The various leaves are held together by a centre bolt.

Constructional details and characteristics of Coil spring:

Coil springs can store about twice as much energy per unit volume as that of leaf springs. Thus for the same job coil springs need weight only about half that of leaf springs. But leaf springs serve both the purposes. Cushion the shocks and to guide or control cushioned motion.

Constructional details and characteristics of Torsion bar spring:

A rod or tube acting in torsion can work as a torsion-bar spring. The torsion-bar spring is a bar of spring steel that is anchored to the frame at one end while the other end is freely supported and connected to a lever arm. The lever-arm is pin-jointed to the axle spindle or steering head. The action of torsion-bar springs is essentially same as that of coil spring.

Rubber suspension:

The advantages of using rubber as a means of suspension are:

1. It can store greater energy per unit weight than the steel. For this reason rubber springing system can be made more compact.
2. The rubber has excellent vibration damping properties.
3. The absence of squeaking which is always present in steel springs.
4. The number of bearings is reduced considerably for the rubber suspension system. This means longer life.
5. Rubber is more reliable. A rubber suspension cannot suddenly fail like the metal springs.

Air suspension:

The advantages of air suspension system 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 headlamp alignment due to varying loads are avoided.
3. The spring rate varies much less between the laden and unladen conditions, as 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.

Shock absorbers:

Shock absorbers are necessary because springs do not “settle down” fast enough. After a spring has been compressed and released, it continues to shorten and lengthen, or oscillate for a time.

This is what happens if the spring at the wheel is not controlled. When the wheel hits a bump, the spring compresses. Then the spring expands after the wheel passes the bump. The expansion of the spring causes the car body and frame to be thrown upward. But, having over expanded, the spring shortens again. This action causes the wheel to move up and momentarily leave the road at the same time that the car body and frame drops down. The action is repeated until the oscillations gradually die out.

Such spring action on a car would produce a very bumpy and uncomfortable ride. It could also be dangerous, because a bouncing wheel makes the car difficult to control. Therefore, a dampening device is needed to control the spring oscillations. This device is the shock absorber.

The shock absorber is the direct-acting tubular or telescope type. In operation, the shock absorbers lengthen and shorten as the wheels meet irregularities in the road. As they do this, a piston inside the shock absorber moves in a cylinder filled with fluid. Therefore the fluid is put under high pressure and forced to flow through the openings slowly. This slows the piston motion and retains spring action.

EXPERIMENT NO. - 08

OBJECT: Study and Demonstration of different Automobile Engines

EQUIPMENT: A working or a non working model of an engine

THEORY :

Introduction

Heat Engine: Any type of engine or machine which derives heat energy from the combustion of fuel or any other source and converts this energy into mechanical work is termed as a heat engine.

Heat engines are classified as

1) External combustion Engines - external combustion engines, the combustion of fuel takes place outside the cylinder. E.g. steam engine in which fuel is burned in the boiler to generate steam which is used in steam engine.

2) Internal combustion Engines - InIn internal combustion engines, the combustion of fuel takes place inside the cylinder e.g. petrol engine, diesel engine.

Advantages of I.C. engines over E.C. engines

1. Overall efficiency is high
2. Greater mechanical simplicity
3. Generally lower initial cost
4. Easy starting from cold conditions
5. Unit is compact which requires less space.

Advantages of E.C. engines over I.C. engines

1. Starting torque is generally high.
2. Because of external combustion of fuel, cheaper fuels can be used.
3. Due to external combustion of fuel it is possible to have flexibility in arrangement.

Classification of I.C. Engines

A) According to cycle of operation

1) Two stroke cycle engines
2) Four stroke cycle engines

B) The thermodynamic cycle used

1) Otto cycle (Combustion at constant volume)
2) Diesel cycle (Combustion at constant pressure)
3) Dual combustion

C) Arrangement of cylinder

1) Single cylinder engine
2) In line or straight engines
3) V-engine
4) Opposed piston engine
5) Opposed cylinder engine
6) Radial engine
7) W-engine.

D) According to their uses

1) Stationary engine
2) Marine engine
3) Portable engine
4) Automobile engine

E) Speed

1) Low speed engine
2) Medium speed engine (500 - 1000 rpm)
3) High speed engine (>1000 rpm)

F) Method of ignition

1) Spark ignition engine

2) Compression ignition engine

G) Method of cooling

1) Air cooled engine

2) Water cooled engine

H) Fuel used

1) Petrol engine 2) Diesel engine

3) Gas engine 4) Kerosene engin

MAIN PARTS OF I.C.ENGINE

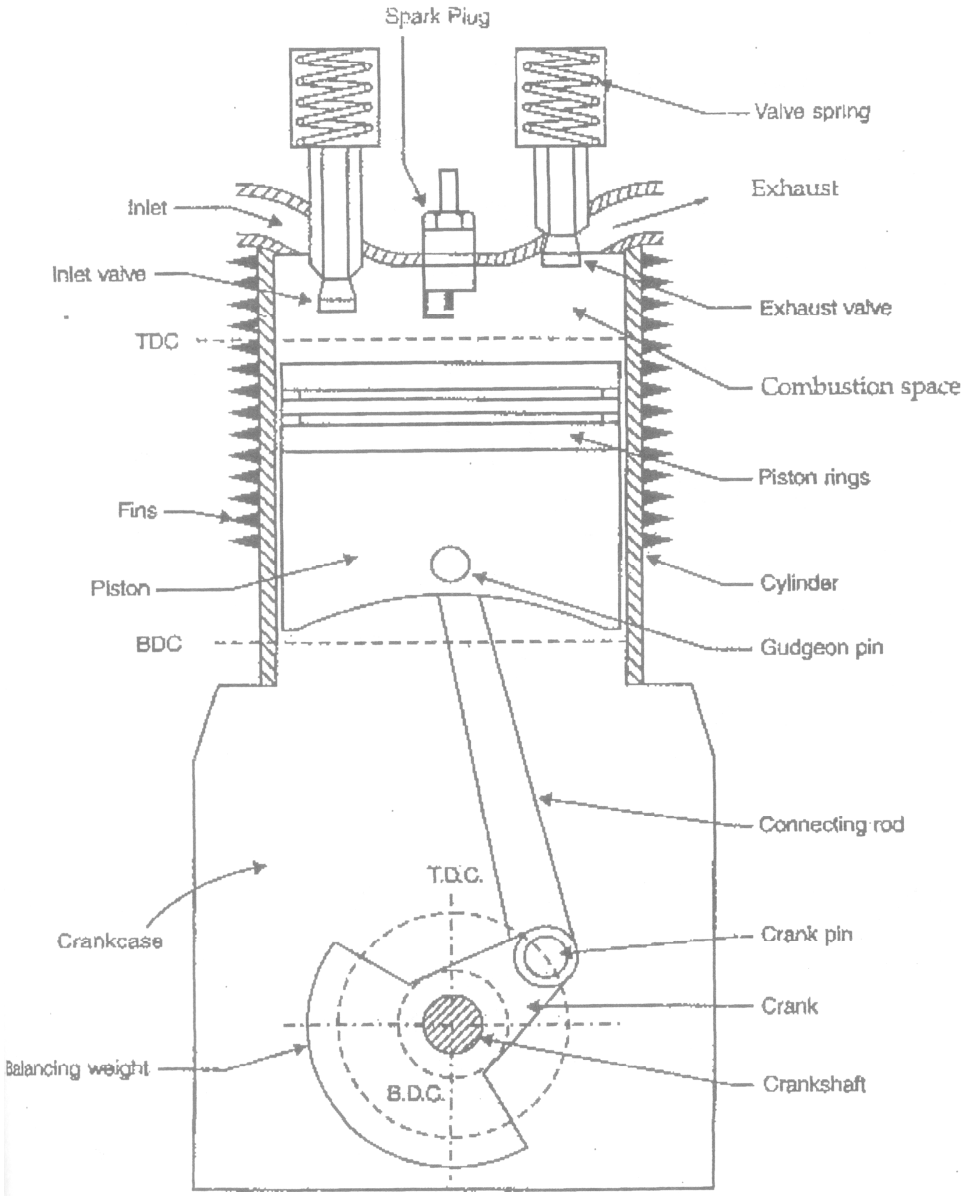


Fig. Main Parts of I.C. Engine

1. **Cylinder Head:** A cylinder head closes one end of the cylinder. It holds the inlet, outlet ports, valves and ignition system at suitable positions according to the type of engine. It forms the combustion chamber.

2. **Piston and Piston Rings:** The function of the piston is to compress the charge during compression stroke and transmit the gas force to the crank through connecting rod during power stroke. It is usually made of aluminum alloy. The piston rings are housed in the circumferential

grooves provided on the outer surface of the piston. It gives gas tight fitting between the piston and cylinder and prevents the leakage of high pressure gases.

3. **Connecting Rod:** Its function is to transmit reciprocating motion of the piston into rotary motion of the crank. It connects the piston to the crank shaft with bearings.

4. **Crankshaft:** The piston is connected through gudgeon pin and a connecting rod to the crank shaft which forms a crank pair to convert reciprocating motion of piston to rotary motion at the output shaft of the crank. Flywheel is keyed to this shaft.

5. **Piston Pin:** It connects the small end of the connecting rod to piston. It is also known as gudgeon pin.

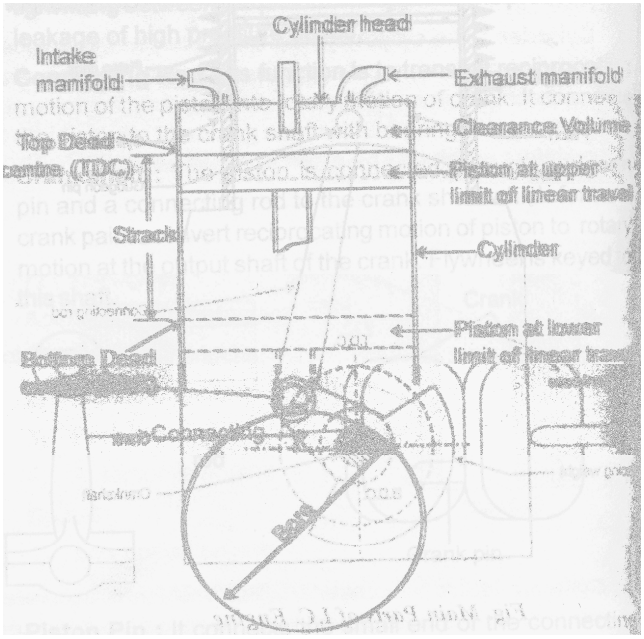
6. **Crank case:** It holds the crankshaft and the cylinder block can be bolted to it. It forms lower cover to the engine. It serves as sump for lubricating oil used for lubricating the engine parts.

7. **Flywheel:** It is mounted on the crank shaft which stores excess energy during the power stroke and returns that energy during the other strokes and maintains a fairly constant output torque on the crankshaft.

8. **Carburetor and spark plugs:** Used in petrol engines.

9. **Fuel pump and Nozzle:** Used in Diesel engines.

Terms Relating To I.C. Engine



1. **Bore:** The inside diameters of the cylinder is called bore.

2. **Stroke:** As the piston reciprocates inside the engine cylinder, it gets limiting upper and lower positions beyond which it cannot move and reversal of motion takes place at these limiting positions.

   The linear distance along the cylinder axis between two limiting positions, is called "stroke".

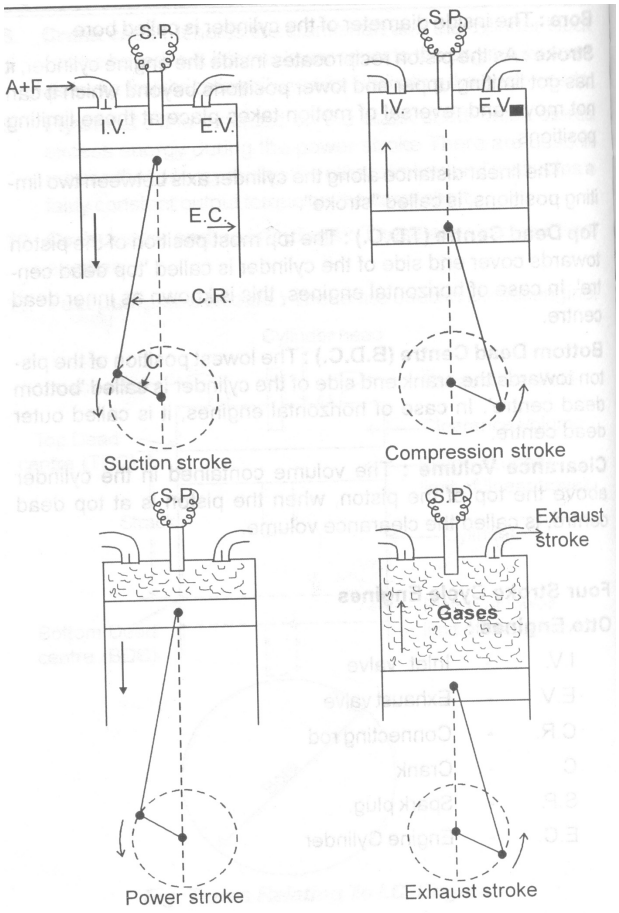
3. **Top Dead Centre (T.D.C.):** The top most position of the piston towards cover end side of the cylinder is called 'top dead centre'. In case of horizontal engines, this is known as inner dead centre.

4. **Bottom Dead Centre (B.D.C.):** The lowest position of the piston towards the crank end side of the cylinder is called 'bottom dead centre'. In case of horizontal engines, it is called outer dead centre.

5. **Clearance Volume:** The volume contained in the cylinder above the top of the piston, when the piston is at top dead centre, is called the clearance volume.

FOUR STROKE CYCLE ENGINES

(Otto Engines)



I.V. - Inlet valve

E.V. - Exhaust valve

E.C. - Connecting rod

C - Crank

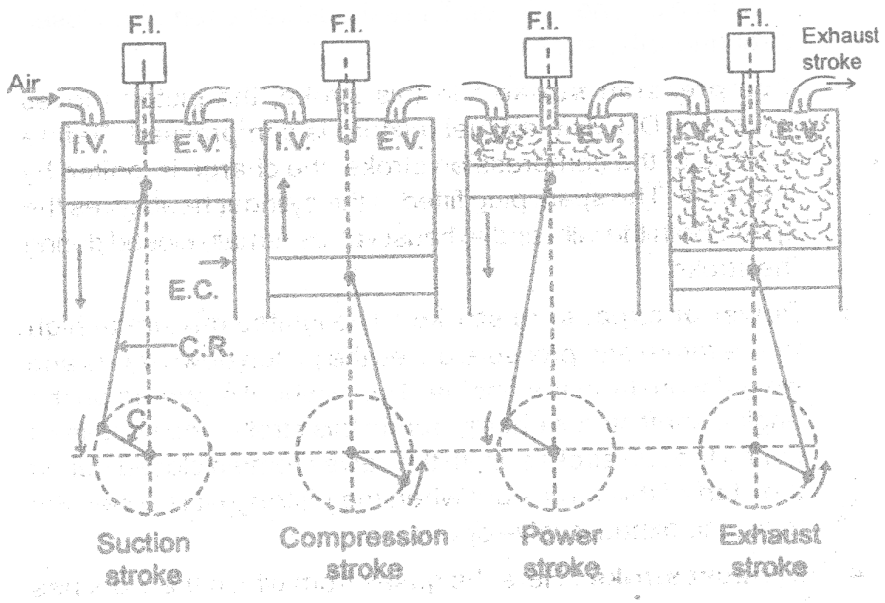
S.P. - Spark plug.

1. **Suction Stroke:** During this stroke piston moves form TDC to BDC; mixture of air and petrol is admitted through inlet valve into engine cylinder. The exhaust valve remains closed throughout the stroke.
2. **Compression Stroke:** In this stroke, the piston moves towards TDC. The air fuel mixture is compressed. Before the end of the compression stroke, the charge is ignited by the spark. The spark plug fitted in the cylinder head gives the spark. Both the inlet and exhaust valves remain closed during the stroke.
3. **Power or Expansion Stroke:** The ignited mixture at high temperature and pressure drives the piston downwards and we get work from the engine. The flywheel mounted on the engine shaft stores energy during this stroke and supplied it during the idle stroke. Both the valves remain closed during the start of this stroke but when the piston just reaches the BDC, the exhaust valve opens.

4. **Exhaust Stroke:** Here the gases from which the work has been collected become useless after the completion exhaust valve to the atmosphere. The piston moves from BDC to TDC and exhaust gases are driven out of the engine cylinder.

Four Stroke Diesel Engines

F.I. = Fuel injector; I.V. = Inlet valve, E.V. = Exhaust valve



F.I. = Fuel injector ; I.V. = Inlet valve, E.V. = Exhaust valve

Fig. Four Stroke Diesel Engine

1. **Suction Stroke:** During this stroke air is admitted through inlet valve into the engine cylinder. The exhaust valve remains closed throughout the stroke.
2. **Compression stroke:** In this stroke, air is compressed. Before the end of the compression stroke, fuel is injected into the combustion chamber. The fuel gets ignited by high temperature of compressed air. Both the valves remain closed during this stroke.
3. **Power or Expansion Stroke:** The ignited mixture of air and fuel at high temperature and pressure drives the piston downwards. The piston, through gudgeon pin, connecting rod, crank pin and crank, converts reciprocating motion of piston into rotary motion of the crank shaft. Both valves remain closed during this stroke.
4. **Exhaust Stroke:** This is the last sroke in which the products of combustion are removed from the engine cylinder through exhaust valve.

1-2: Intake - A/F sucked.

2-3: Piston compresses A/F mixture to a minimum volume

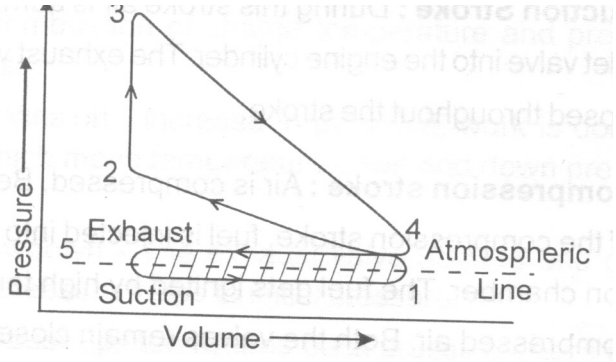
3-4: Combustion - charge ignited by a spark in a spark plug. Due to combusting of charge temperature and pressure increases.

4-5: Expansion - increase in pressure, work is done on piston which move temp. And pressure reduces.

5-2: Blowdown - The exhaust valve opens and gases escape, pressure drops to initial pressure.

2-1: Exhaust - piston returns back pressing gases out of cylinders.

Actual P.V. Dia. Of A 4-Stroke Petrol Engine



Actual P.V. dia. of a 4-stroke petrol engine

Two Stroke Cycle Engines

In this engine suction and exhaust strokes are eliminated. Here instead of valves ports are used. The exhaust gases are driven out from engine cylinder by the fresh charge of fuel entering the cylinder nearly at the end of the working stroke.

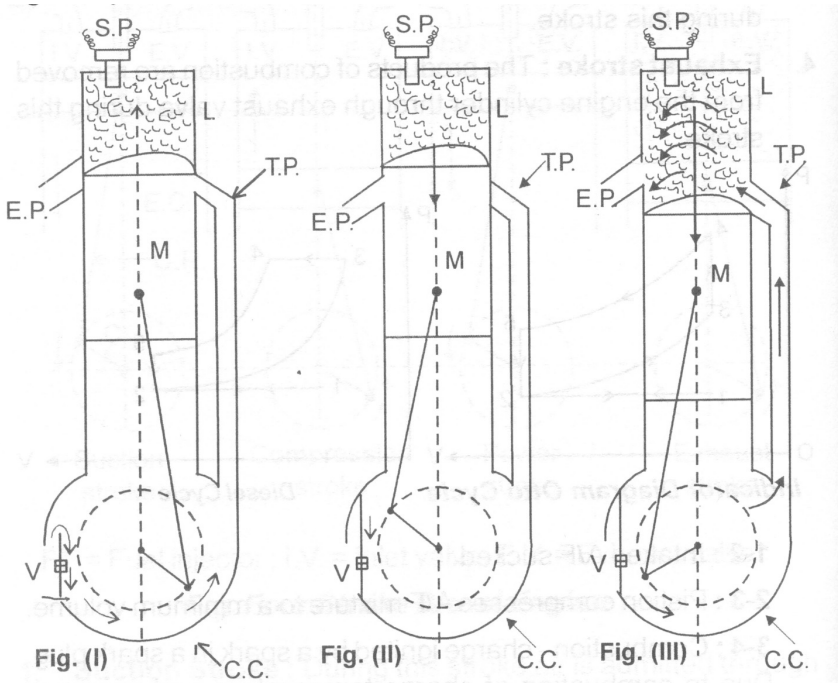


Fig. Two Stroke Cycle Engines

The cylinder (L) is connected to a closed crank chamber. During the upward stroke of the piston M, fresh air and fuel (petrol) mixture enters the crank chamber through the valve V. When the piston moves downwards. V closes and the mixture in the crank chamber is compressed. In first fig. the piston is moving upwards and is compressing an explosive charge which has previously been supplied to L. Ignition takes place at the end of the stroke. The piston then travels downwards due to expansion of the gases (fig. II) and near the end of this stroke the piston uncovers the exhaust port (E.P.) and burnt exhaust gases escape through this port (fig.III). The transfer port (T.P.) then is uncovered immediately, and the compressed charge from the crank chamber flows into the cylinder and is deflected upwards. Incoming air petrol mixture helps the removal of gases from the engine cylinder.

Comparison between Four Stroke and Two Stroke Cycle Engines

Four Stroke Engines	Two Stroke Engines
1. The cycle is completed in four strokes of the piston or in two revolutions of the crankshaft. One power is obtained in every two revolutions of the crankshaft. 2. Because of the one power stroke for two revolutions, power produced for same size of engine is small or for the same power the engine is heavy and bulky. 3. Heavier flywheel is needed. 4. Lesser cooling and lubrication required 5. It has valve and valve mechanism 6. Higher initial cost 7. Higher thermal efficiency 8. Used in cars, buses, aeroplanes, tractors.	1. The cycle is completed in two strokes of the piston or in one revolutions of the crankshaft. One power stroke is obtained in each revolution of crankshaft. 2. Because of one power stroke for one revolution, power produced for same size of engine is more or for same power the engine is light and compact. 3. Lighter flywheel is needed. 4. Greater cooling and lubrication required. 5. It has no valves but only ports 6. Initial cost is less 7. Lower thermal efficiency 8. Used in Scooter , Motorcycle etc.

Comparison between Petrol Engines & Diesel Engines

Petrol Engines	Diesel Engines
1. Air–Petrol mixture is sucked in the engine cylinder during suction stroke 2. Works on Otto cycle 3. Spark plug is used 4. Power is produced by spark ignition 5. It occupies less space 6. Thermal efficiency is less i.e. up to 25% 7. Running cost is high 8. Light in weight 9. Costlier Fuel 10. Petrol being volatile, dangerous	1. Only air is sucked during the suction stroke 2. Works on Diesel cycle 3. Fuel injector and fuel pump is used. 4. Power is produced by compression ignition 5. It occupies more space 6. Thermal efficiency is high i.e. up to 40% 7. Running cost is less 8. Heavy in weight 9. Cheaper Fuel 10. Fuel being nonvolatile , non dangerous 11. Used in heavy duty vehicles like

11. Used in cars and motorcycles	truck ,buses etc