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(Empowering Students with 21st Century Skills)

DEPARTMENT OF MECHANICAL ENGINEERING

LAB MANUAL

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FOR

AUTOMOBILE ENGINEERING LAB
(MEC-363)

Vision of the Department

The Mechanical Engineering Department aims to be recognized as an outstanding educational centre to develop innovative engineers who are proficient in advanced fields of engineering and technology and can contribute effectively to the industry as well as for socio-economic upliftment of the society.

Mission of the Department

M1: To impart outcome-based education with a research orientation to the students to develop them as globally competitive engineers.

M2: To imbibe the students with academic, leadership and entrepreneurship skills needed by the industry in particular and society in general.

M3: To adopt flexibility and dynamism in designing the programme structures to cope up with emerging market needs.

M4: Establishment of liaison with top R & D organizations/Industries and leading educational institutions for practical exposure of the students and faculty as well as to the state of the art.

Programme Educational Outcomes (PEOs)

After the successful completion of undergraduate course, Mechanical Engineering, Graduates will be able to:

PEO1: Plan, design, construct, maintain and improve mechanical engineering systems that are technically sound, economically feasible and socially acceptable.

PEO2: Apply analytical, computational and experimental techniques to address the challenges faced in mechanical and allied engineering streams.

PEO3: Communicate effectively using conventional platforms as well as innovative / online tools and demonstrate collaboration, networking & entrepreneurial skills.

PEO4: Exhibit professionalism, ethical attitude, team spirit and pursue lifelong learning to achieve career, organizational and societal goals.

Program Outcomes (POs) - B. Tech. Mechanical Engineering

PO1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4: Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6: The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues, and the consequent responsibilities relevant to the professional engineering practice.

PO7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9: Individual and teamwork: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

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PO11: Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments

PO12: Life-long learning: Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSO) - B. Tech. Mechanical Engineering

PSO1: **Academic Competence:** Apply mechanical and interdisciplinary knowledge to analyze, design and manufacture products to address the needs of the society.

PSO2: Professional Competence: Apply state of the art tools and techniques to conceptualize, design and introduce new products, processes, systems and services.

Department of Mechanical Engineering

L	T	P	Credits
0	0	2	1

Course Code	MEC 363							
Course Title	**Automobile Engineering Lab**							
Course Outcomes	On the completion of the course the student will be able to: **CO1:** To understand the construction and working principle of various parts of an automobile. **CO2:** To understand the Lubricating System, Cooling System, Chassis & Transmission. **CO3:** To understand the steering and breaking systems of automobile. **CO4:** To know about the resent advancements in automobiles.							
Examination Mode	Practical							
Assessment Tools	Continuous Assessment (CA)				MSE	MSP	ESE	ESP	Total
	Quiz	Assignment/ Project Work	Attendance	Lab Performance					
Weightage	-	-	-	20%	-	30%	-	50%	100
S. No.	**LIST OF EXPERIEMENTS**								**CO Mapping**
1.	To study the constructional details, working principles and operation of Carburettor, Multi-Point Fuel Injection system and Common Rail Direct Injection System.								CO1
2.	To study the constructional details, working principles and operation of different Ignition Systems.								CO1
3.	To study the constructional details, working principles and operation of the Engine Cooling & Lubricating Systems.								CO2
4.	To study the constructional details, working principles and operation of the Hydraulic & Pneumatic Brake systems.								CO3
5.	To study the constructional details, working principles and operation of the Drum Brake System, Disk Brake System and Antilock Brake System.								CO3
6.	To study the constructional details, working principles and operation of Front Suspension System and Rear Suspension System.								CO2
7.	Demonstration of steering system and measurement of steering geometry angles and their impact on vehicle performance.								CO2
8.	To study the constructional details, working principles and operation of single plate &Multi-Plate Clutch.								CO4
9.	To study the constructional details, working principles and operation of Differential.								CO4
10.	To study the construction and working of four wheeler, manual shift gear box used in Automobile.								CO4

Mapping of COs with PO(s)

CO's / PO's	CO-1	CO-2	CO-3	CO-4
PO-1	3	3	3	3
PO-2	3	3	3	3
PO-3	2	2	2	2
PO-4	1	1	1	1
PO-5	1	1	1	1
PO-6	3	3	3	3
PO-7	3	3	3	3
PO-8	2	2	2	2
PO-9	1	1	1	1
PO-10	1	1	1	1
PO-11	1	1	1	1
PO-12	2	2	2	2

1- Slight (Low) 2- Moderate (Medium) 3- Substantiate (High)

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Mapping of COs with PSO(s)

COs / PSOs	CO-1	CO-2	CO-3	CO-4
PSO-1	3	3	2	3
PSO-2	3	3	2	3

1- Slight (Low) 2- Moderate (Medium) 3- Substantiate (High)

EXPERIMENT NO: 1

Experiment 1: To study the constructional details, working principles and operation of Carburettors, Multi-Point Fuel Injection system and Common Rail Direct Injection System.

Apparatus:

Carburettor, Multi-Point Fuel Injection system and Common Rail Direct Injection System

Carburettor

Functions of a carburettor:

- To keep a small reserve of fuel at a constant head.
- To vaporise the fuel to prepare a homogenous air-fuel mixture.
- To supply correct amount of air-fuel mixture at the correct strength under all conditions of load and speed of the engine.

Types of carburettors:

- Simple Carburettor
- Carter Carburettor
- Zenith Carburettor
- S.U. Carburettor
- Solex Carburettor
- Solex Mikuni double venturi carburettor.

Simple Carburettor:

The main parts are a float chamber, fuel jet, venturi, nozzle and a throttle valve. The needle valve attached to the float lever serves to close or open the fuel inlet to the float chamber depending upon the requirements. When the fuel level falls below a definite predetermined value, the float also falls along with the fuel level, thus opening the passage for the fuel supply. The fuel starts flowing in and the float rises gradually till the fuel level reaches the desired value. Currently, the float needle closes the fuel inlet passage. Thus, a constant head of fuel is maintained in the float chamber. This constant level of fuel is slightly below the nozzle outlet, so that the fuel may not drop all the time from the nozzle, even when the engine is not working. A small vent in the float chamber keeps the pressure inside is atmospheric. The fuel supply from the float chamber at any time is metered by means of a fuel jet from where the fuel flows to the venturi through the discharge nozzle. The venturi is simply a restriction in the air passage. Thus, due to less area, the air velocity increases and because of this increase in velocity, decrease in pressure is caused at the nozzle which is in the venturi itself. Due to depression being applied at the nozzle, the fuel comes out and is vaporized by the coming air stream. The mixture then goes to the inlet manifold, to the engine cylinders. The amount of fuel delivered depends upon the jet size, float level and venturi vacuum. The purpose of a throttle valve is to control the quantity of air fuel mixture. It is attached to the accelerator pedal by means of suitable linkage so that when the pedal is depressed the valve opens out.

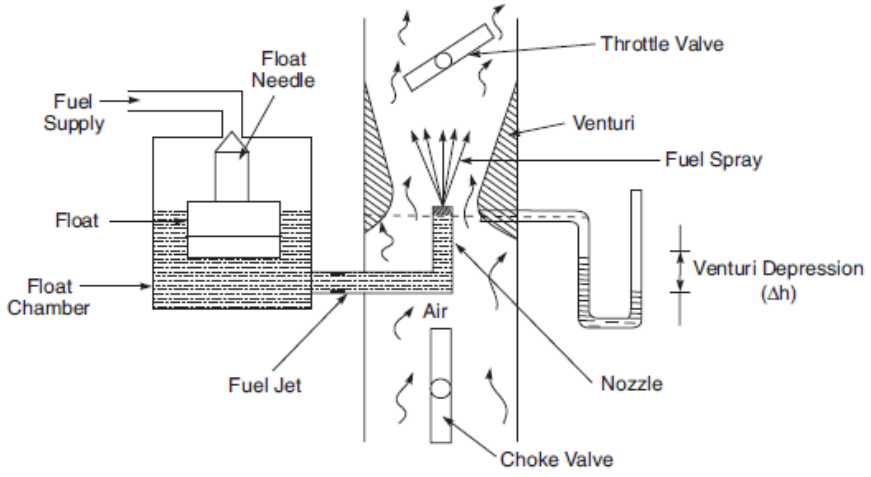

Fig: Simple carburettor

Fuel Injection System:

A fuel injection system in a diesel engine must satisfy the following fundamental requirements:

- To spray the correct quantity of fuel as required, depending on the load.
- To inject the fuel at the correct time in the cycle.
- To inject the quantity of fuel at such rate that constant pressure combustion is obtained.
- The sprayed fuel must be atomized such that the fuel gets depression and penetration.
- Starting and ending of injection must be sharp without dribbling.

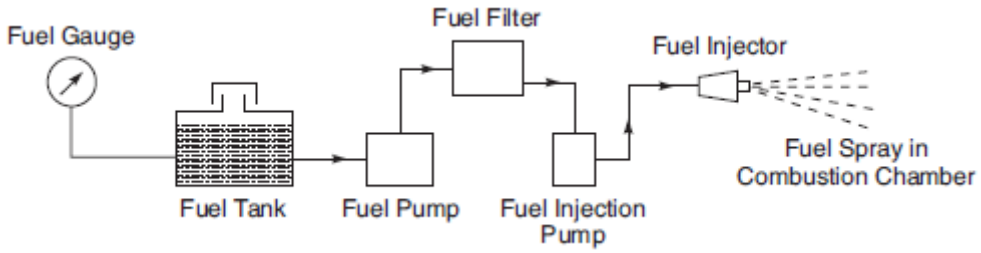

Fig: Layout of Fuel Injection System for Diesel Engine

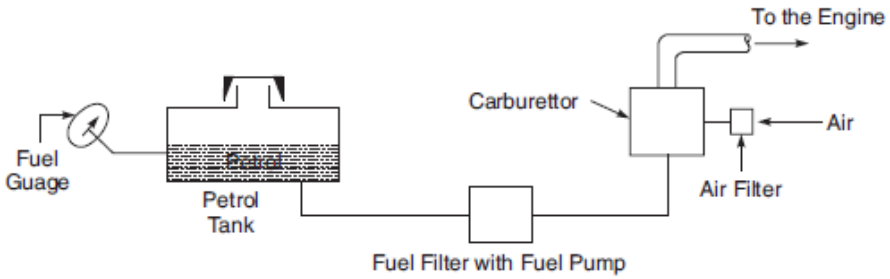

Fig: Layout of Fuel Injection System for Petrol Engine

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. Whereas ordinary diesel direct fuel injection systems must build up pressure a new for each 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 needed, 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 Carburettor is being used in the earlier days before the invention of MPFI engine. It is the duty of the carburettor to mix the fuel and air in a fixed air-fuel ratio.

The fuel thus mixed in the carburettor 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 Carburettor 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 carburettor engine, the MPFI engine is being introduced.

Working of MPFI engine:

The MPFI is an advanced version of carburettor engine. As we said earlier the MPFI engine is having a fuel injector for each cylinder. A computer is used to control each 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.

Result:

Thus, the given fuel injection system and carburettor is dismantled, studied, and assembled.

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EXPERIMENT NO: 2

Experiment 2: To study the constructional details, working principles and operation of different Ignition Systems.

Function:

The function of the Ignition system is to produce a spark in the engine cylinder towards the end of the compression stroke.

Types of Ignition System

Battery Ignition System:

- The battery which supplies the electrical energy.
- The ignition switch which controls the battery current when it is desired to start or stop the engine.
- The ignition coil which transforms the battery low tension current to high tension current which can jump the spark plug in the cylinder under compression.
- The distributor which delivers the spark to the proper cylinders and incorporates the mechanical breaker, which opens and closes the primary circuit at the exact times.
- The wiring which connects the various units.
- The spark plugs which provide the gap in engine cylinders.

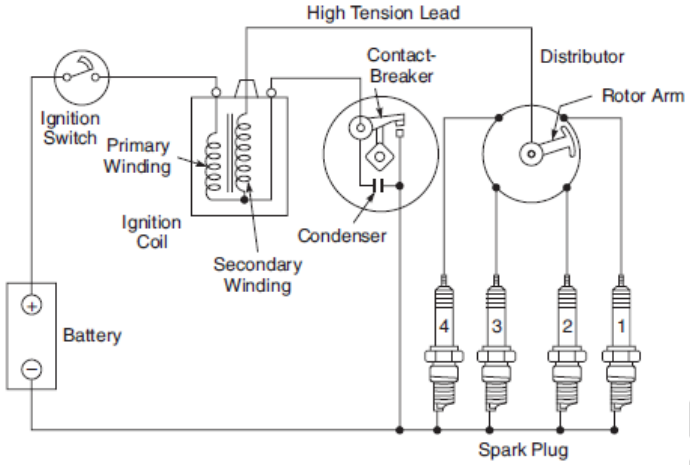

Fig: Battery Ignition System for Four Cylinder Engine

The system is subdivided into two circuits:

(a) The low-tension circuit or primary circuit, which starts at the battery and passes through the ignition switch, primary winding contact breaker points to the ground. A condenser is also connected in parallel to the contact breaker points.

(b) The high-tension circuit or secondary circuit, which starts from the ground and passes through the secondary winding, distributors, spark plug to the ground.

When the ignition switch is 'ON', the current flows from the battery through the primary winding and produces a magnetic field in the coil. When the contact points open the magnetic field collapses and this movement induces current in the secondary winding. The ignition coil steps up 12 volts from the battery to high tension voltage of about 20 to 30 thousand volts required to jump the spark at the spark plug gap (15000 volts are needed to jump 1 mm gap). The distributor then directs this high voltage to the proper spark plug when it jumps the gap, producing a spark which ignites the combustible mixture in the cylinder.

Magneto Ignition System:

In the magneto ignition system, it is the magnet which produces and supplies the current in the primary winding. The other parameters are same as that of battery coil ignition system.

The magneto ignition system is of two types.

- Rotating Armature type.
- Rotating Magnet type.

Advantages over rotating armature type

- Larger armature may be provided, which means more space for insulation.
- No centrifugal stresses occur in the windings, because these remain stationary.
- Contact breaker and condenser are also stationary.

Electronic Ignition System:

In the electronic ignition system, a timer is employed in the distributor instead of a contact breaker. This timer may be a pulse generator or a Hall Effect switch which triggers the electronic ignition control unit. This control unit primarily contains transistor circuit whose base current is triggered off and on by the timer which results in the starting and stopping of the primary current. Other than this, the electronic ignition system works like the conventional system.

Result:

Thus, the functions of various ignition systems and its components used in automotive were studied.

EXPERIMENT NO: 3

Experiment 3: To study the constructional details, working principles and operation of the Engine Cooling & Lubricating Systems.

Introduction:

All the heat produced by the combustion of fuel in the engine cylinder is not converted into useful power at the crank shaft. It is seen that the quantity of heat given to the cylinder wall is considerable and if this heat is not removed from the cylinders it would result in pre-ignition of the charge. In addition, the lubricant would also burn away, thereby causing the seizing of the piston. Excess heating will also damage the cylinder material. Keeping the above factors in view, it is observed that suitable means must be provided to dissipate the excess heat from the cylinder walls, to maintain the temperature below certain limits. However, cooling beyond optimum limits is not desirable because it decreases the overall efficiency of the engine.

Methods of Cooling:

i) Air Cooling

ii) Water Cooling

- Thermosyphon System of cooling
- Pump circulation system.

Components of water-cooling system:

Radiator

The function of the radiator is to ensure close contact of the hot coolant coming out of the engine with outside air, to ensure high rates of heat transfer from the coolant to air. A radiator consists of an upper tank, core, and the lower tank. Besides, an overflow pipe in the upper tank and drain pipe in the lower tank are provided. Hot coolant from the engine enters the radiator at the top and is cooled by the cross flow of air, while flowing down the radiator. The coolant collects in the collector tank from where it is pumped to the engine for cooling.

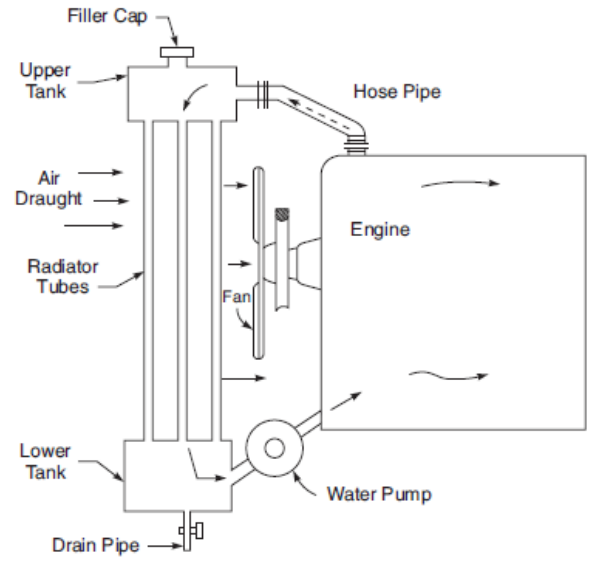

Fig: Water cooling System

Pressure Cap and expansion reservoir

A pressure cap contains a pressure valve and a vacuum valve. When due to severe working conditions, the coolant starts boiling and vaporises, the pressure in the system exceeds a certain predetermined value, the pressure blow-off valve open releasing the excess pressure to the atmosphere through the overflow pipe. On the other hand, if due to any reason a vacuum is created inside, the vacuum valve operates to avoid collapse of the radiator.

Thermostat

To keep a rigid control over the cooling, a thermostat is used, which automatically keeps the cooling water temperature at a pre-determined value. Moreover, it also helps the engine to reach the operating temperature as soon as possible after starting.

Two types of thermo stats are used in automobiles

- Bellows or aneroid type.
- Wax or hydrostatic type.

Coolant Pump:

A coolant pump is a necessity for the forced circulation type of engine cooling system. The pump is mounted at the front end of the engine and is driven from the crank shaft by means of a v-belt. Centrifugal type pump is the one which is used for this purpose. The coolant from the radiator enters the pump at the centre where inlet is located. The flow of the coolant depends upon the pump speed which is proportional to engine speed. The main parts of the

pump are casing and a shaft – mounted impeller having number of vanes. The impeller shaft is mounted on bearing while the seal serves to prevent the leakage of coolant around the shaft.

Fan

When the vehicle is going at high speed with light load, the natural draft of air passing through the radiator may be sufficient for cooling of the engine, but when the vehicle is moving under heavy load and at a slow speed, the natural draft is certainly insufficient to produce the desired cooling. That is why fan is a necessary part of the cooling system. It is mounted behind the radiator on the same shaft on which the water pump is mounted. It is driven by a v-belt from the crankshaft pulley. It may have four to seven blades, sometimes spaced unevenly to reduce noise. It is generally made of sheet metal, but these days moulded plastic materials are being used for making fans.

Lubricating System:

Lubrication circuit is one of the most important ones in the engine. The engine cannot run smoothly for more than a few minutes without lubricating oil.

Functions of Lubrication

- It reduces the friction between moving parts & so that power loss in minimum.
- It reduces wear of the moving parts.
- It provides cooling effect.
- It provides cushioning effect.
- It provides cleaning action.
- It provides sealing action.

Systems of Engine Lubrication

The various systems adopted for the lubrication of automobile engines are

- Petrol System.
- Splash System.
- Pressure System.
- Dry-Sump System.

The main parts of an automotive engine which require lubrication are

- Main crankshaft bearings.
- Big end bearings.
- Gudgeon pin bearings.
- Piston rings & Cylinder walls.
- Timing Gears.
- Camshaft and camshaft bearings.
- Valve Mechanisms.
- Electrical Equipment's.

Components of Lubrication System:

Oil Strainers:

Oil strainer is attached at the inlet of the oil pump to guard it against the entry of grit etc. The strainer is made of ordinary wire mesh screen. A good practice is to install a floating strainer, which is hinged to the oil pump inlet. The floating strainer remains at the surface of the oil, whereas the grit, dust etc., remains at the bottom of the crankcase. The result is that very small number of impurities goes to the strainer screen and hence the chances of it being blocked up are minimised.

Oil Pumps

Next to oil strainer in the lubrication system sequence, comes the pump. Its function is to supply oil under pressure to the various engine parts. The oil pump is generally located inside the crankcase below the oil level.

The pump is usually driven from the end of the distributor shaft, which gets its drive from the camshaft through a skew gear if a low-mounted camshaft is employed. In some automobile engines mounted transversely, the oil pump is driven directly from the camshaft end through a coupling, since no separate shaft is required, this is a compact arrangement. The oil pressure in the engine increases with the increase in engine speed which would increase the pump speed.

The size of the pump should be sufficient to maintain the desired pressure with reasonable amount of wear. The different types of pumps used are.

- Gear Pump.
- Vane Pump.
- Rotor Pump.
- Plunger Pump.
- Oil Filters

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The lubricating oil with use is deteriorated resulting in the formation of sludge, lacquer and carbon. Further it is contaminated by various by-products of combustion of fuel. In addition to these the fine particles of metal due to wear are the other impurities present in the oil. It is therefore necessary to remove these impurities to avoid permanent damage to any running parts of the engine. Commonly used materials for filtering are wire gauze, cotton, plastic – impregnated paper etc. The filtering element must let the oil pass through without much resistance, but should prevent the undesirable particles from entering the oil galleries.

Oil filters are basically of two types, the primary and the secondary, the primary filter is also called as surface filter or strainer since the impurities are retained on the outer surface of the filter. The secondary filters used in the automobile engines are of various kinds.

- Cartridge Type.
- Edge Type.
- Centrifugal Type.
- Oil Coolers.

In all heavy-duty engines, the temperature of oil becomes quite high because of high engine temperature. As the viscosity of the lubricating oil decreases with temperature rise, the oil film in the bearings might break and the conditions of boundary lubrication may be created instead of fluid lubrication which is desired. To avoid such thing oil coolers are provided. Oil coolers are simple heat exchangers.

Oil Pressure Gauges:

If any leakage occurs at any part of the lubrication system, the pressure in the entire system would fall, reducing consequently the oil supply to various bearings because of which they are bound to starve and be damaged. Thus, is very important for the driver to keep a watch on the oil pressure in the gauge. The gauges generally are bourdon type or electrical type.

Result:

Thus, the functions of Cooling and lubrication systems and its components used in automotive were studied.

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EXPERIMENT NO: 4

Experiment 4: To study the constructional details, working principles and operation of the Hydraulic & Pneumatic Brake systems.

Function:

Hydraulic brakes are applied by the driver through an actuating system using hydraulic principles to multiply the brake pedal force. The science of hydraulics is based on Pascal's principle which states that pressure applied to any area of an enclosed fluid is transmitted undiminished in all directions to every interior surface of the vessel.

In a brake actuating system, the enclosed vessel is a master cylinder and a wheel cylinder with connecting lines and hoses. Any pressure applied to the master cylinder is transmitted undiminished to each wheel cylinder.

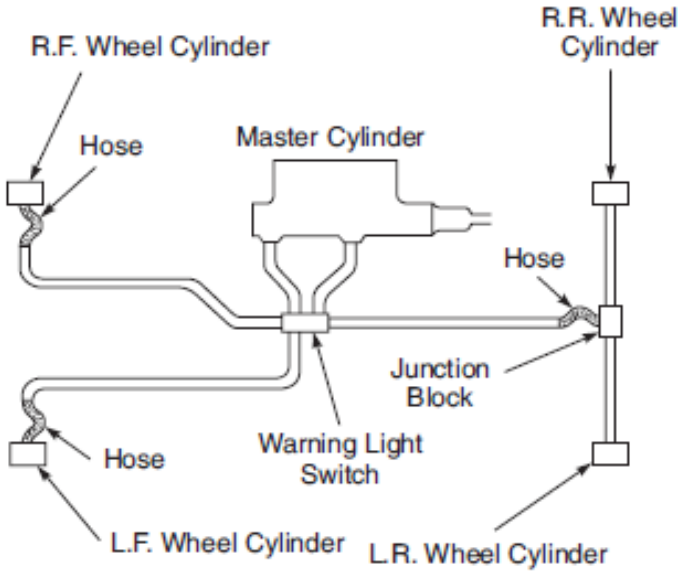

Fig: Break Actuating Mechanism

Classification of Brakes:

The automobile brakes are classified according to the method of applying the brake shoes to the revolving brake drums as internal-expanding or external-contracting. Another classification is based on whether the braking force is transferred from the foot pedal or hand lever to the brake shoes by means of mechanical linkage or by hydraulic pressure. These are known as mechanical or hydraulic brakes.

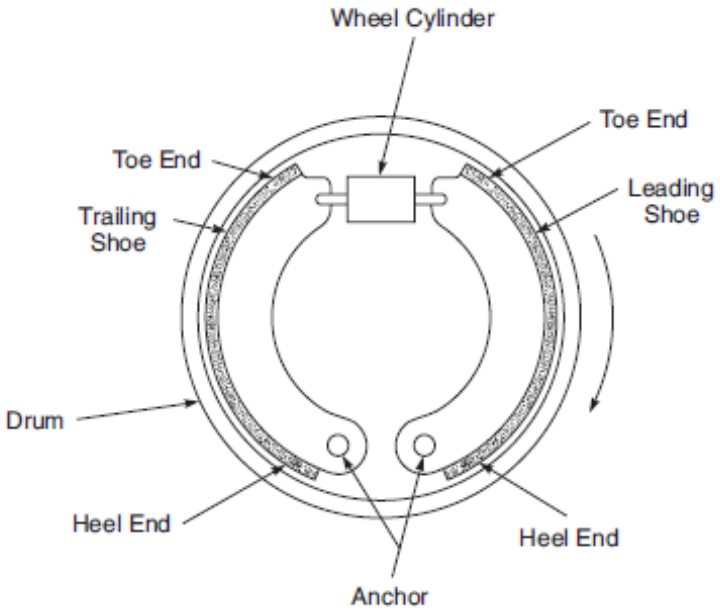

Fig: Leading and trailing brake shoes

Mechanical Brakes:

In a mechanical brake system, the pressure from the brake pedal is transmitted to the wheel brakes by means of rods and shafts as shown in Figure or by means of cables and shafts. The shoes are expanded against the drum by cams or by means of levers, toggles or wedges. The entire mechanical linkage between the brake pedal and the shoes operates to transmit the pedal force to the brake shoes.

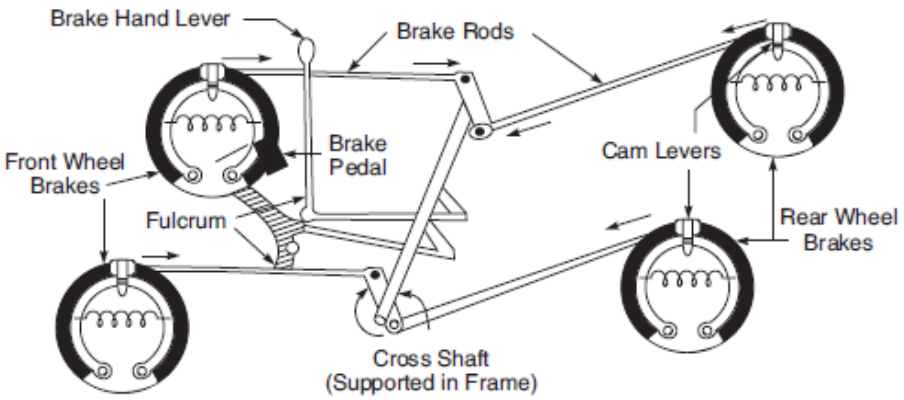

Fig: Mechanical break

Hydraulic Brakes:

One of the major advantages of using a fluid to operate the brakes is that complete compensation is achieved. This is because a fluid in a closed circuit exerts an equal pressure in all directions. A further advantage is that as no mechanical linkage is necessary (except for the hand brake), frictional losses are considerably reduced. Passenger cars and medium capacity trucks have hydraulic brakes. Figure shows the principle of the Lockhead hydraulic brake system. It is used in Ambassador car manufactured in India by M/s Hindustan motors Ltd. It comprises a combined fluid supply tank and a master cylinder in which the hydraulic pressure is generated, and a wheel cylinder which operates the brake-shoes. Steel pipe lines, unions and flexible hoses convey the hydraulic pressure from the master cylinder to each wheel cylinder.

As the brake pedal is depressed, the rod pushes the piston of the master cylinder, thus applying pressure to the brake fluid. Moving through pipes and hoses to the wheel cylinders, the fluid forces apart the cylinder pistons, and the latter press the shoes against the brake drums. When the brake pedal is released, the piston in the master cylinder returns to the initial position, the shoes are pulled back by the return springs, the fluid flows back into the brake master cylinder, and braking ceases.

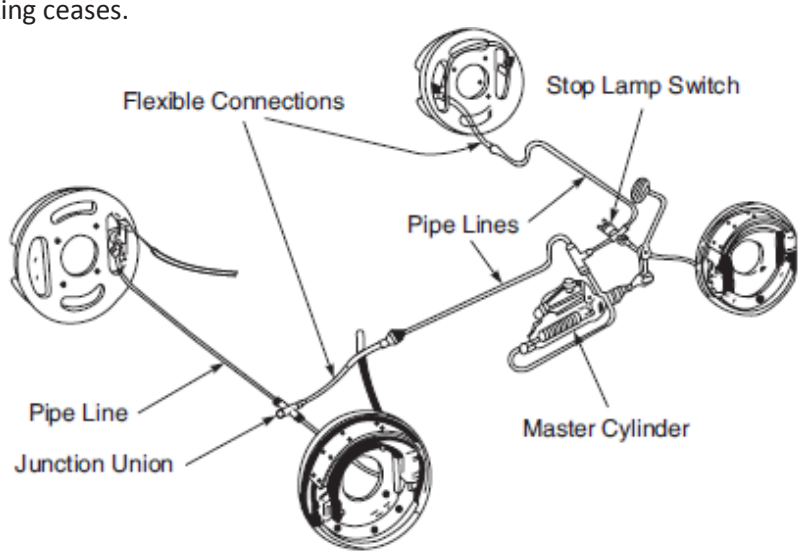

Fig: Lockhead Hydraulic Brake System

Master Cylinder:

The master cylinder is a cast iron body containing a cylinder bore, a fluid reservoir and fluid passages. Ports are drilled between the reservoir and the cylinder bore to allow the make-up fluid to enter the system or to allow the expanded fluid to return to the reservoir. The master cylinder piston is a long piston with two lip-type cup seals, one close to each end. The inner seal, called a primary cup is used to build up hydraulic pressure in the system. The outer seal, called a secondary cup, keeps fluid from leaking out of the master cylinder.

Check Valve:

The check valve opens during the pressure stroke to allow the fluid to enter the lines. The returning fluid is also to re-enter the cylinder by raising the entire valve from its seat until the pressure in the lines drops below 0.56 kg/cm2

(6 to 8 lb per square inch). Then the return spring is capable of sealing the valve so as to maintain that slight pressure in the lines. This residual pressure acts as a seal to prevent gravity and the entrance of air into the system.

Wheel Cylinder:

The wheel cylinder consists of two small pistons with a spring and cups. When the brake is applied the fluid pressure exerts pressure on the cups or washers. The motion is transmitted to the brake shoes to force them against the brake drum. The piston cup fits lightly in the cylinder against each piston and seals the mechanism against leakage of brake fluid. The light spring serves to hold the cups against the pistons when the pressure is released. The boots protect the cylinder from the entry of foreign material. Brake fluid enters the cylinder from a brake-line connection inlet between the opposed pistons as shown in Fig. Bleeder valves are provided in each wheel cylinder to permit air and liquid to be pumped out of the system during the bleeding operation.

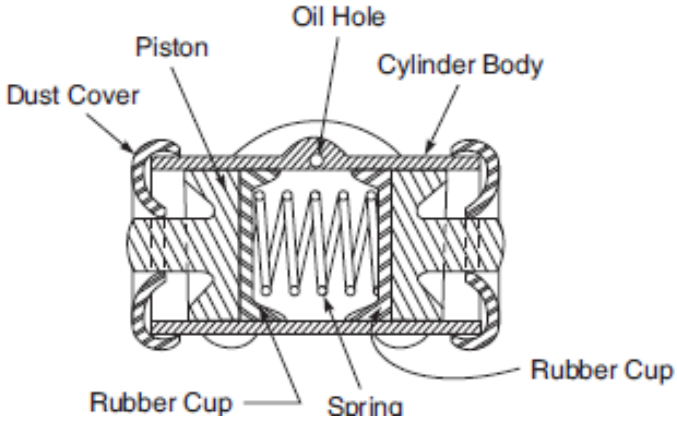

Fig: Sectional view of wheel cylinder

Result:

Thus, the functions and operation of the Hydraulic & Pneumatic Brake systems used in automotive were studied.

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EXPERIMENT NO: 5

Experiment 5: To study the constructional details, working principles and operation of the Drum Brake System, Disk Brake System and Antilock Brake System.

Drum Brakes:

Brakes are mounted on all four wheels. They stop the car by changing the kinetic energy of the vehicle (motion) into heat energy (heat). This is the same principle as that used when dragging a foot on a skateboard or bicycle. For many years, drum brakes were used exclusively. However, they have been almost totally replaced in the front wheels of new cars by disc brakes. Drum brakes are still used in the rear wheels of most cars.

Drum Brake Assembly (Rear Wheel Brake)

Figure shows the drum brake assembly of Maruti 800 cars having a self-shoe clearance adjusting system. This assembly consists of the following main components:

1. Backing Plate and Brake Shoes Backing plates are bolted to the rear axle housing or spindle. Thus, the backing plate and the parts mounted on it do not rotate with the wheels. Attached to the backing plates with pins and springs being two brake shoes, the shoes being free to move by limited amounts.

Brake shoes are built on a steel frame with a composition lining riveted or bonded to them. Initially, this composition material used to contain lots of asbestos. Other lining materials are— bonded resin and fillers. Such asbestos/resin linings are called organic linings. Some heavy-duty linings have powdered iron in them and are called metallic linings. Some linings use a combination of organic and metallic linings.

2. Wheel Cylinders Rigidly fixed to the backing plate between the brake shoes is the wheel cylinder. The wheel cylinder is simply a cylinder with two pistons at each end. It is like a small master cylinder, working in reverse and with no reservoir.

In the wheel cylinder, hydraulic pressure is converted to mechanical force. The brake lines connect to the wheel cylinders at the wheel cylinder's centre. Thus, a chamber formed by the wheel cylinder and the pistons at each end are open to the brake lines. Fluid pressure from the master cylinder is felt in this chamber. It forces the wheel cylinder pistons outward. The outer end of the pistons is connected to the brake shoes. So when the pistons are pushed outward, the shoes must move outward as well.

3. Drums Covering the entire brake, including the shoes, wheel cylinder and backing plate, is the brake drum. The drum is attached to a suspension hub or axle, so that it rotates with the wheel.

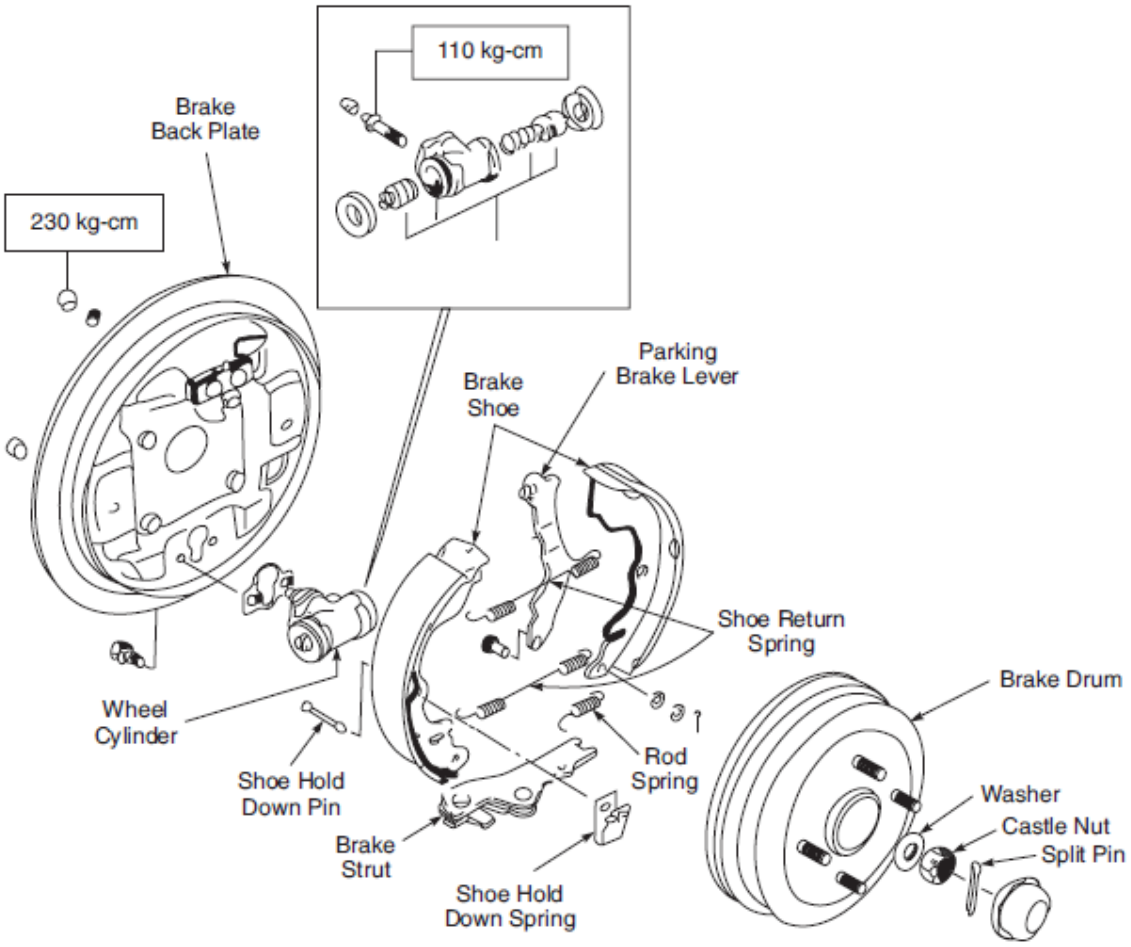

Fig: Drum Brake Assembly

It is the only part of the brake that rotates with the wheel and tyre. When the wheel cylinder pistons press the brake shoes outward, the shoes are forced against the rotating drum. Friction between the lining and drum turns the motion into heat causing the car to stop. When brake pressure is released, the shoes retract to their at-rest position. The springs mounted between the shoes retract the shoes.

Because the drum brake is enclosed by the drum and backing plate, cooling is difficult. Heat must pass into the drum and backing plate before it can dissipate into the atmosphere. Excessive heat warps the brake drum, causing grabby brakes.

Disc Brakes:

Disc brakes are quite different from the drum brakes is that the drum is replaced by a circular plate and the brake shoes are replaced by a caliper which supports a pair of friction pads, one on each side of the disc. These pads are forced inward by the operating force and so retard the disc.

The advantages and disadvantages of disc brakes compared with drum brakes are as follows:

Advantages:

- Disc brakes are lighter than drum brakes.
- Disc brakes have better cooling than the drum brakes because the braking surface is exposed directly to air.
- Disc brakes offer better resistance to fade than drum brakes.
- The pressure distribution is uniform since disc brakes have no self-servo effect.
- The brake pads can be easily replaced. It is not necessary to remove the tyre. Only two screws have to be removed and the brake pads replaced.
- Disc brakes are self-adjusting by design.

Disadvantages:

- There is no servo action in disc brakes.
- It is difficult to install an adequate parking brake attachment.
- The cost of disc brakes is higher than drum brakes because it includes the cost of a booster.
- Higher pedal pressure is required for stopping vehicles.

Figure shows the component of this type of disc brake. It has no servo assistance as in drum braking and it is necessary to increase the working pressure of the piston and pad. For this purpose, the wheel cylinders have a large bore. Only a little change in clearance between the disc and pad has a large influence on the brake pedal stroke. It is necessary to have the clearance always adjusted to minimum, by means of the piston (rubber) seal.

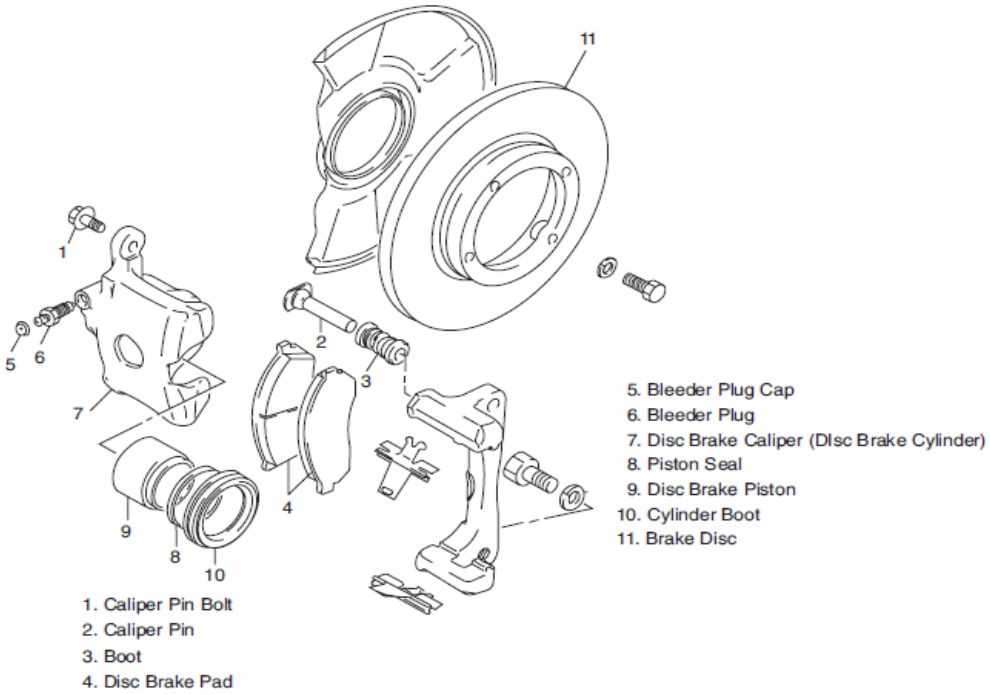

Fig: Components of Disc brake

Antilock brake system:

Anti-Lock Brake systems, also known as ABS, are a safety feature found in most modern cars. They are designed to prevent the wheels from locking up when the driver applies the brakes too hard or too suddenly. By stopping the wheels from locking up, the car can maintain stability and control even when braking at high speeds. The ABS system works by using sensors located near each wheel to detect when the wheel is rotating too quickly. When this happens, the electronic ABS system will automatically apply and release the brakes in a very fast, yet controlled manner. This then allows the driver to maintain control of the vehicle. This is especially useful when braking on wet or icy roads, where the car is more likely to skid on the road surface. With the help of ABS, drivers can avoid skidding and loss of control, helping to keep them safe on the road.

EXPERIMENT NO: 6

Experiment 6: To study the constructional details, working principles and operation of Front Suspension System and Rear Suspension System.

Front Wheel Suspension System:

The front suspension in a car must bear a lot of forces particularly due to acceleration, braking and cornering. The assembly used for the front suspension must provide a movement in the up and down direction along with steering. It has therefore to adhere to the following conditions:

- The suspension must not allow the various forces coming from the road irregularities and cornering to deflect the car from its course of movement decided by the driver.
- It should not permit the wheels to wobble, move any significant distance backwards or forwards or sideways.
- It should not allow the system to alter the tilt of the wheels to any serious degree.

The above conditions are necessary for the control and handling of the vehicle.

Types of Independent Front Suspension Systems

Although over the years many arrangements have been developed and successfully fitted on the front wheels, two representative types of independent suspension systems of the front wheel are next discussed:

- Double wish bone suspension system
- Single wish bone, i.e. MacPherson strut assembly.

Double Wish Bone Suspension System As the name suggests, the assembly in the double wish bone suspension system primarily uses two wish bone shaped links (Fig). A wish bone is a vee shaped link which is so named because of its shape. The two ends of the vee are hinged onto the body or the sub frame while the narrow ends carry between them (i.e. narrow ends of upper and lower wish bone links) the swivel member which carries the stub axle on which the wheel is mounted. Thus the two wish bones are placed one over the other while the swivel member is vertically positioned. Between the two wish bone links are placed the spring and the shock absorber (damper) system which take the shocks and reduce vibrations.

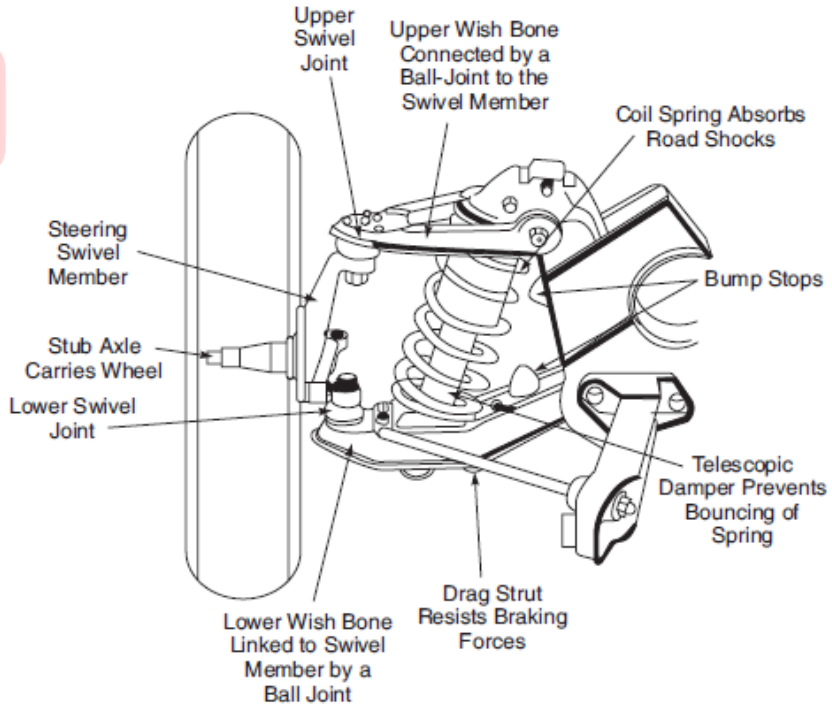

Fig: Double Wish Bone Suspension

MacPherson Strut Assembly (Single Wish System)

Earle S. MacPherson, an engineer with Ford USA, developed a single wish bone with a telescopic strut type system (Fig.) in the forties. In this system, there is a telescopic strut, a single arm, and a diagonal stay. The whole system is known as the MacPherson system.

The strut is fixed to the body structure at the upper end through a flexible mounting and the lower part of the strut is connected at the bottom by a joint to the lower arm. The lower part of the strut also carries the stub axle, which in turn carries the wheel. The steering motion is supplied to the lower part of the strut and it turns the whole strut. A coil spring and a hydraulic damper surround the upper part of the strut which takes care of the road irregularity shocks and vibrations.

The MacPherson strut has some distinct advantages:

(i) It is mechanically simple.

(ii) Its light moving parts help the wheels to follow the road irregularities.

(iii) The wheel camber does not vary much.
(iv) It has distinct advantages in case of transverse engines, since in that case there is either no space or very little space for upper links to fit.
(v) Its maintenance is very easy.
However this system does have a couple of disadvantages:

- Radial loading comes on the piston due to the lateral forces during cornering and brake torque.
- The body structure has to be really strong above the wheel arches, where the struts are attached, to absorb the full suspension loads.

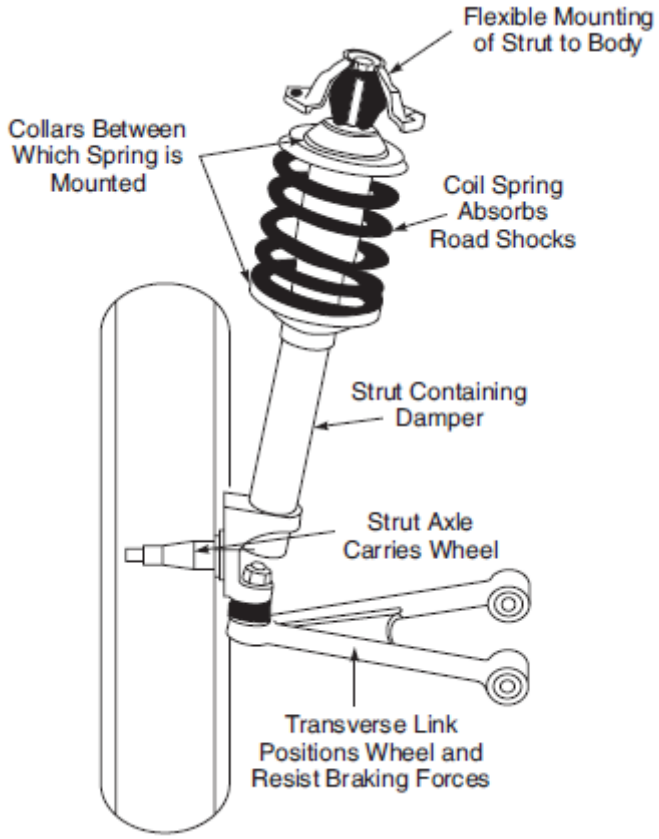

Fig: MacPherson Strut Assembly

Rear Wheel Suspension System

Unlike the front axle which is in most of the cars, a dead axle, except in case of front wheel drive cars, the rear axle is a live axle. Even in case of four-wheel drive vehicles like jeeps, the rear axle mostly transmits the power. The front axle is designed to transmit power in situations when the four-wheel drive is used. In case of heavy passenger vehicles or load carrying vehicles, the power is transmitted through the rear axle. A live axle is one that either rotates or houses shafts that rotate, while a dead axle is one that does neither, but simply carries at its ends the stub axles on which the wheels rotate.

Live axle performs two functions:

(i) It acts as a beam that carries through the medium of springs and the other suspension system, the weight of the passenger compartment and its contents, and transmits these loads under dynamic conditions through the road wheels—rotating on its ends—to the ground. The dynamic loading is principally a result of the motions of the wheel and axle assembly over the ground and the reactions due to its mass, the flexibilities of the tyres and road springs and the mass of the carriage unit and its contents.
(ii) To house and support the final drive, differential and shafts to the road wheels and to react the torques in both the input and output shafts.

The rear axle suspension poses problems to designers since the weight on the front axle remains constant, and the front axle or front suspension as it should be correctly called, is under the engine and its movements are not coming on the passengers as directly as the rear axle. Rear suspension must be designed not only for an empty car when the car is moving with driver, but also when the car carries occupants and when the car boot at the rear is loaded. This variation of load on the rear axle is further complicated when it is realised that the weight of the car is shifted to a larger extent, at the time of acceleration, to the rear axle. The springs and dampers, on the rear suspension, should therefore be soft enough to give a comfortable drive in an empty car but also hard enough to carry extra weight when running with full capacity.

The suspension system for the rear axle must be capable of dealing with:

- The weight of the carriage unit including contents.

- Torque reaction—for both drive line and brakes.
- Driving thrust.
- Brake drag.
- Lateral forces.

The rear axle suspension system therefore must be designed to overcome the above forces. Both rigid suspension and independent rear wheel suspension have been designed in many ways and some are specifically known by the names of the car models in which they were used. However, in the present chapter, a representative of each of both rigid suspension and independent suspension is described.

Hotchkiss Drive

The Hotchkiss drive is a rigid suspension which employs two leaf springs located as far as possible on the axle (Fig.). These springs apart from absorbing shocks, also position the axle and the axle moves up and down with it. Two telescopic hydraulic dampers, i.e. shock absorbers are attached one each to the two sides of the real axle near the leaf springs. The axle is usually fixed exactly at the mid-point of the spring. However, in some cases, it is fixed a bit ahead of the mid-point to give a downward tilt as the axle rises when riding over bumps. This reduces the amount by which the propeller shaft lifts on a bump and in turn minimises the height of the propeller shaft tunnel and the amount it intrudes into the car body. The leaf springs are fitted to the body with a rubber bush in the front while the rear end of the spring is fitted to the body through a shackle with rubber brushes. This helps in accommodating the increase or decrease in length of the spring as it flexes up and down. One of the disadvantages of leaf spring is that it tends to distort when the axle tries to turn during acceleration or braking. Some modifications to the simple Hotchkiss drive have been made to overcome some of the shortcomings. For example, fore and aft distortion of the springs can be limited by linking the axle to the main car structure. Radius rods trailing from mountings on the structure help to position the axle. Another design uses a transverse rod known as Panhard rod which pivots on the body structure at one end and on the axle at the other. This assists in holding the axle in position (Fig.).

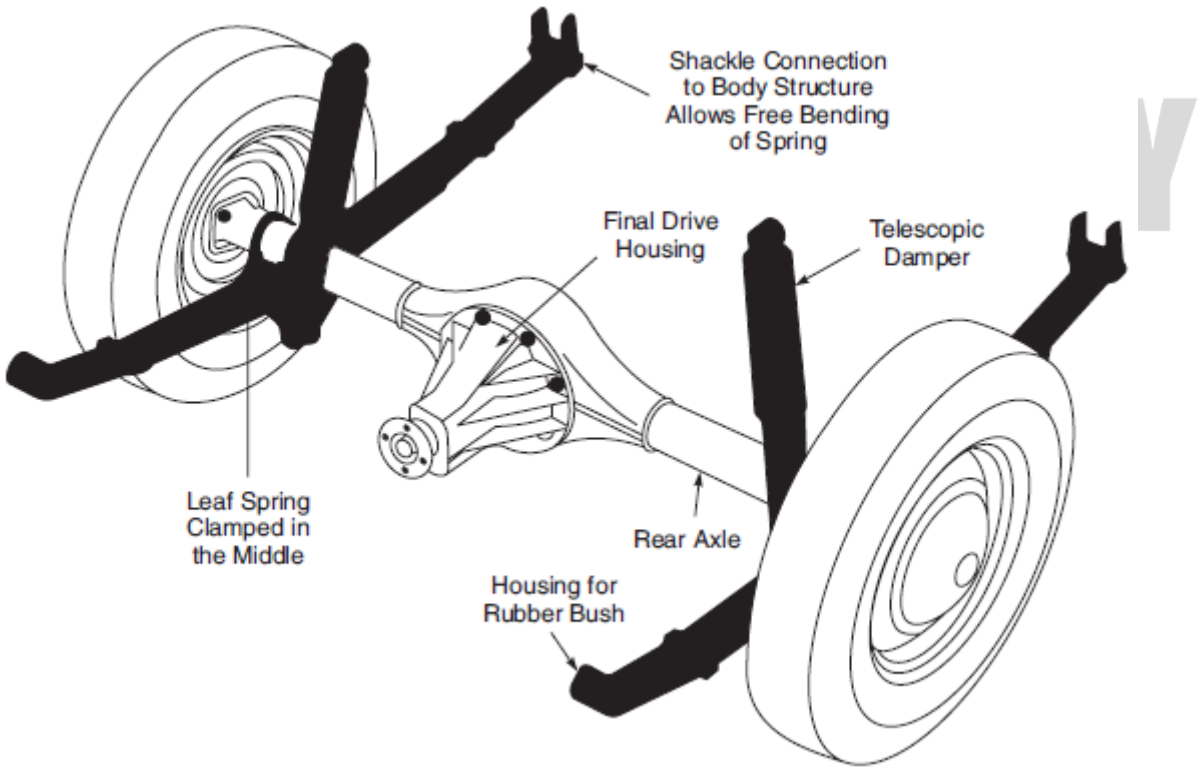

Fig: Hotchkiss Drive

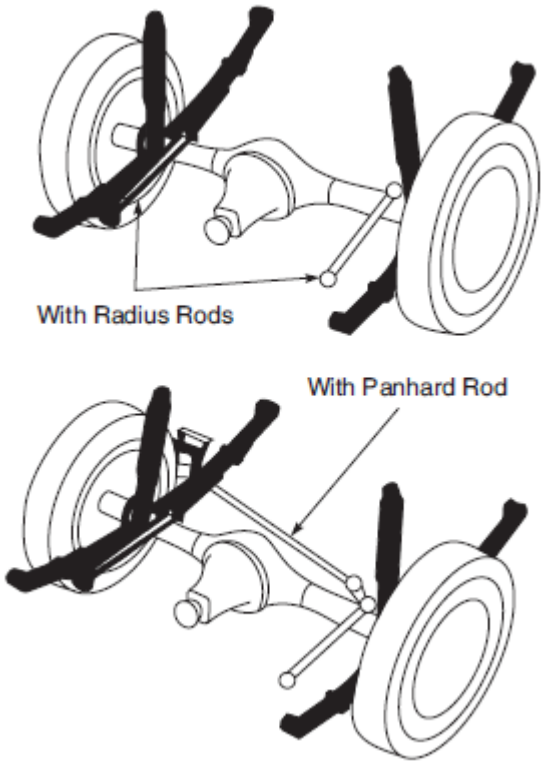

Fig: Leaf Spring

Independent Rear Suspension:

Many arrangements have been tried for independent rear suspension. However, since the rear axle is in general a live axle, arrangements must be made to have independent movements of the two wheels which in turn require the movements of two halves of the axle. The usual arrangement in such a case is to have a double universal coupling on each half of the rear axle, i.e. one at the point of power take off from the differential, while the other at the stub axle of the wheel. This allows the angular movement of the half rear axle while freeing the wheel from angular tilt with it.

Swinging Half Axle:

The oldest arrangement in independent rear wheel suspension was the swinging half axle type. This system has two tubes pivoted to a central drive casing carried by the car structure. A universal joint is centred on each pivot. Suspension is usually by a leaf spring lying across the car bolted to the frame or axle casing in the middle and shackled at its ends to the axle tube. A later version carried a coil spring, and a double universal joint to reduce camber changes when cornering (Fig.).

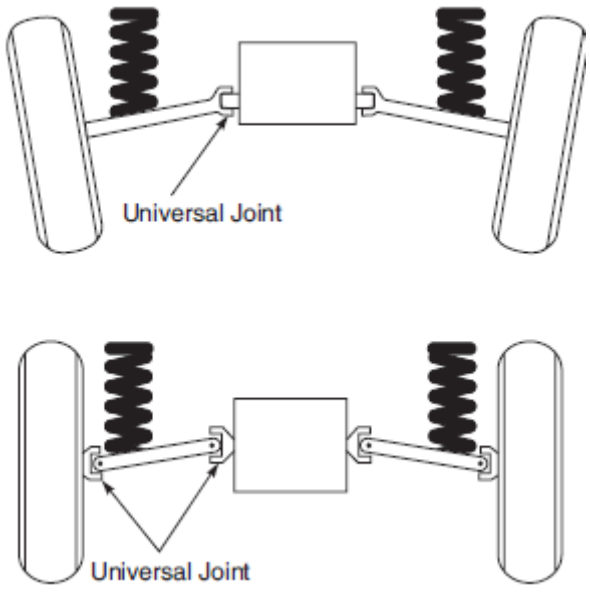

Fig: Swinging Half axle

MacPherson Strut:

Similar to what was described in front suspension, the MacPherson strut is used in rear suspension with half axles as described in the previous section.

Trailing Arm Design:

In the trailing arm design, two trailing arms are used one on each side of the rear axle (Fig.). The trailing arm is a partial "Y" structure as shown and usually of forged construction. This trailing arm is hinged ahead of the rear axle to the body structure and the hinge pin is at right angles to the car axis. In such a case, the wheels move up and down without any change in camber. The coil springs are housed in between the trailing arm and the body while the hydraulic dampers are fixed to the body and the trailing arm. The trailing end of the trailing arm is hinged on the rear axle.

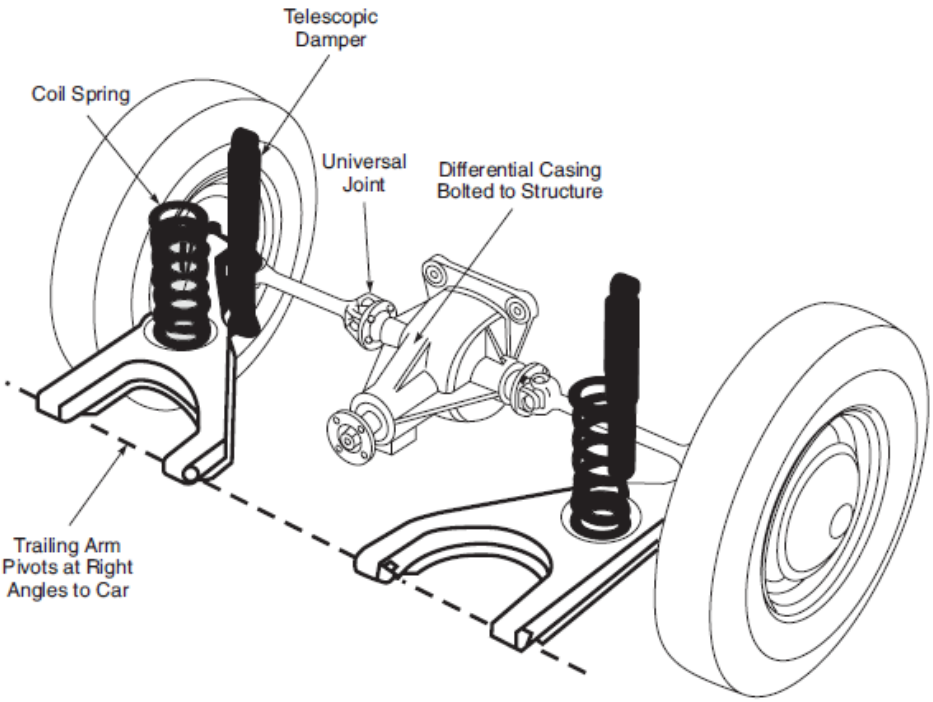

Fig: Trailing Arm

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Result:

Thus, the functions and operation of Front Suspension System and Rear Suspension System used in automotive were studied.

EXPERIMENT NO: 7

Experiment 7: Demonstration of steering system and measurement of steering geometry angles and their impact on vehicle performance.

Function Of the Steering System:

The function of the steering system is to enable the driver to control accurately 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. The working of the system depends on proper alignment of the front wheel for directional control and ease of steering.

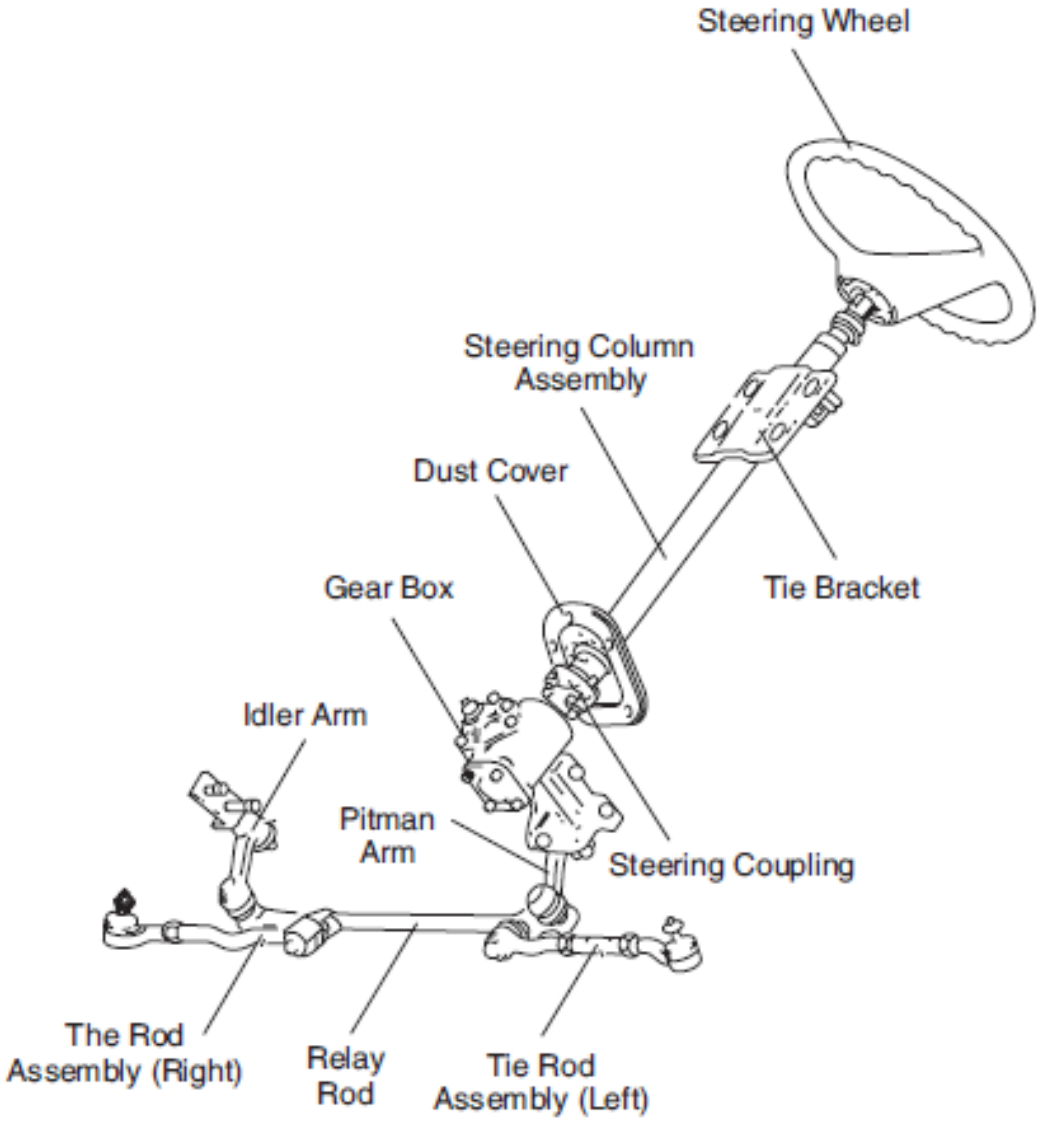

Fig: Steering Linkage

Steering Gears:

Steering gears have two functions: to change the rotary motion of the steering wheel into straight line motion that will move the steering linkage and to provide a gear reduction that will make the automobile easier to steer. A small effort at the steering wheel is multiplied into a larger effort at the steering linkage. The amount of gear reduction is described as the steering ratio. A typical ratio of 16:1 means that in order to turn the front wheels by one degree the steering wheel has to be rotated 16 degrees. A light sports car with quick steering may have a ratio of 12:1, while a large heavy automobile may have a ratio of 20:1.

The Worm and Nut Steering:

In the worm and nut steering method the steering shaft ends in a square cut screw thread. A nut is made to work on these threads. The turning of the steering wheel moves this nut along the steering rod screw thread, and the nut activates a bell crank lever, pivoted (Fig.) in the steering box casing. The steering gear drop arm forms the other arm of this bell crank. The recirculating ball and worm type of steering gear box is developed on this type of steering gear box.

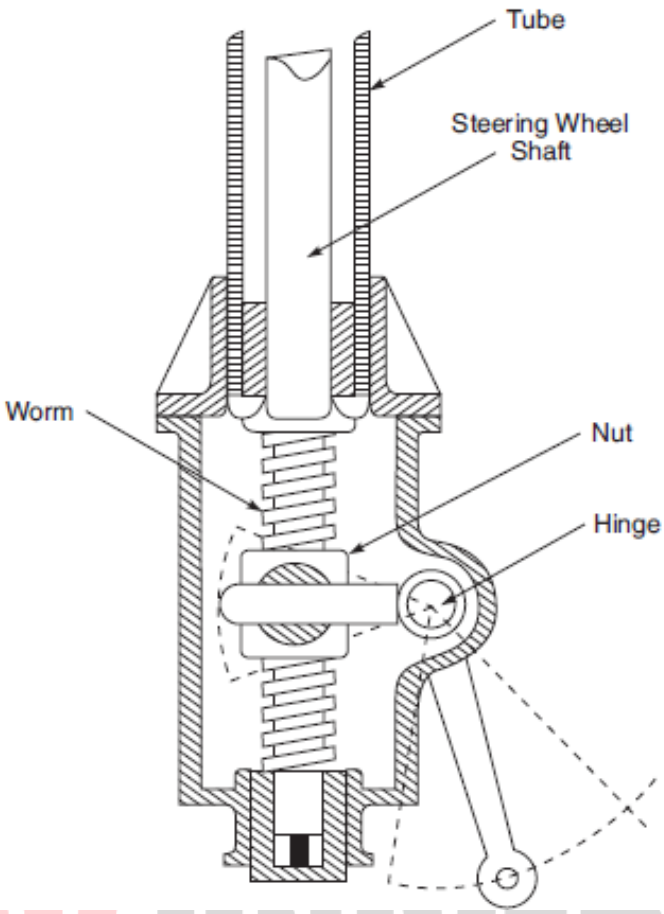

Fig: Worm and Nut Steering Gear

Worm and Worm Wheel Steering:

In the worm and worm wheel steering system there are square threads or worms on the steering rod end as before, but instead of working in a nut, it engages in a worm wheel. The drop arm (pitman arm) is keyed to the same shaft as the work wheel and works rigidly with it. Usually, a square shaft is used for the worm wheel, so that as wearing of the worm sector occurs, the worm wheel can be turned round to a new position. The arc of movement of the drop arm is usually from 60 degrees to 90 degrees. Many makers provide only a sector of a wheel for this purpose. This gives a smaller and lighter mechanism but has no provision for worm and wheel teeth wear. Figure illustrate the principle of this type of steering. This system is most common in tractors.

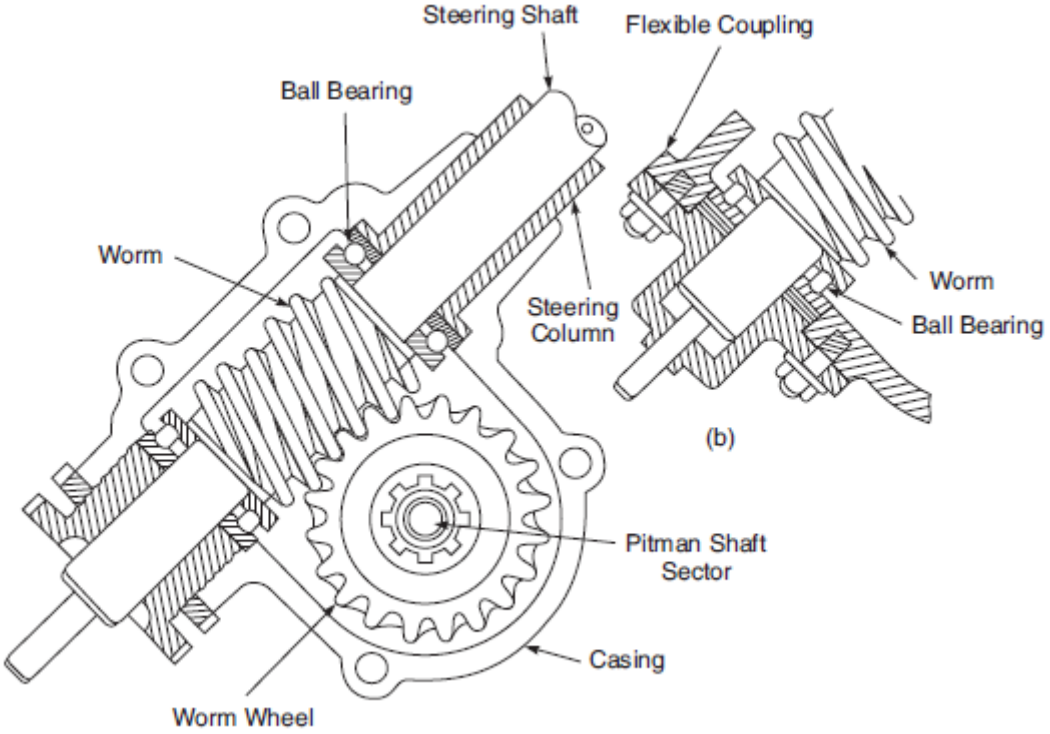

Fig: Worm and Worm Wheel Steering Gear

The Worm and Roller Steering:

In the worm and roller steering designs a single or double roller is mounted between two arms integral with the inner end of the cross-shaft, and this roller is meshed with the worm. The roller is free to turn on its shaft and moves in an arc, the correct mesh being obtained throughout its movement by the hour-glass shape of the worm. The worm is supported and located by two ball or taper roller bearings mounted in the case and its end float may be adjusted by shims placed between the outer bearing track and the end plate of the case. The roller shaft is eccentric and may be turned to compensate for wear between the roller and the worm. The upper end of the column is supported in the tube by a felt bush (Fig).

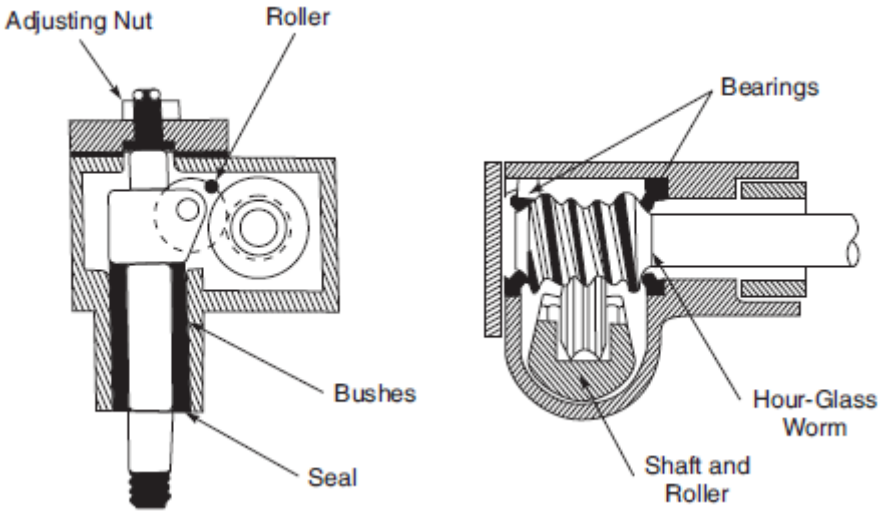

Fig: Worm and Roller Steering

Recirculating Ball Steering

Most large automobiles use a worm gear which look like a large bolt thread on the end of the steering shaft. Turning the steering wheel turns the worm gear, which causes a large nut in mesh with the large threads to move up and down the worm. The nut has teeth which mesh with the other gear in the gear box, the sector gear, so that it also rotates. The sector gear, hooked to the steering linkage, completes the gear reduction process that increases the steering wheel's turning effort. To reduce friction and steering effort, small ball bearings may be used between the worm and nut. The bearings ride in the threads of the worm and mesh with the nut. Therefore, this type of steering unit is called a recirculating ball steering gear (Fig).

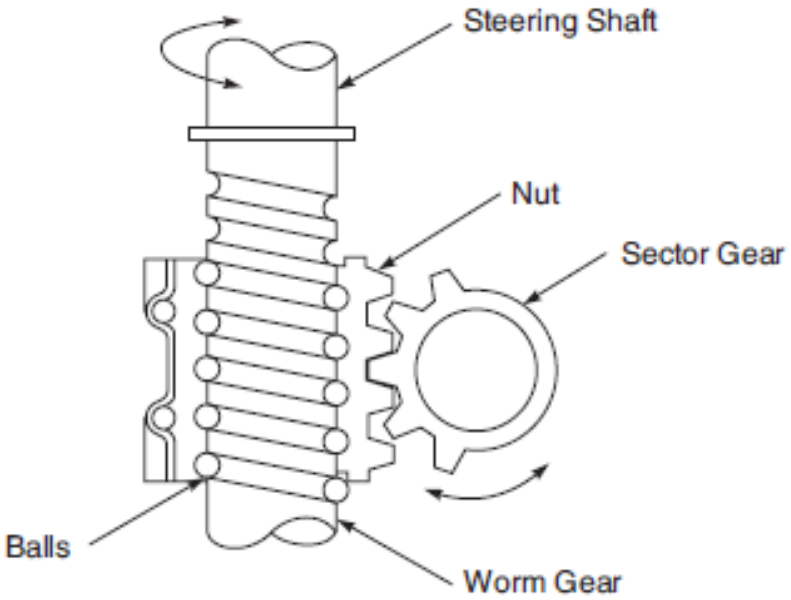

Fig: Recirculating Ball Steering Gear

Rack and Pinion Steering

Many small cars use a rack and pinion steering system in which the steering wheel and shaft are connected to a small pinion gear (Fig. 16.5). This gear is in mesh with teeth on top of a long bar, called a rack. Turning the steering wheel turns the pinion gear, which moves the rack back and forth. The rack is attached to the steering linkage that turns the wheels. The main advantage of this system is that it takes up very little space, making it especially suitable for compact vehicles.

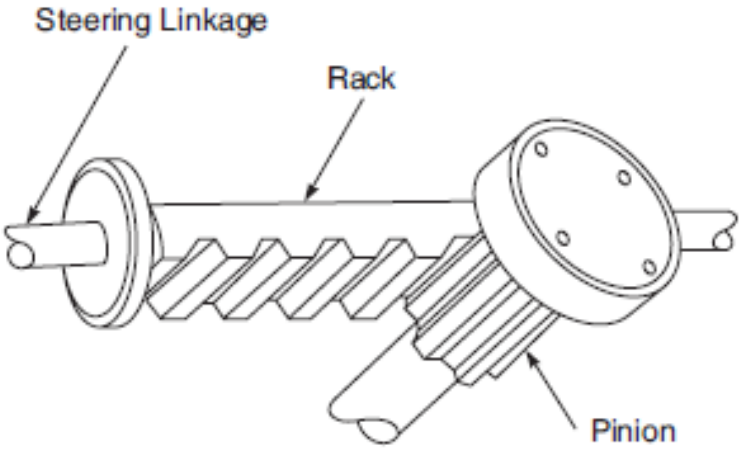

Fig: Rack and Pinion Steering

Steering Geometry:

Whenever two or more things such as support arms, are connected together they form angles in relation to each other. Since geometry is the branch of mathematics which deals with angles, therefore the study of the angles in the steering system is called steering geometry. It is important to know the name of each angle which is produced in steering geometry.

- Caster angle
- Camber angle
- Angle of king pin inclination
- Toe-in
- Toe-out

Caster Angle: Caster angle is the tilt, i.e. the inclination of the top axle or kingpin towards the front or rear of the car. If tilted towards the front it is positive caster (+) and if tilted towards the back it is negative (–) caster. The purpose of caster is to give a trailing effect to the front wheels. When the wheel trails the line of weight, that is, moves in the same direction as the vehicle, it is easy to steer a straight course (see Fig. (a)).

Camber Angle: Camber angle is the outward or inward tilt of the wheel at the top. If tilted outward it is positive (+) camber and if inward it is negative (–) camber. The main purpose of the camber is to bring the road contact of the wheel more nearly under the point of the load and to throw the weight on the inner wheel bearings which are larger than the outer (see Fig. (b)).

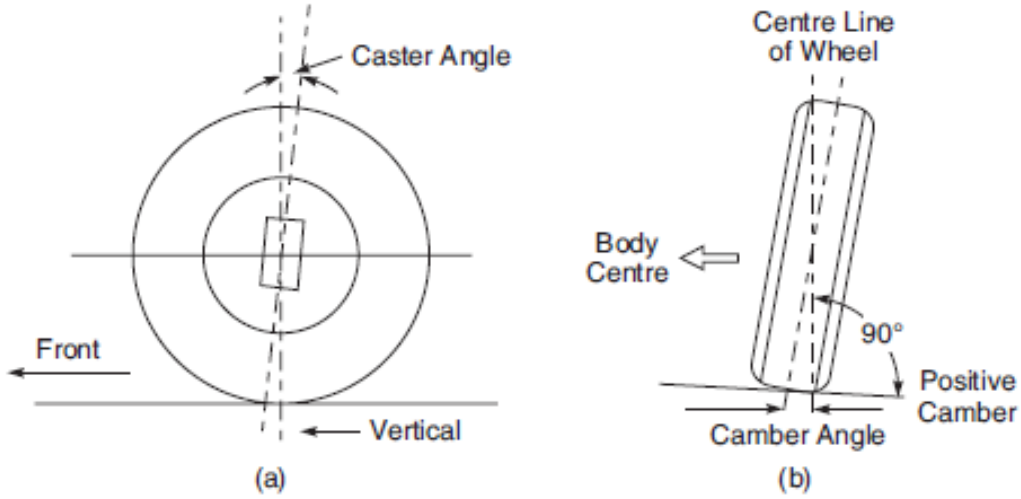

Fig: Caster Angle and Camber angle

King Pin Inclination: The king pin is tilted in at the top towards the vehicle in order that the weight of the load will be thrown towards the tyre centre. The angle between the vehicle line and the kingpin centre line is known as kingpin inclination angle (Fig.).

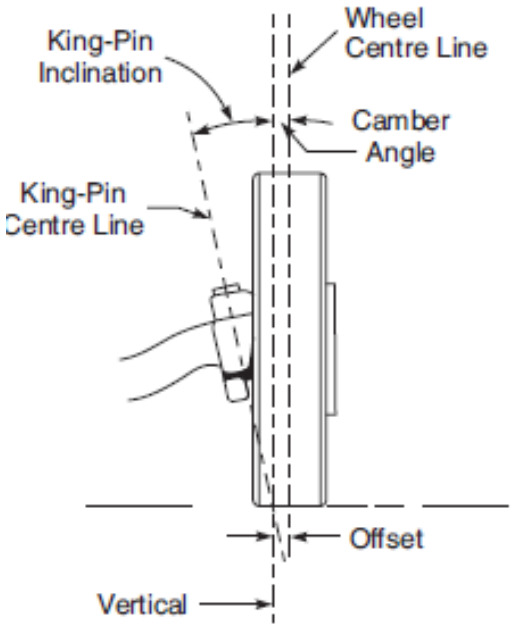

Fig: King pin inclination

Toe-in: The wheels are closer together at the front than they are at the back. The purpose of toe-in is to offset the camber and prevent excessive tyre wear (Fig.).

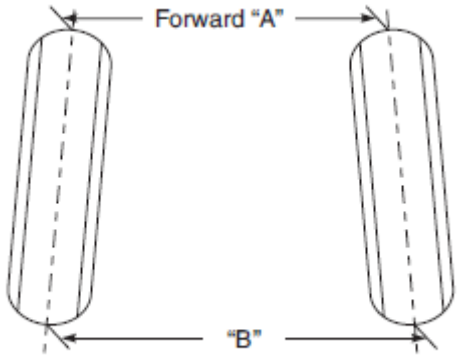

Fig: Toe in

Toe-out: Toe-out is the spreading apart of the front wheels on turns. The purpose of toe-out is to give correct turning alignment and to prevent excessive tyre wear (Fig).

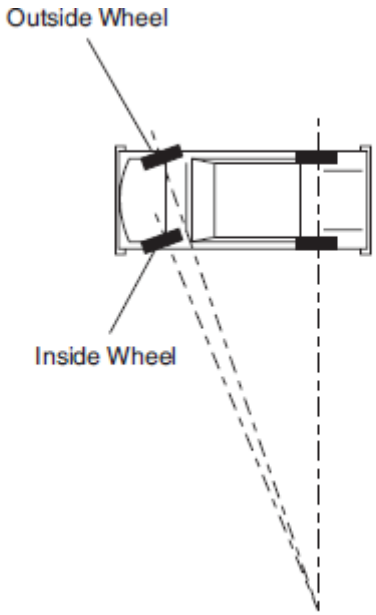

Fig: Toe out

EXPERIMENT NO: 8

Experiment 8: To study the constructional details, working principles and operation of single plate &Multi-Plate Clutch.

Function of clutch:

- To permit engagement or disengagement of a gear when the vehicle is stationary and the engine is running.
- To transmit the engine power to the road wheels smoothly without jolt/shock to the transmission system while setting the vehicle in motion.
- To permit the engaging of gears when the vehicle is in motion without damaging the gear wheels.

Main Parts of Clutch:

- **Pressure Plate:** It is accurately machined and presses the driven plate against the flywheel.
- **Driven Plate**: It is provided with annular facings and a spring-cushioned hub, i.e. with springs and with two vibration damper rings. Its outer diameter is 184 mm.
- **Release Levers**: Release levers are provided with every lever mounted on an eye bolt locked on the cover by a nut and held in place by a retainment spring.
- **Engagement springs**: Six powerful springs force the pressure plate on driven plate.
- **Sliding sleeve with thrust bearing**: The sleeve controlled by a fork lever may slide until it presses with the thrust bearing on the release lever inner ends.
- **Cover:** The cover which is of pressed sheet steel, is fixed to the flywheel by six screws.

Types of Clutch

- The cone clutch which is now only used in the synchromesh units of gear boxes, and in overdrives and some epicyclic gear boxes.
- The single plate clutch (multi spring or diaphragm spring) which is used in most cars and small commercial vehicles.
- The multiplate clutch which is used in motor-cycles, in some racing cars, tractors and also in special types of very heavy commercial vehicles.

Single Plate Clutch

The single plate clutch is used in most automobiles for producing a quick disengagement and permitting change of gears with minimum effort. The clutch is of conventional design, having coiled pressure springs and three adjustable release levers. There are many designs of coil spring pressure plates, some using three large coil springs; others using nine or twelve smaller springs. Another type of pressure plate uses a one-piece conical or diaphragm spring steel which is punched to give it greater flexibility. It claims following advantages over the coil spring type:

- As the diaphragm itself acts as a series of levers, release levers are not needed.
- Less effort is needed on the pedal to keep the clutch disengaged.
- Operating load is practically uniform and constant on the driven plate.
- Squeaks, rattles and vibrations are mostly eliminated.

Multiplate Clutch:

Multiplate clutches are used for large trucks and racing cars where high torque transmission is necessary but the diameter is limited. These are also used in automatic transmission and motor cycles. In this type of clutch several parallel discs of metal and friction material are arranged to transmit the drive. In comparison to the single plate type these are smoother and easier to operate. The increased number of plates/friction discs provide the increased torque carrying ability thus making it suitable for use in heavy commercial vehicles and special purpose military and agricultural vehicles. These clutches may be dry or wet.

Multiple Wet Clutch:

A multiple wet clutch consists of several thin plates made of steel fitted to the engine shaft and those on the gear shaft are made of phosphor bronze. These plates are immersed in a bath of oil and have grooved surfaces for permitting the oil to flow through them. These grooves help to dissipate the heat generated during the engagement and release operations. The wet clutches are generally used in conjunction with or as a part of the automatic transmission.

Multiple Dry Clutch

The multiple dry clutch has its different plates lined with a frictional material similar to that used in case of a single plate clutch. Cork inserted multiplate clutches are used in motor cycles while those with metal plates are used in tractors or other light powered engine vehicles. To avoid scorching or changing of cork-inserts due to frictional heat, it is necessary to have the clutch oil-cooled.

Centrifugal Clutch

The centrifugal clutch automatically disengages itself when the speed falls below and engages when the speed rises above a pre-set value. Centrifugal bob-weights are positioned in such a way (see Fig.) that the centrifugal forces

exerted by them with the clutch rotation result in the release levers to be pivoted on their bearings. The clearance between the release levers and the bearing is reduced due to the outer end of the release lever moving towards the flywheel. This results in the proportionate increase of centrifugally generated pressure with the increase of engine speed. Therefore, at low engine speeds only the spring pressure acts, while at high engine speeds the force generated by the weights supplements the spring pressure. Thus, smooth, and acceptable gear changes are obtained under varying conditions of load and speed.

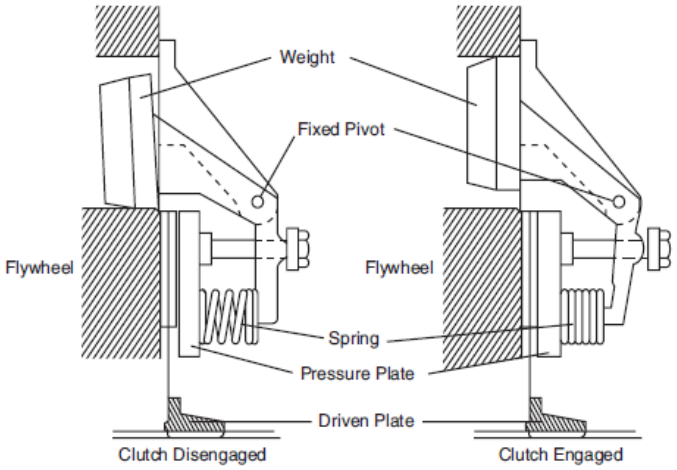

Fig: Centrifugal Clutch

Semi-Centrifugal Clutch

The semi-centrifugal clutches are like the centrifugal clutches, only difference being that relatively lighter clutch pressure springs exerting low pressure at idling speeds can be used. From Fig. it can be seen that the release levers are provided with weights on its outer ends. These weights are forced outwards because of the centrifugal force when the clutch speed increases. This way the release levers apply more pressure on the pressure plate, thus increasing the contact of the friction disc with the flywheel. This type of construction permits the use of light coil pressure springs and the clutch can operate without too much pressure.

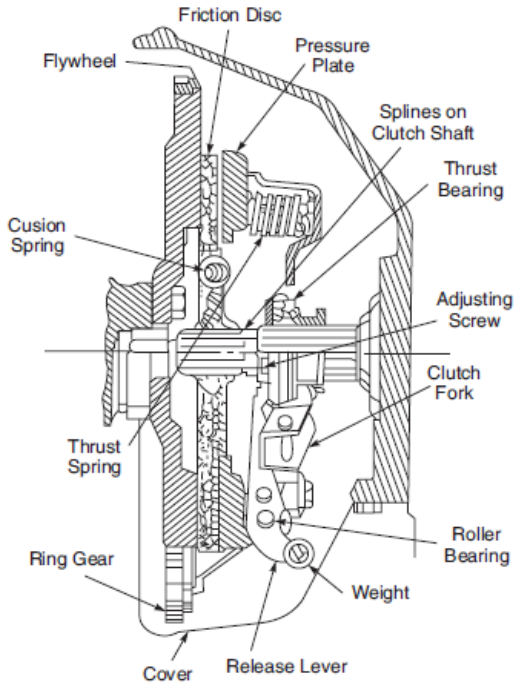

Fig: Semi-Centrifugal Clutch

Free Wheel or One-way Clutch:

The free wheel or one-way clutch is a device which transmits power in one direction only. This is fitted in transmission components just behind the gearbox so that transmission components beyond it can be overrun by components before it. With this arrangement, the engine can idle without having to disengage the gears and also helps in gear changing. While going downhill on a long steep road also the engine can overrun the transmission components so that no power is transmitted from the engine.

Diaphragm Clutch:

Figure shows the cross-sectional view of the diaphragm clutch used in Maruti 800 manufactured in India by M/s Maruti Udyog Ltd. It is a dry single disc type clutch and the diaphragm spring is of a tapering finger type, which is a solid ring in the outer diameter part. The disc carrying six torsional coil springs is slidably mounted on the

transmission input shaft with a serration fit. The clutch cover is secured to the flywheel and carries the diaphragm spring in such a way that the peripheral edge of the spring pushes on the pressure plate against the flywheel (with the disc in between), when the clutch release bearing is held back. This is the engaged position of the clutch.
Depressing the clutch pedal causes the release bearing to advance and push in the tips of the tapering fingers of the diaphragm spring. When this happens, it acts like the release levers of a conventional clutch putting the pressure plate away from the flywheel. This interrupts the flow of drive from the flywheel through the clutch disc to the transmission input shaft. Figure shows the components of this type of clutch.

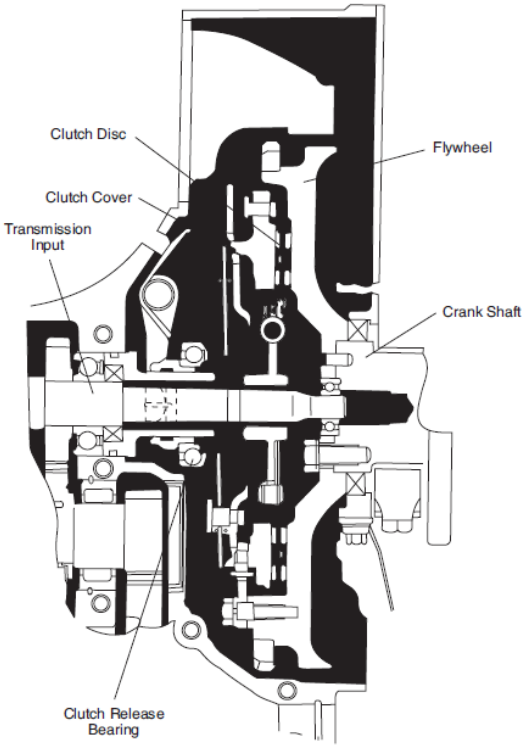

Fig: Cross-sectional View of Diaphragm Clutch

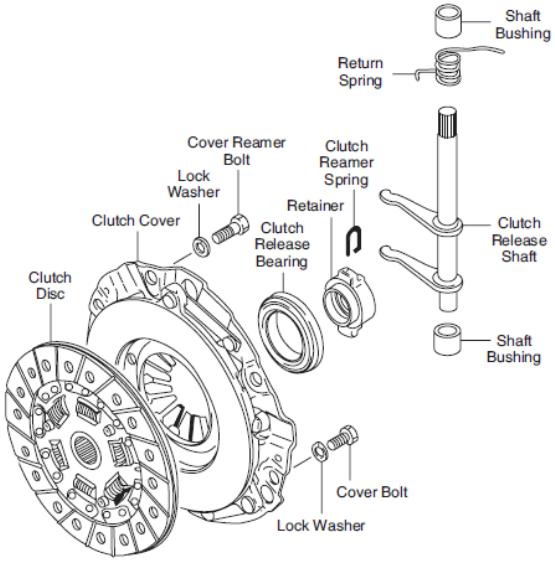

Fig: Clutch Component

Automatic Clutches:
Several automatic clutch designs have recently become available. Ferlec of French origin and the Smith's electro shift design have been used on certain Renault models and continental cars. It has a conventional type of friction disc. When battery current is supplied, an electromagnet in the flywheel operates the pressure plate which engages the disc thus transmitting engine torque. Figure shows the electro shift magnetic particle clutch which consists of two rotating members. One is attached to the engine and the other is attached to the gear box. A gap is provided between the two members. The torque is transmitted through this gap by means of magnetic particles. It may be mentioned that when the particles are magnetised by an external magnetic field, they tend to solidify, thus forming a solid connection between the engine and the gearbox. By the adjustment of this magnetic field, the slip to any degree can be conveniently obtained.

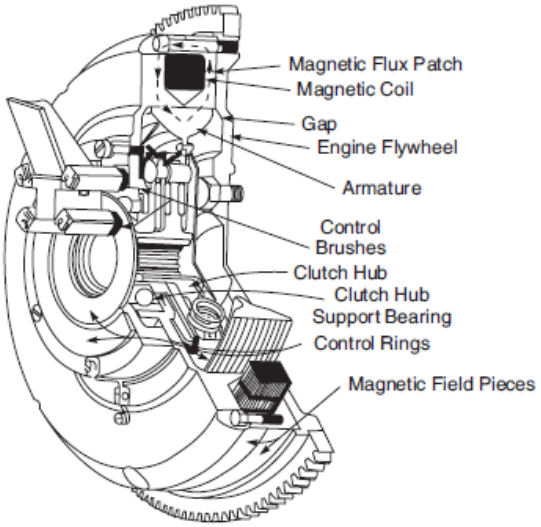

Fig.: Magnetic Particle Clutch

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EXPERIMENT NO: 9

Experiment 9: To study the constructional details, working principles and operation of 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 reduces 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.

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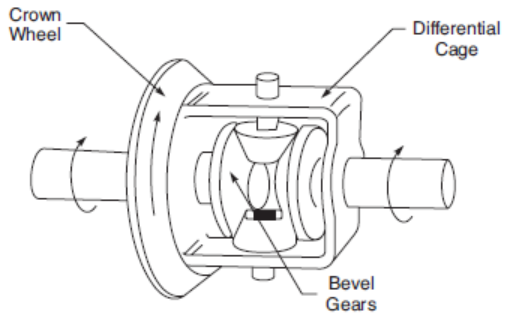
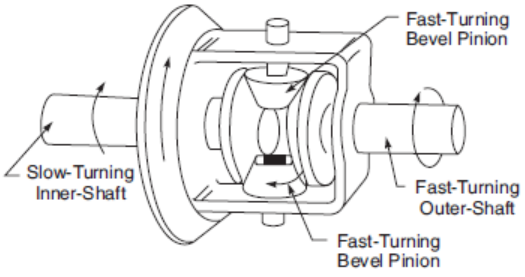


On the Straight the Cage Rotates with the Crown Wheel; the Bevel Pinions, Orbiting but Spinning, Turn the Bevel Gears and with Them the Half-Shafts



Taking a Bend When the Inner Bevel Gear Turns more Slowly than the Crown Wheel the Outer Gear Driven by the Bevel Pinions, Turns Correspondingly Faster

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 to apply the clutch which locks both axle shafts and forces them to turn at the same speed.

Results:

Students learned the necessity and importance of differential.

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EXPERIMENT NO: 10

Experiment 10: To study the construction and working of four-wheeler, manual shift gear box 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.

Functions of Transmission:

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. If engine is directly connected to the road drive it may not have tractive effort to start the vehicle from rest. 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. It also provides a neutral position so that engine and road wheels are disconnected even with the clutch in the engage position. A means to back the car by reversing the direction of rotation of drive is also provided by the transmission.

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 is 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.

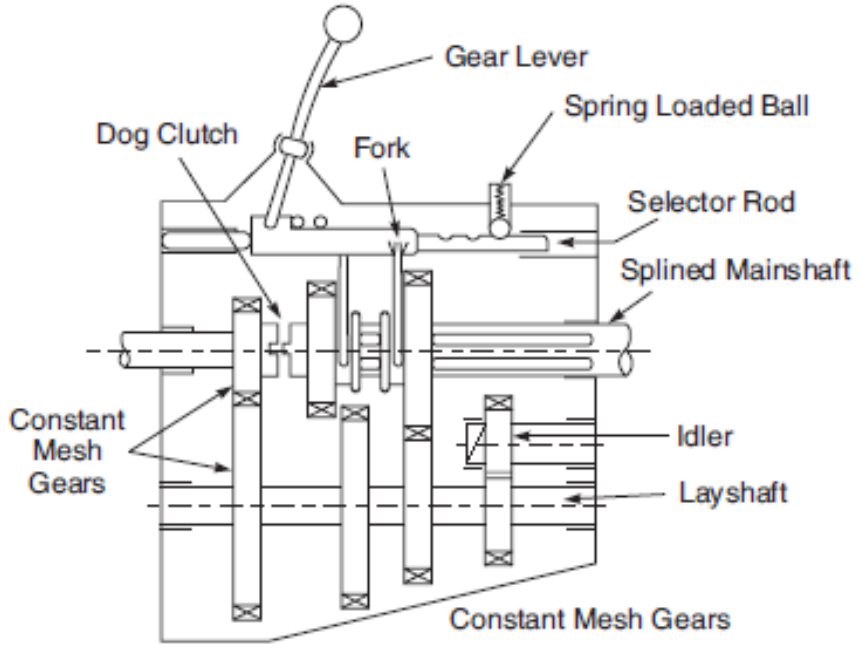

Fig: Three Speed Sliding Type Gear Box in First Gear

Constant Mesh Gear Box:

In the constant mesh gear box all the gears mesh with each other, all the time and this gives a silent or quiet operation. Gear changing is made easier by employing helical gears. The primary shaft which carries the clutch is splined and carries a gear that meshes with the largest layshaft gear. The main shaft has several gears that mesh with the gears on the layshaft. However, these gears being on bushes or ball/roller bearings are free to move on the main shaft without transmitting any torque. All the gears on the layshaft are rigidly fixed with it. When the left-hand dog clutch is made to slide to the left by means of the gearshift lever, it meshes with the clutch gear and the top speed gear is obtained (Fig.). When the dog clutch meshes with the second gear the second speed gear is obtained. Similarly, by sliding the right-hand dog clutch to the left and right, the first speed gear and reverse gear is obtained respectively. However, skilful handling is necessary on the part of the driver so that the speed of the locking dogs and respective pinion remain the same to affect a clash-free gear change.

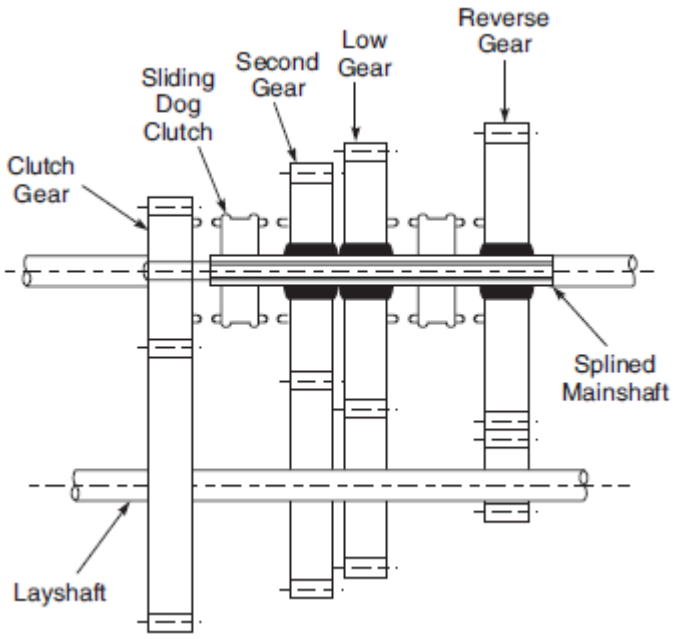

Fig: Constant Mesh Gear Box

Synchromesh Gear Box:

Synchromesh gear boxes use synchromesh gear devices which work on the principle that two gears to be engaged are first brought into frictional contact which equalises their speed after which they are engaged readily and smoothly. Two types of such devices are mostly used in vehicles, viz. pin type, and synchronizer ring type. This gear box is like the constant mesh gear box and its main features are:

1. The main shaft or output gears are free to rotate on bushes on the output shaft. The end of the main shaft at the rear of the transmission is called the output shaft.
2. The output gears are locked to the shaft by the dog clutch of the synchronising hub when their speeds have been equalised by their cones.

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