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Automobile Engineering

Course Code: 23BTMEL305

B. Tech - V Semester

Prepared by:

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Teaching and Evaluation Scheme

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Course Title: **Automobile Engineering**										
Semester	V	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	Odd	Th	Tu	Pr	Credits	TAE	CAE	ESE	INT	EXT
Course Category	PEC1	3 Hrs	-	2	4	10	15	50	25	-
Course Code	23BTMEL305 23BTMEP305									
Teaching Mode	Offline	5 Hrs.			Total	75			25	
Duration of ESE	2.5 Hrs.					100				

Course Objectives and Outcomes

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Course Objectives	1. To make the student conversant with fundamentals of automotive systems.
	2. To make the student acquainted with automotive electrical system and vehicle maintenance
	3. To understand the emerging trends of electric vehicles, hybrid electric vehicles and solar vehicles
Course Outcomes	Upon successful completion of this course, student shall be able to:
	CO 1. Understand the automotive systems and its components.
	CO 2. Demonstrate the various types of transmission system.
	CO 3. Evaluate the constructional features of wheels, tyres and suspension systems.
	CO 4. Utilize the basic knowledge of electric vehicles, hybrid electric vehicles and solar vehicles for further development.
	CO 5. Apply the concept of automobile engineering for development of modern vehicle technology.

Mapping of Course Outcomes with Program Outcomes and P
Specific Outcomes:

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Following mapping is only for reference

Course Outcomes	Program Outcomes and Program Specific Outcomes													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	2	2	3	1	-	-	-	-	-	3	3	2	2
CO2	3	2	2	3	2	-	-	-	-	-	3	3	2	2
CO3	3	2	2	2	1	-	-	-	-	-	3	3	2	2
CO4	3	2	2	2	1	2	2	-	-	-	3	3	2	2
CO5	3	2	2	2	2	2	2	-	-	-	3	3	2	2

Syllabus

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Unit	Contents
Unit 1	**Introduction** Introduction, Automobile history and development, Chassis, articulated and rigid vehicles and vehicles layout. Prime movers Engine construction – Structural components and its materials, Fuel supply system, cooling and lubrication system, Filters.
Unit 2	**Transmission System** Types of transmission system automatic and manual, necessity and selection of clutch, different types gear box, fluid flywheel, torque convertor, continuous variable trans mission, overdrive and differential, automatic transmission system. **Axles:** Purpose, requirement and types of front and rear axle, loads acting on rear axles. **Wheels and Tyre:** Wheel construction, alloy wheel, wheel balancing, type of tyre, tyre construction, tyre materials, factors affecting tyre life.
Unit 3	**Brake and Suspension** **Steering:** Steering mechanism, steering geometry and steering gear box, Steering column, wheel alignment. **Suspension:** Types of suspension linkages, types of suspension springs, leaf, coil, air springs, self-leveling suspension (active suspension), shock absorbers (hydraulic and air). **Brake systems**: Drum, disc, mechanical, hydraulic, air brakes,

Syllabus

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Unit	Contents
Unit 4	**Electric and Hybrid Electric Vehicles** **Electric vehicles:** Layout, construction and working, study of charging system. **Hybrid electric vehicles:** Types, layout, hybridization factor, plug in hybrid electric vehicles, fuel efficiency analysis, challenges, and future scope of electric and hybrid electric vehicles.
Unit 5	**Modern Automobiles Systems** Autonomous car, Driver Assistance Systems, Safety Systems, Comfort Systems, Electronic Engine Management, antilock braking system (ABS), electronic brake distribution (EBD).

Study Material

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Text Books	1.	Singh K., "Automobile Engineering", Volume 1, Standard Publishers distributors. 13th Edition, 2022.
	2.	Crouse W.H., "Automotive Mechanics", McGraw-Hill Higher Education; 10theditions, 1993.
	3.	T. Kenneth Garrett, Kenneth Newton and William Steeds, "The Motor Vehicle" 13th, Edition, Butterworth-Heinemann Limited, London, 2005.
E-Books	1.	Fundamentals of Automotive System, Prof. C.S.Shankar Ram, NPTEL, https://archive.nptel.ac.in/courses/107/106/107106088/
Reference Books	1.	Sclar D., "Auto repair for dummies", John Wiley & Sons Publication 2nd edition,2019.
	2.	Gupta B K and Gupta R. B., "Automobile Engineering", SatyaPrakashan, 2016.

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Unit 1

Introduction

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- What do you mean by Automobile

- Components of Automobile
- Basic Structure
- Power Source
- Transmission system
- Control

History of Automobile

In 1880, Benz was one of the earliest builders; he named his company after his daughter,Mercedes.





Borrow from the bicycle. Notice the three wheels and the
simplistic engine!

History of Automobile



Note the primitive “headlight.” and wooden-spoked wheels.



It was used for starting the engine. And the cranking” the engine. hand lever moved left and right would steer it.

History of Automobile

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Mud flaps and a simple suspension system suggest that this car reached greater speeds



The different-sized wheels

History of Automobile



Complexity in the steering column—many more levers and a shaft enclosed in a housing. The driver and passenger face each other.



What is the new breakthrough design in this car?" (a steering wheel)

History of Automobile



By early 1900's cars, an enclosed body, forward facing seating, headlights up front, equal-sized wheels and tires.



1905,the radiator, horn and break levers license plate

History of Automobile



Henry Ford, invented the assembly line process which brought the cost of the auto down to an affordable level



From 1925 to
1947, steering wheel on the left, headlights

History of Automobile



1950’s Jeep, forerunner of the SUV,



1978, Gas prices increased. More efficient car preferred
Honda and Toyota gained a foothold in the U.S.

History of Automobile

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Chevrolet Volt, 2007

Courtesy: en.wikipedia.org/wiki/Chevrolet_Volt

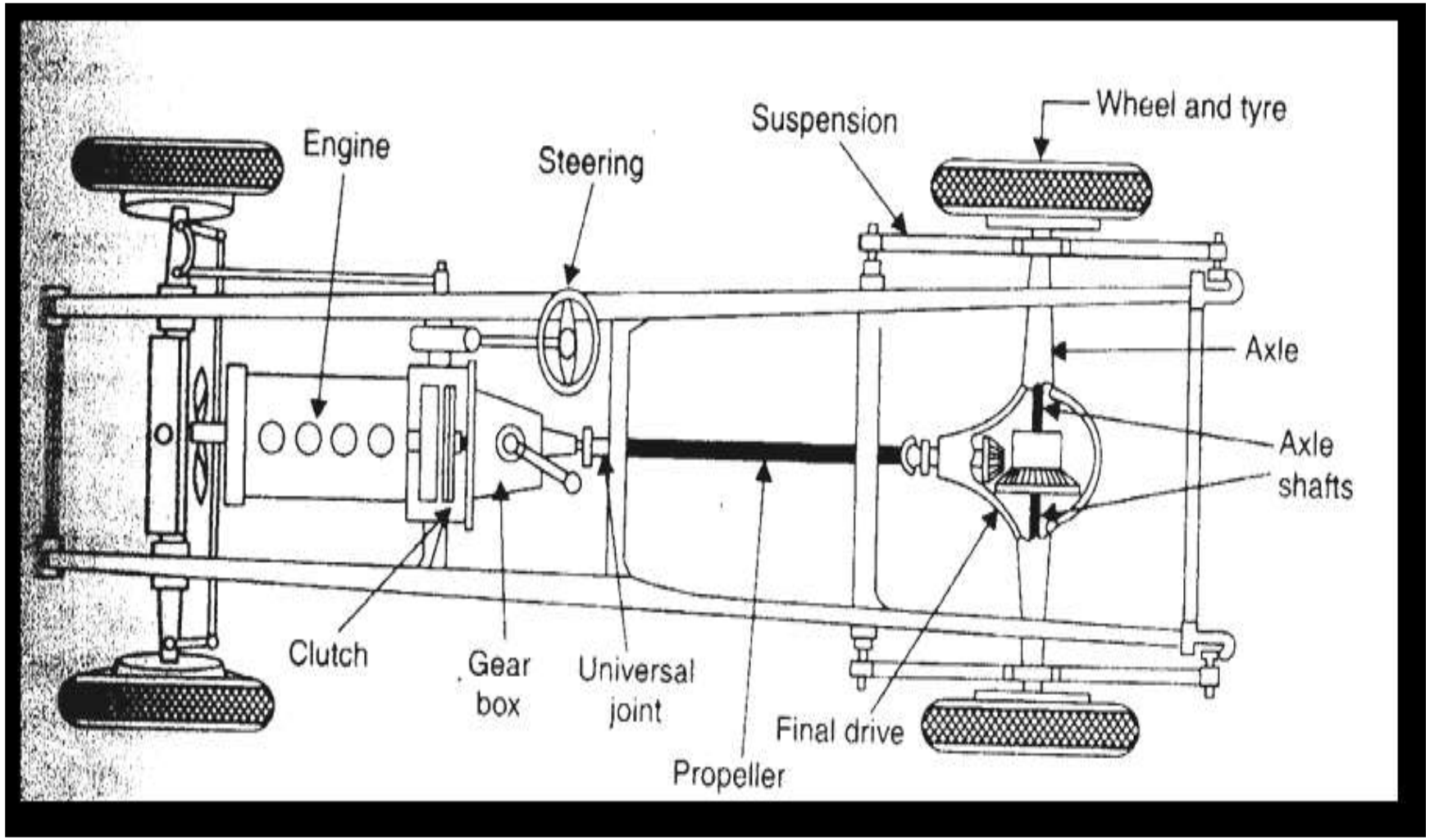


Tesla Roadster, 2008

Ref: www.teslamotors.com/roadster Indo

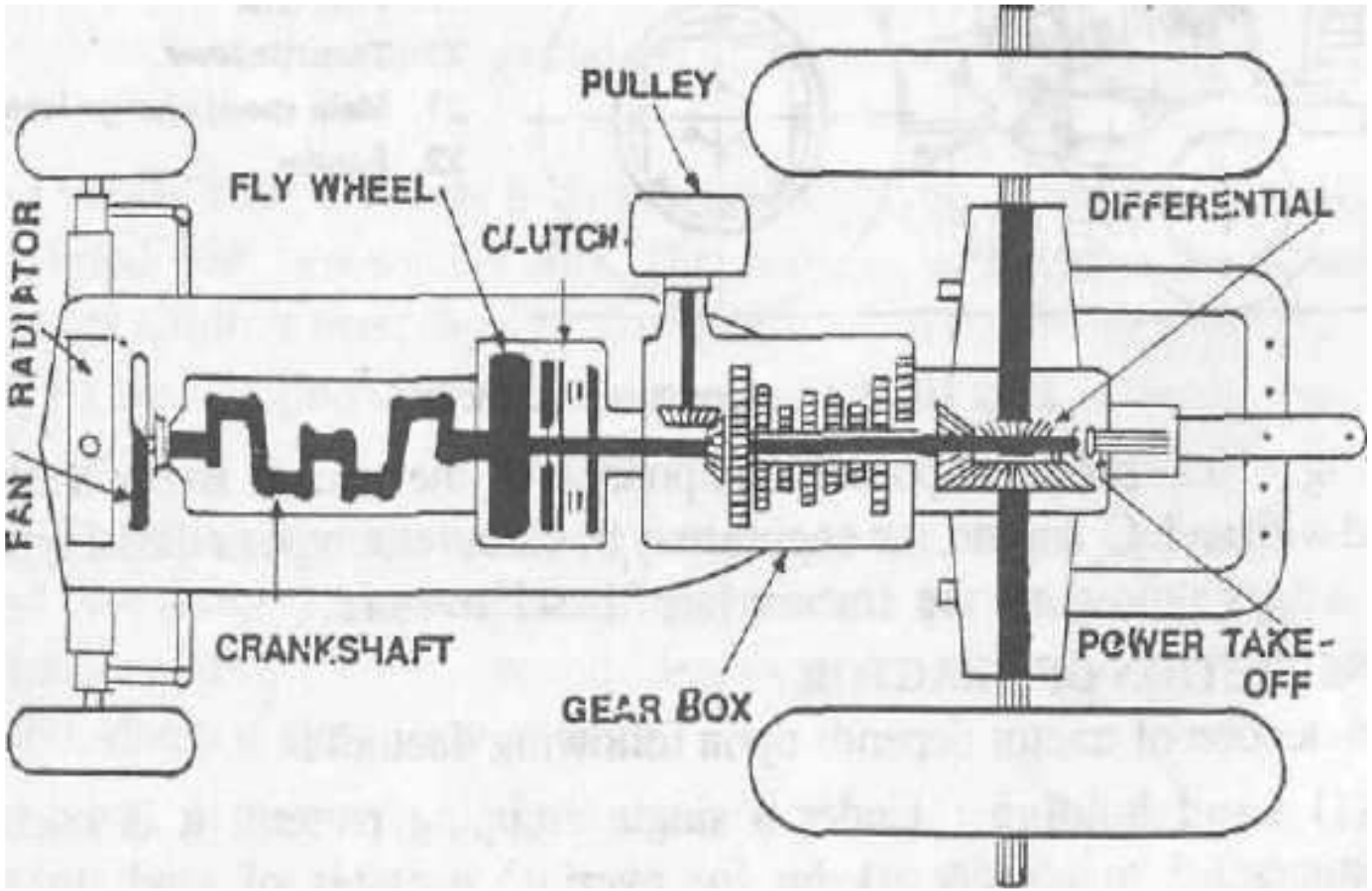
Layout of Automobile

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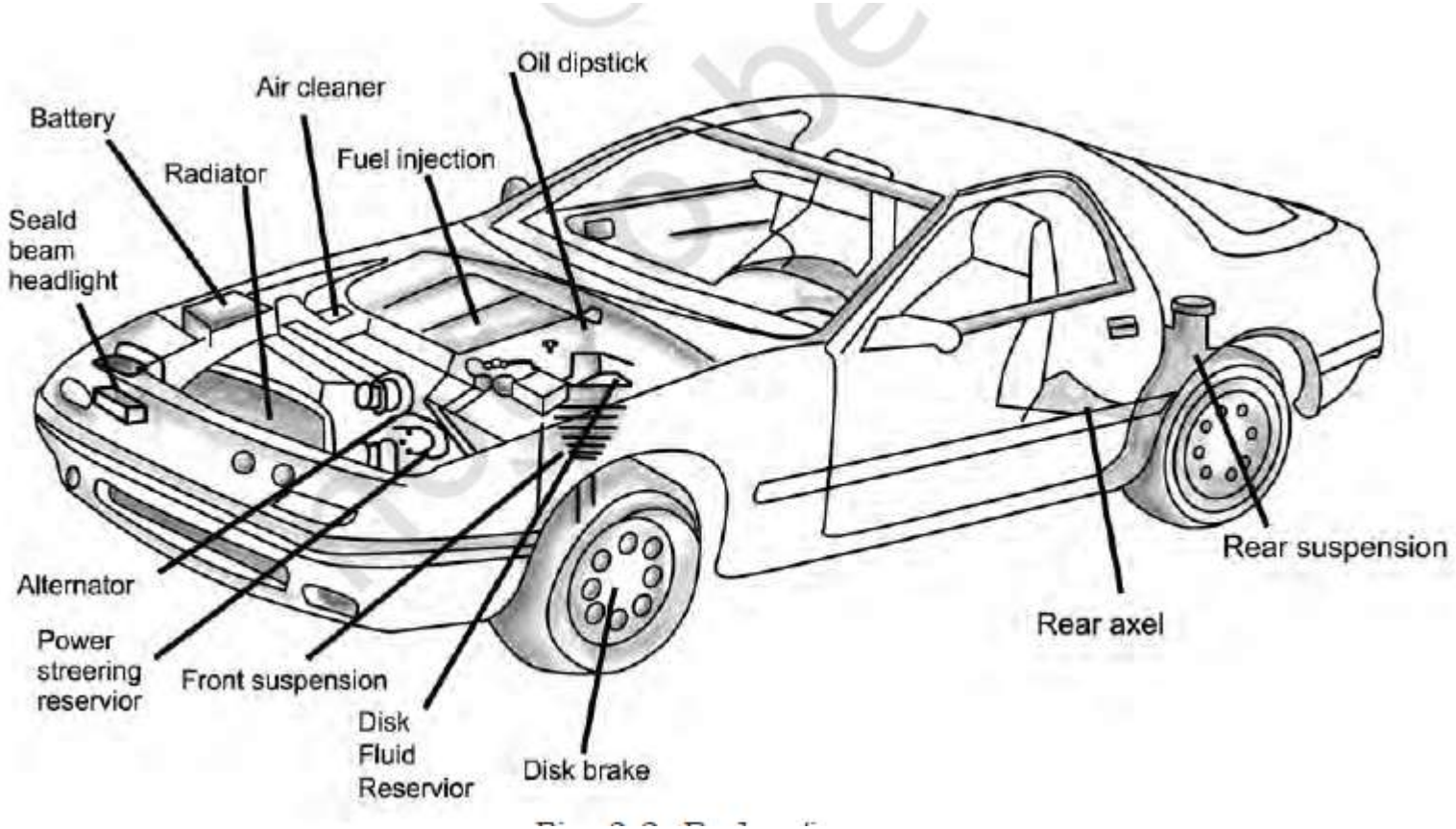
Layout of Tractor Transmission

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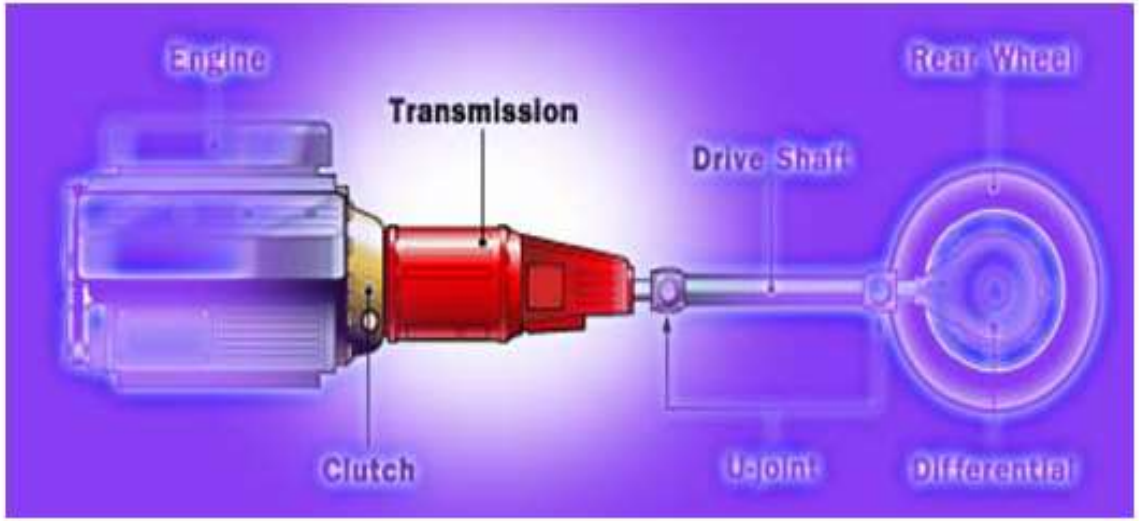
Layout of Car

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Prime movers

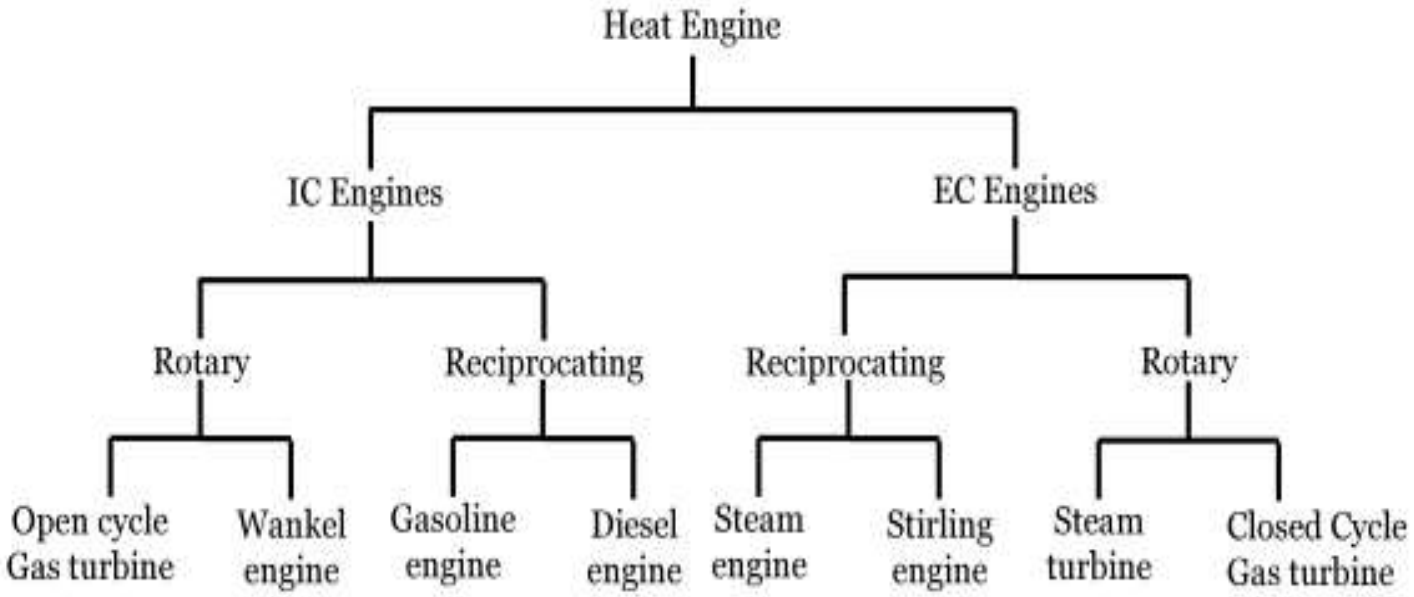
- The Engine or Power Plant : It is source of power.
- In general, internal combustion engine with petrol,diesel fuel,CNG,LPG etc is used to run a vehicle.



Types of Prime movers

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Classification of Heat Engine



Classification of IC Engines

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Type of Ignition used

- Spark ignition (SI) engine
- Compression ignition (CI) engine

Types of fuel used

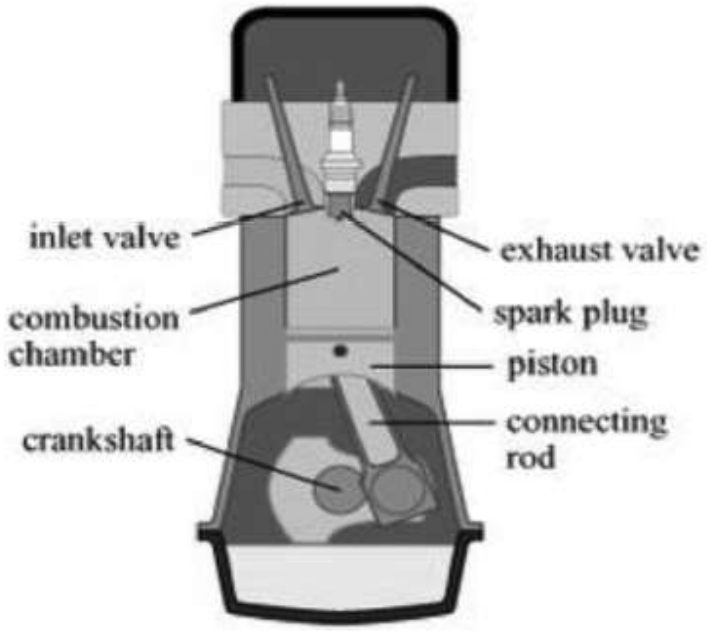
- Petrol or Gasoline engine
- Diesel engine
- Gas engine

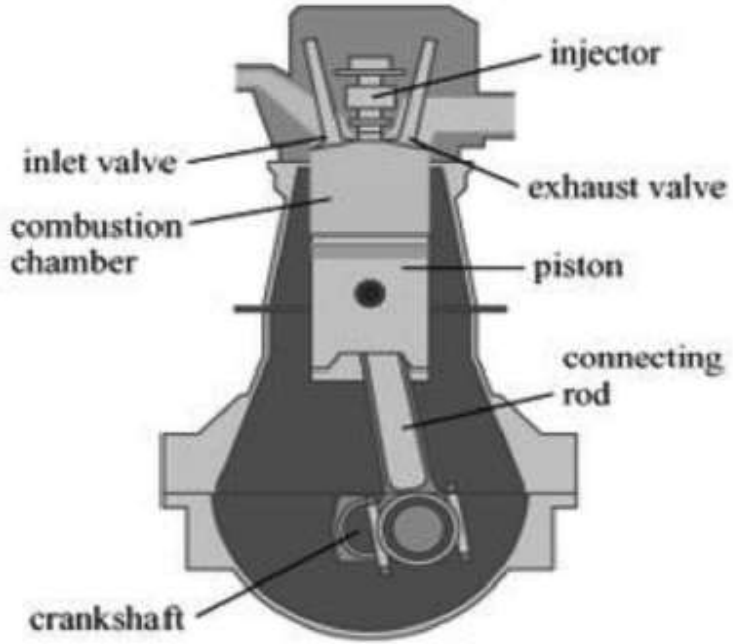
Number of stroke per cycle

- Four stroke engine: Cycle completed in 2 rotation of crank
- Two stroke engine: Cycle completed in one rotation of crank

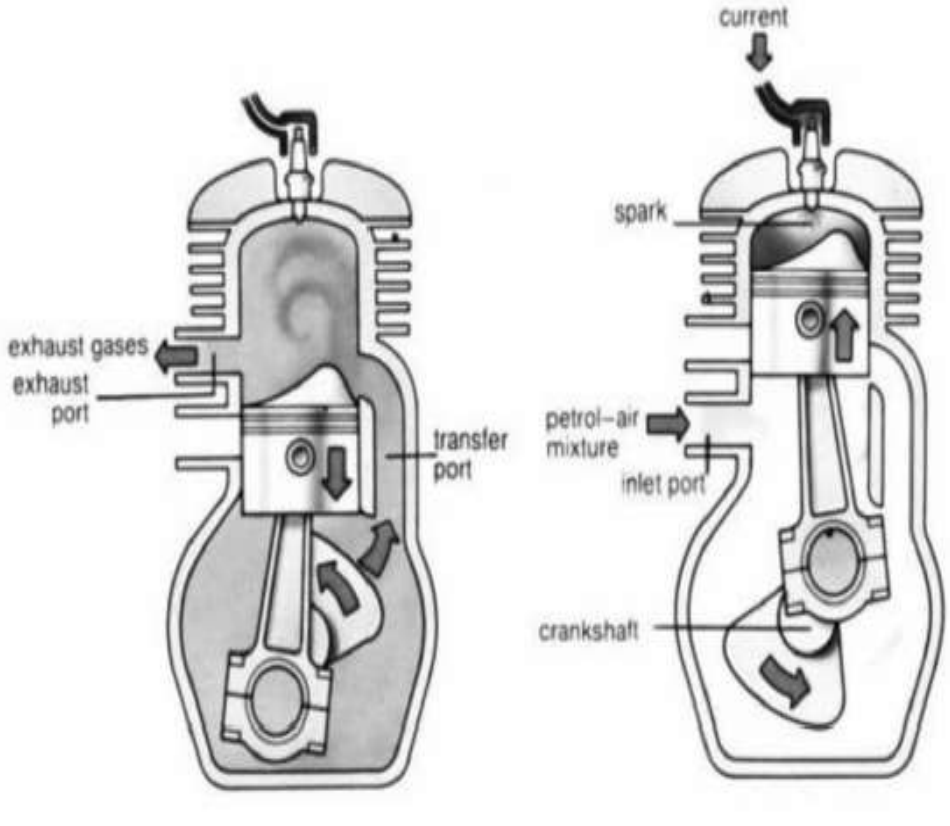
Classification of IC Engines

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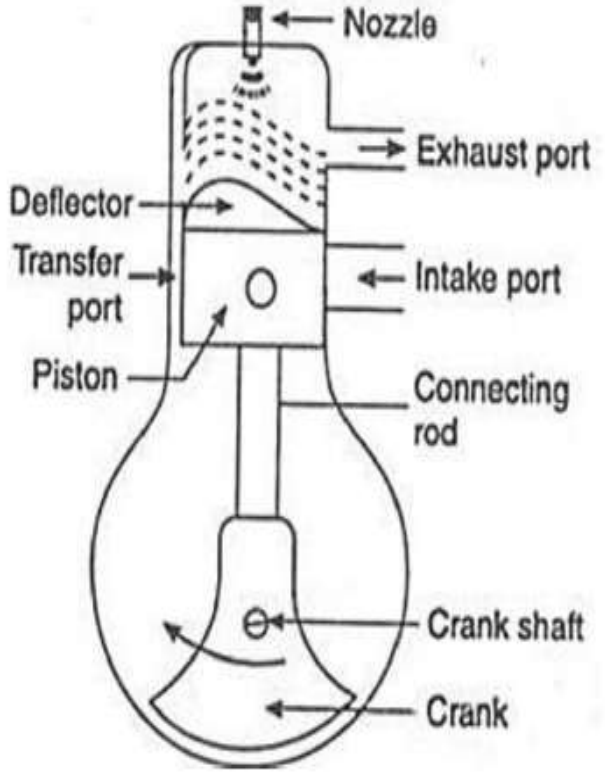




Classification of IC Engines



A two-stroke SI engine



A two-stroke CI engine

Classification of IC Engines

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Type of cooling system

- Air cooled engine
- Water cooled engine

Arrangement of cylinder

- Vertical engine
- Horizontal engine
- Radial engine
- V-engine
- Opposed cylinder engine
- Opposed piston engine

Classification of IC Engines

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Applications

- Stationary engine
- Automotive engine
- Aircraft engine
- Locomotive engine

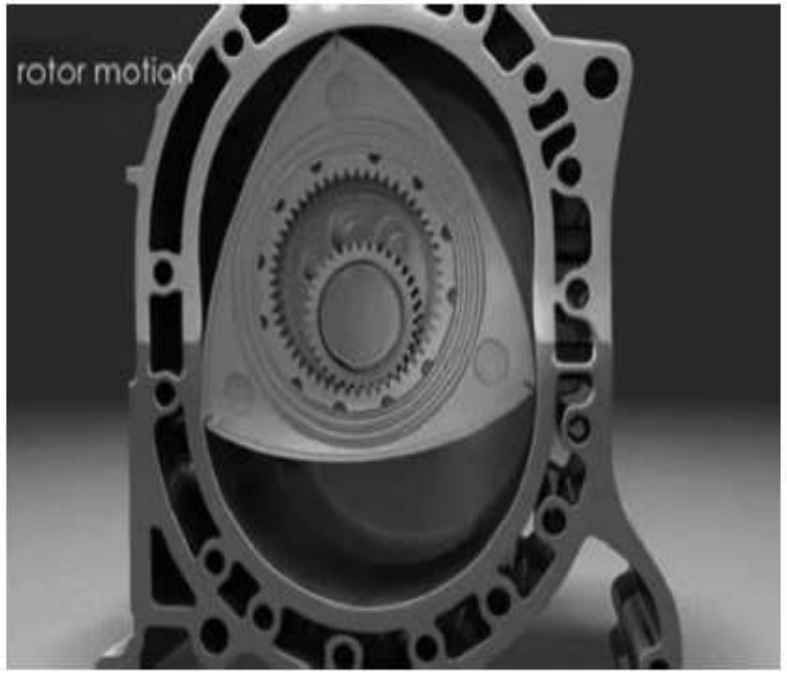
Based on Design:

- Reciprocating
- Rotary
- Rotary Engine.mp4

Classification of IC Engines



Reciprocating engine



Rotary engine

Classification of IC Engines

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Nature of Aspiration:

- Naturally aspirated: Admitting Atmosphere air.
- Supercharged: Admitting pre compressed fresh mixture
- Turbocharge: Admitting fresh mixture compressed in a compressor driven by an exhaust turbine.

Based on combustion chamber design:

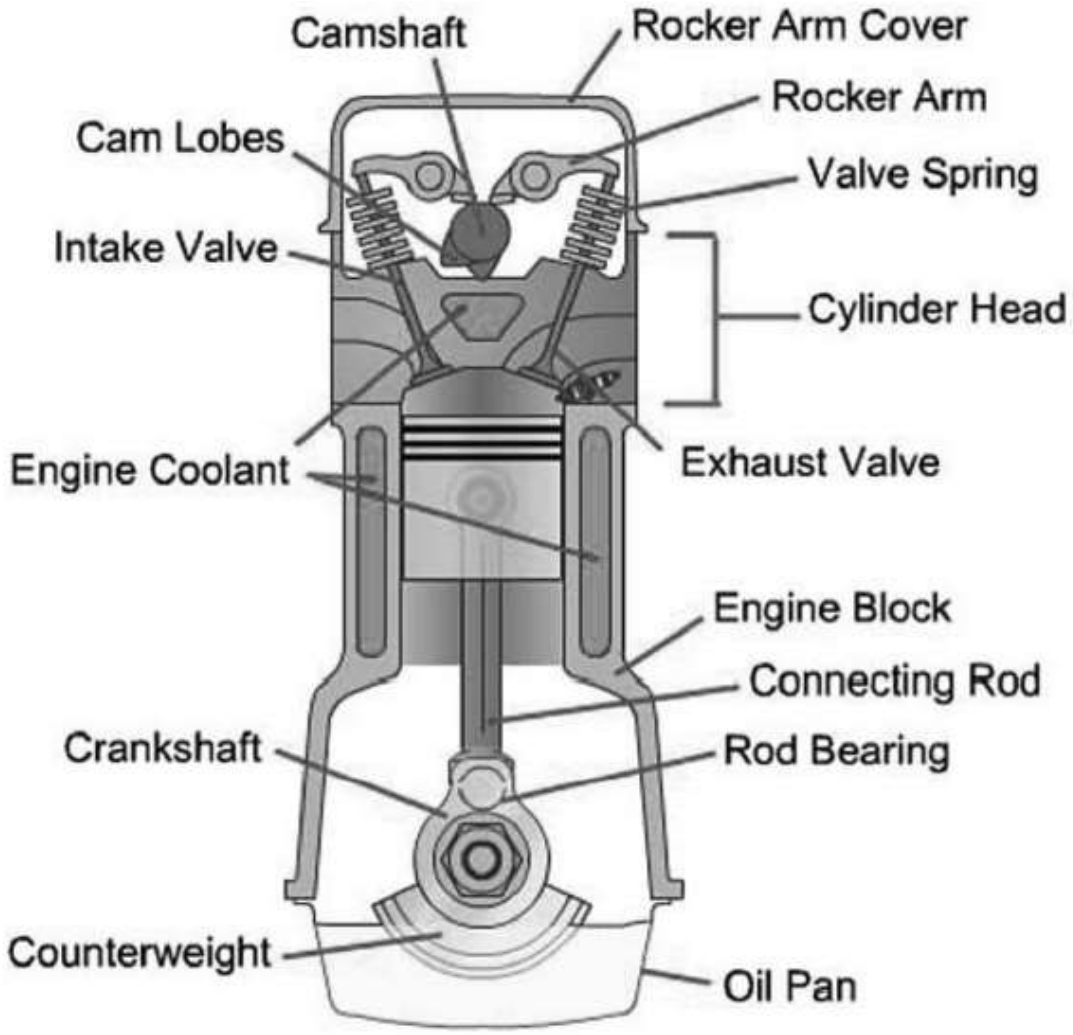
- Open chamber: Disc, wedge, hemisphere etc
- Divided Chamber: pre-chambers, swirl chambers

Based on method of load control:

- Throttling of fuel and air flow together
- Control of fuel flow only
- Combination of two

Components of IC Engine

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Components of IC Engine

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- Engine Block: Body of Engine
- Piston: Reciprocates inside the cylinder and transfer power to crank shaft to connecting rod
- Cylinder: Volume inside which combustion take place
- Cylinder Head: Top portion of engine cylinder which holds spark plug, valves etc.
- Crankshaft: Engine output is obtained
- Connecting Rod: Connects piston and Crankshaft.
- Cam Shaft: Controls opening and Closing of valves

Components of IC Engine

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- Crank case: Lower part of engine surrounding the crankshaft.
- Intake valve: Allow air or air fuel mixture to come in through intake manifold
- Exhaust Valve: Allow burnt gases discharge through exhaust manifold

Engine Terminology

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- Top dead center(TDC):Extreme piston position close to cylinder top.
- Bottom dead center(BDC):Extreme piston position close to crank case.
- Clearance Volume: Volume of combustion chamber when piston at TDC.
- Swept Volume: Volume swept by piston between TDC to BDC.
- Compression ratio: Ratio of maximum to minimum volume. 8-12 for SI engine, 12-24 for CI engine.
- Stroke:Linear distance travelled by piston between TDC to BDC.

Chassis

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Definition:

- Chassis is a French term and was initially used to denote the frame or main structure of a vehicle.
- The chassis contains all the major units necessary to propel the vehicle, guide its motion, stop it and allow it to run smoothly over uneven surfaces.
- It is the main mounting for all the components including the body. It is also known as the carrying unit.

Major components of Chassis

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- A steel frame, which is a major part .
- In case of a passenger car, the whole body is also an integral part of the chassis.
- In commercial vehicles like trucks and buses, the body is not a part of the chassis.
- Chassis is almost a complete vehicle except the body and other accessories, which are not involved in the movement of the vehicle.
- Other major components include engine, transmission system, front and rear axle, steering system, suspension system, wheels, tyres and brakes.

Function of Chassis

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- Carrying the weight of the vehicle and its passengers.
- Withstanding the engine and transmission torque and thrust stresses, as well as accelerating and braking torque
- Withstanding the centrifugal force while taking a turn.
- Withstanding the bending load and twisting due to the rise and fall of the front and rear axles.

Types of Chassis

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- **Conventional chassis or frame-full c**
- In this type of chassis the body is made as a separate unit and then joined with ladder frame.
- It supports all the systems in a vehicle such as the Engine, Transmission system, Steering system, Suspension system.
- Advantages: Higher load capacity and strength
- Disadvantages: The body tends to vibrate easily and the overall vehicle handling and refinement is lower.
- It is used in truck, bus and in SUV cars and bigger vehicles.

Types of Chassis

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- **Non-conventional chassis or frameless chassis:**
- In this type of chassis the ladder frame is absent and the body itself act as the frame. It supports all the systems in a vehicle such as the Engine, Transmission system, Steering system, Suspension system.
- Advantages: Less rattles and squeaks are developed.
- Handling is better due to the higher body rigidity and weight.
- Disadvantages: The load carrying capacity is lower.
- Used mostly in hatchback (Hatchbacks are vehicles with a separate engine area, and passenger area (or two boxes), the luggage area is enclosed with the passenger area behind the rear seats.) .**Example**: Nano, Indica, Jazz, Punto etc. Sedan are basically vehicles with an engine area, passenger area, and boot area (or three box), all separate.

Types of Frame

- **Monocoque:**This type of automotive chassis is manufactured by welding floor pan and other pieces together.
- Since monocoque chassis is cost effective and suitable for robotised production, most of the vehicles today make use of steel plated monocoque chassis.



Rolling Chassis:

- **It** is the frame in ‘ready to run’ condition.
- It means that such a frame has engine,transmission,axle ,tires and all the other systems attached to it that are mandatory to run a vehicle (collectively called ‘Running gear’). Hence, it could be



Requirements of automobile body

- light weight.
- have minimum number of components.
- have long fatigue life.
- have uniformly distributed load.
- have sufficient space for passengers and luggage.
- have good access to the engine and suspension system.
- have minimum vibrations when the vehicle is running.
- have minimum resistance to air.
- be cheap and easy in manufacturing.
- have clear all-round vision through glass areas.
- have an attractive shape and colour.

Materials Used in Chassis and Body Components of the Vehicle

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- Most of the manufacturers prefer featured materials which are lightweight, economic, safety and recyclability.

- **Steel:** The main elements of selecting material especially for the body is involved in a wide variety of characteristics such as thermal, chemical or mechanical resistance, manufacturing efficiency and durability.

- The best reason for using steel as a body structure is its natural capability to absorb the impact energy produced in a crash

Materials Used in Chassis and Body Components of the Vehicle

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- **Aluminum**
- Aluminum is widely used in the automotive industry, in chassis and body structure.
- Its low weight and high specific energy absorption and precise strength are its most significant characteristics.
- Aluminum is resistant to corrosion, but according to its low modulus of flexibility, it cannot substitute steel parts.
- Aluminum is used for body structures, finishing and exterior attachments such as crossbeams, doors or bonnets.

Materials Used in Chassis and Body Components of the Vehicle

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- **Magnesium:**
- Magnesium is another light-weight metal that is growing increasingly next to aluminum in automotive engineering.
- It is 33% lighter than aluminum and 75% lighter than steel elements.
- Magnesium components have many mechanical disadvantages that need a unique design for utilization to automotive products.
- Magnesium has lower tensile strength, fatigue strength, and creep strength compared to Aluminum

Fuel Supply Systems

- **Fuel Supply System of S.I Engine**
- **Carburetion: In** the carburetion method, fuel stored in the fuel tank is supplied to carburetor by means of a simple diaphragm pump through a fuel filter.

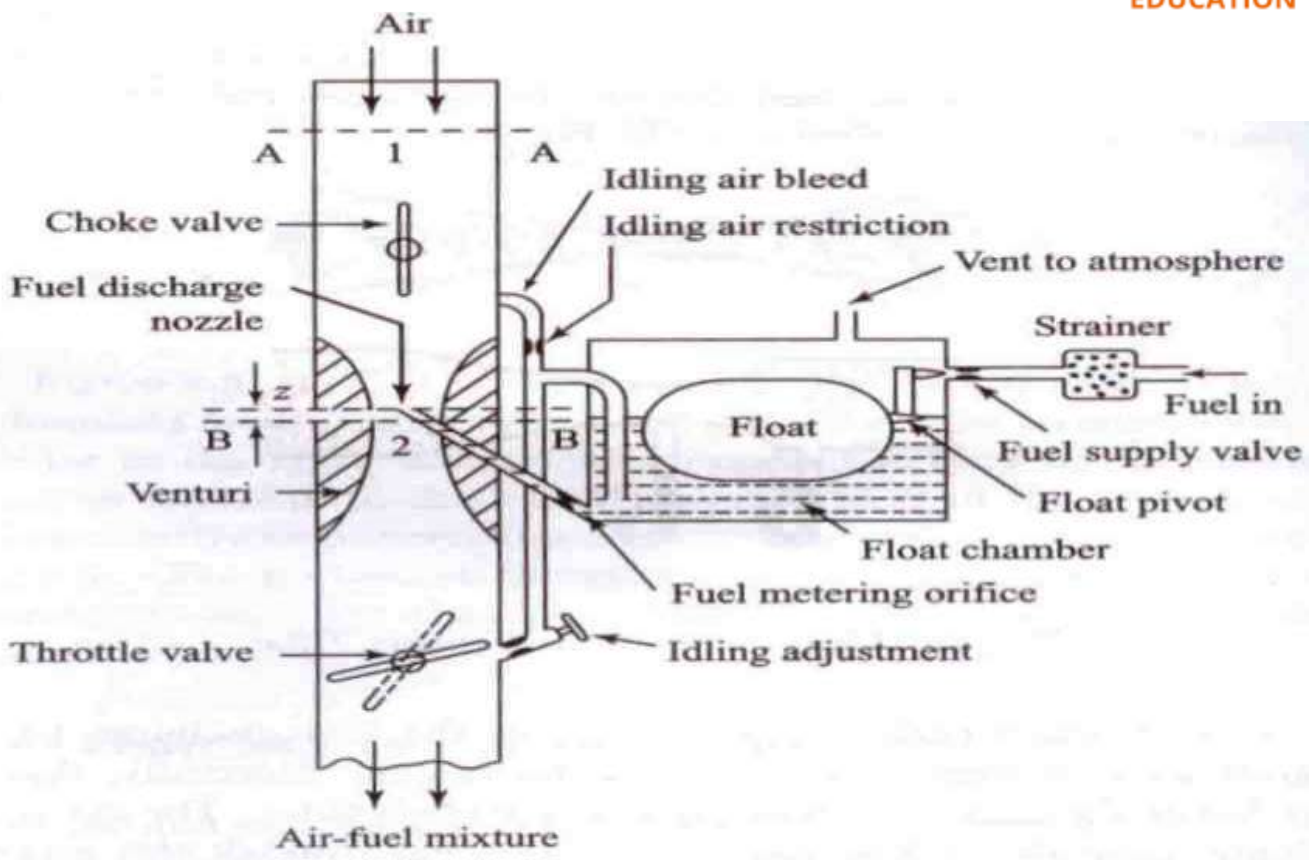


Fig. 8.7 The Simple Carburetor

Fuel Supply Systems

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- **Electronic fuel injection (MPFI system):**
- In this system an electrically driven fuel pump draws fuel from fuel tank and supplies it to a common header or tube.
- In this system an electrically driven fuel pump draws fuel from fuel tank and supplies it to a common header or tube.
- The header is connected to different branches of inlet manifold through fuel injectors. For each cylinder of engine there is separate fuel injector which injects fuel in the corresponding air passage of that cylinder.
- Due to this the system is called multi-point fuel injection (MPFI) system.
- The fuel injectors are precision built solenoid valves having single or multiple orifices. Due to constant pressure of fuel maintained in the common header, the quantity of fuel injected depends only on the time period for which the solenoid valve type fuel injectors are kept in open position.

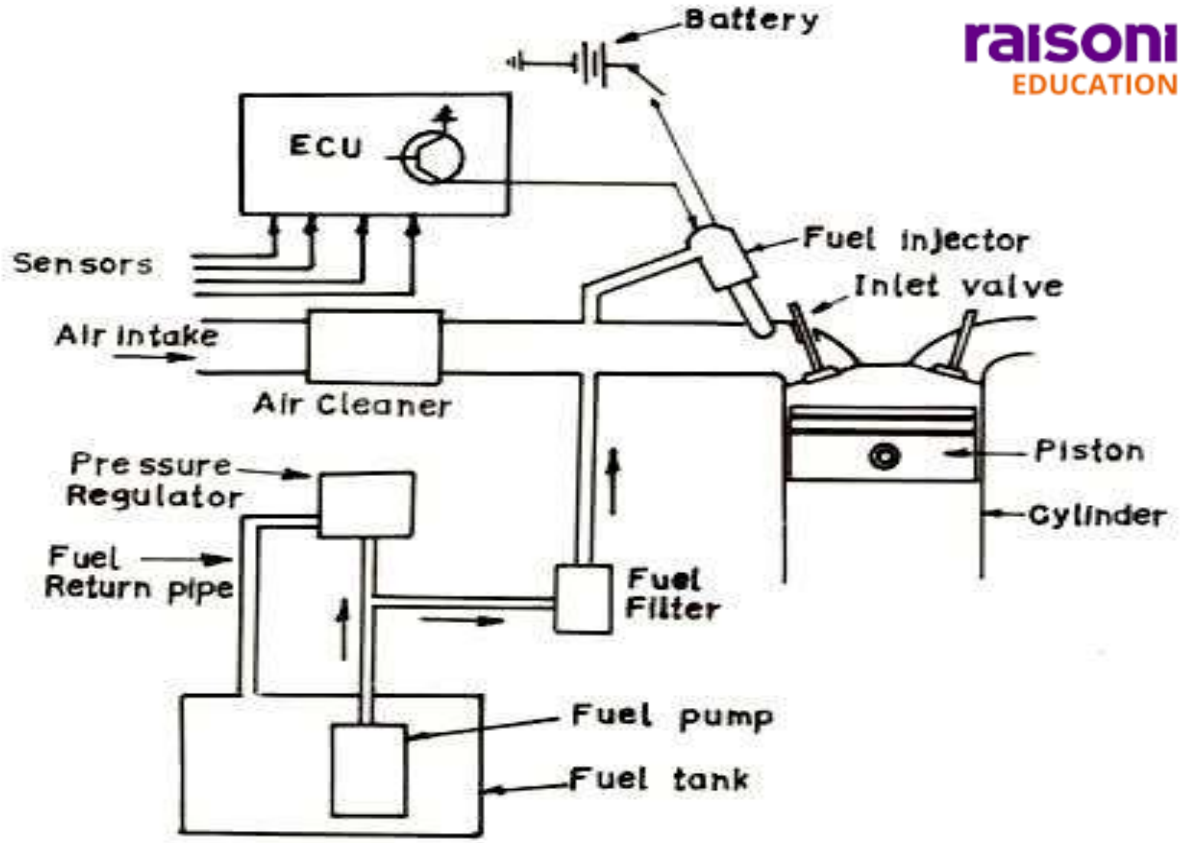
Fuel Supply Systems

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- An on-board ECU (Electronic control unit) i.e. microprocessor controls the quantity of fuel injected to each cylinder individually and also the ignition timing of each cylinder. The data input to the ECU comes from a number of sensors located all over the engine
- In this system an electrically driven fuel pump draws fuel from fuel tank and supplies it to a common header or tube.
- In this system an electrically driven fuel pump draws fuel from fuel tank and supplies it to a common header or tube.
- The header is connected to different branches of inlet manifold through fuel injectors. For each cylinder of engine there is separate fuel injector which injects fuel in the corresponding air passage of that cylinder.

Fuel Supply Systems

- Based on programmed interpretation or processing of this data, ECU calculates the amount of fuel needed to maintain stoichiometry i.e. air/fuel ratio of 14.7:1 and converts it into required pulse width i.e. time period for which it keeps the solenoid injector energized.
- ECU also gives command to spark ignition system. In this way ECU ensures overall satisfactory performance of the engine from start to shut down including emission control by sending right quantity and quality of fuel air mixture to each cylinder of engine at right time based on requirement of engine and also ignites it at right time.



Fuel Supply System of C.I Engine:

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- Mechanical Injection System:
- In this type, there are two basic components as one pressurizing unit (High Pressure Pump) and other atomizing unit (High pressure nozzle or injector).
- Depending on the design, manner of operation and control of these two basic components, mechanical fuel injection system are of three types.
- **Individual pump and injector system: In** this system there is a separate pump and separate injector for each cylinder of engine. The pump creates high pressure of fuel and also meters and times the injection of fuel through injector. It is a plunger type pump driven by engine power itself.
- **Common rail system**
- Here a high pressure pump keeps constant high pressure of fuel in an accumulator with the help of a pressure regulating valve. This accumulator is connected to common rail which is extended to different distributing elements of each cylinder. A separate metering & timing element controls the supply of metered & timed pressurized fuel to each injector of cylinder. This system is self governing and more smooth operation is there.
- **Distributor system :**Like the first system, here also the pump pressurizes, times and meters the fuel. But which quantum of fuel is to be supplied to which injector, is decided by a rotating distributor. This system is cheaper than first system in case of a multi-cylinder engine.

Fuel Supply System of C.I Engine:

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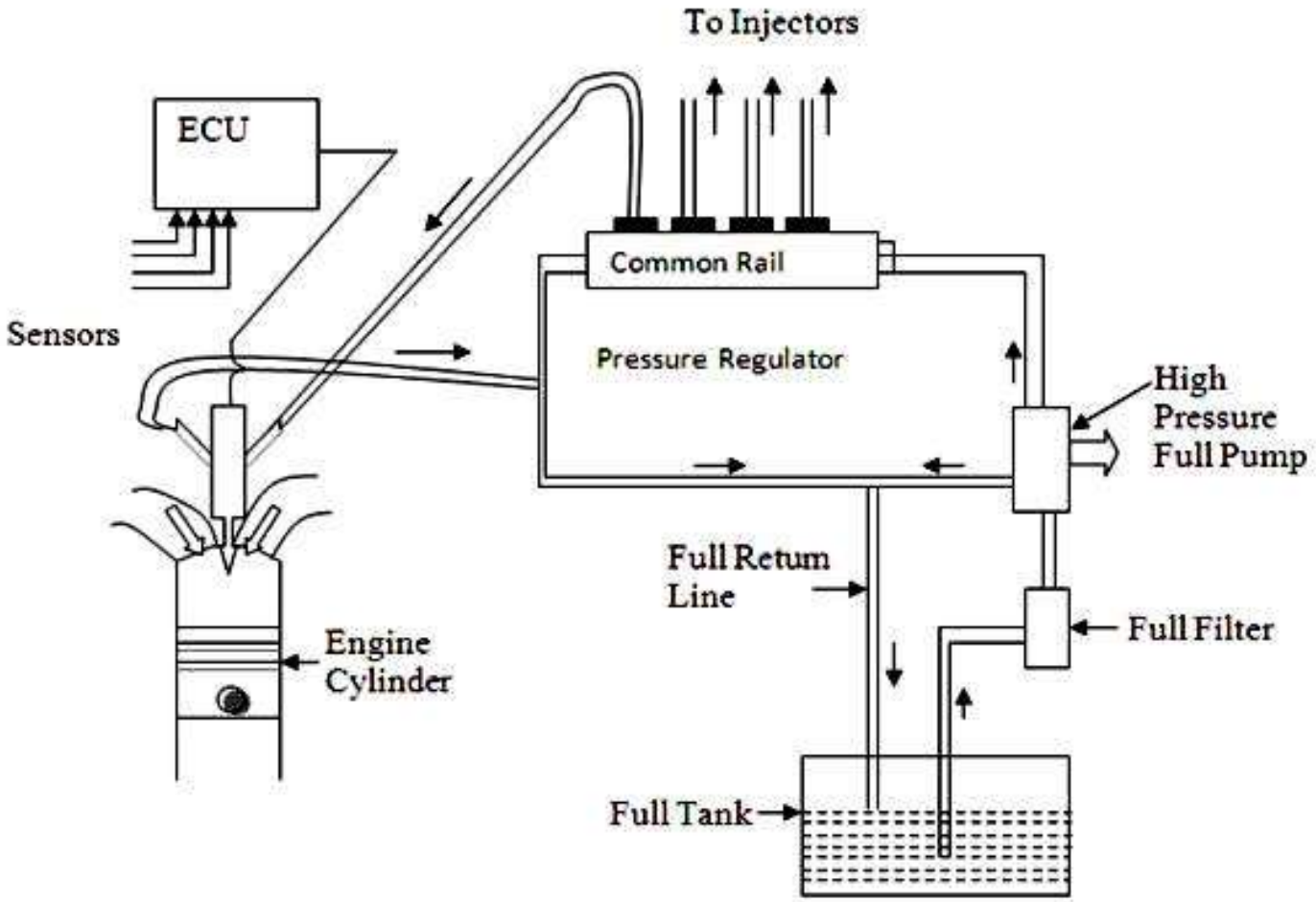
- **Electronic injection system (with CRDI):**
- There is a high pressure fuel pump which maintains high pressure in a common rail (steel tube) through high pressure regulator.
- But here the pressure maintained is very high of the order of 2000 bar as compared to 3-5 bars in MPFI system.
- The fuel injectors are very special either solenoid type or piezzo electric type which control the fuel injection from common rail to each cylinder very precisely.
- The opening time, pulse width etc of fuel injectors can be electrically controlled by the E.C.U.

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Fuel Supply System of C.I Engine:

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- **Electronic injection system (with CRDI):**



L-11

Fuel Supply System of C.I Engine:

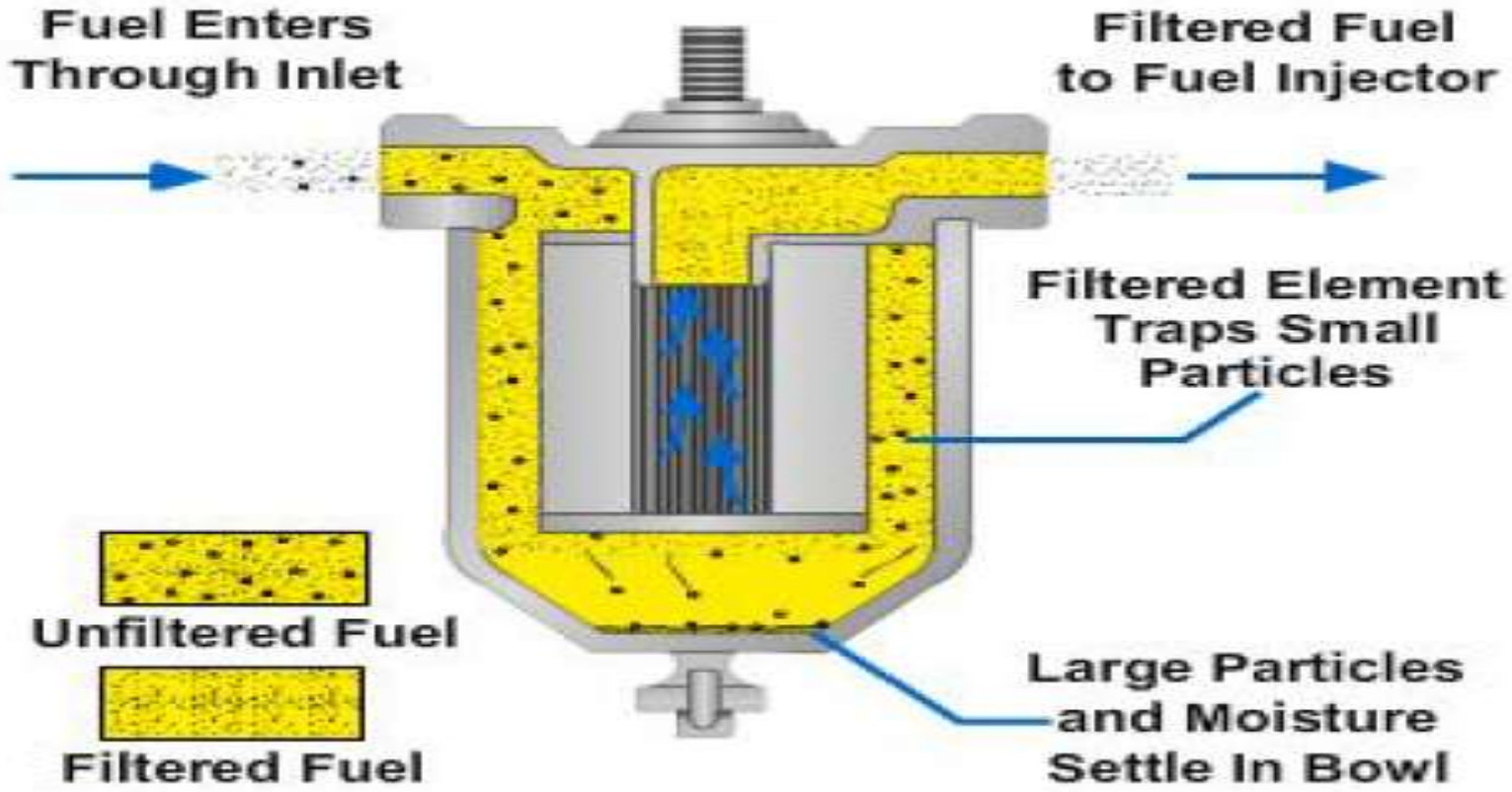
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• Advantages of Electronic injection system (with CR

- The main advantage of system that the fuel can be injected in more than one pulse in a very controlled manner unlike only one pulse or one injection per cycle in the mechanical system.
- A pilot injection is done before the main injection for fast burning and less ignition delay of the fuel.
- It reduces the noise level very much and also ensures complete burning of fuel, high efficiency, low emission and good cold start.
- New technology has considerably removed the demerits of diesel engines like high noise level, high pollution, difficulty in starting etc and improved fuel efficiency a lot.

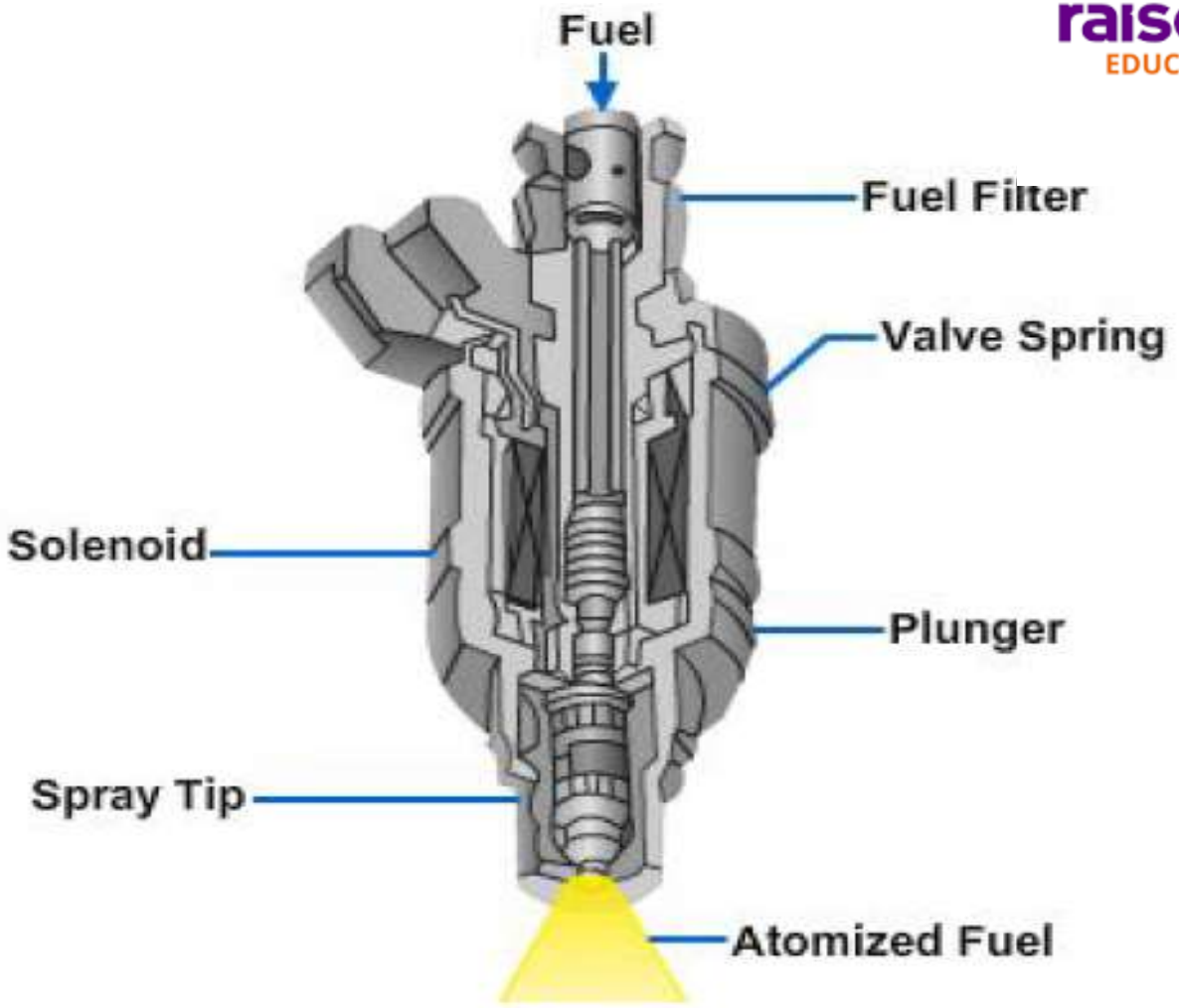
Fuel Filter

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Fuel Injector

- Fuel injectors are controlled by an ECM.
- The computer system sends an electrical current to activate the solenoid inside the injector.
- When the solenoid is activated, the injector nozzle opens and squirts atomized fuel in a cone-shaped pattern.
- The computer system controls the fuel-air ratio by varying the length of time that the injector nozzle remains open.



Fuel injector.

L-12

Cooling System

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- **Purpose of Cooling**
- To maintain optimum temperature of engine for efficient operation under all con
- To dissipate surplus heat for protection of engine components like cylinder, cylinder head, piston, piston rings, and valves.
- To maintain the lubricating property of oil inside engine.

The two main requirements of an efficient cooling system are:

- It must be capable of removing only about 30% of the heat generated in the combustion chamber. Too much removal of heat lowers the thermal efficiency of the engine.
- It should remove heat at a fast rate when the engine is hot. During the starting of the engine, the cooling should be very slow so that the different working parts reach their operating temperatures in a short time.
- **Methods of Cooling**
- Air cooled system
- Liquid (Water) cooled system

Cooling System

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- Air cooled system : Air cooled system is generally used in small engi up to 15-20 kW and in aero plane engines.
- In this system fins or extended surfaces are provided on the cylinder walls, cylinder head, etc.
- Heat generated due to combustion in the engine cylinder will be conducted to the fins and when the air flows over the fins, heat will be dissipated to air.

The amount of heat dissipated to air depends upon :

- Amount of air flowing through the fins.
- Fin surface area.
- Thermal conductivity of metal used for fins.

Cooling System

Advantages of an Air Cooled System :

- They are cheaper to manufacture. They need less care and maintenance.
- The design of air-cooled engine is simple.
- They are lighter in weight than liquid - cooled engines due to the absence of water jackets, radiator, circulating pump and the weight of the cooling water.
- This system of cooling is particularly advantageous where there are extreme climatic conditions in the arctic or where the evaporation factor of liquids is higher- deserts.
- There is no risk of damage from frost, such as cracking of cylinder jackets or radiator water tubes.

Cooling System

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Liquid cooled system :

- The coolant is pumped through the engine, then after absorbing the heat of combustion is circulated to the radiator where the heat is transferred to the atmosphere.
- The cooled liquid is then transferred back into the engine to repeat the process.

Types

- Direct Or Non-Return System :
- Thermo - Syphone System
- Hopper System
- Pump / Forced Circulation System

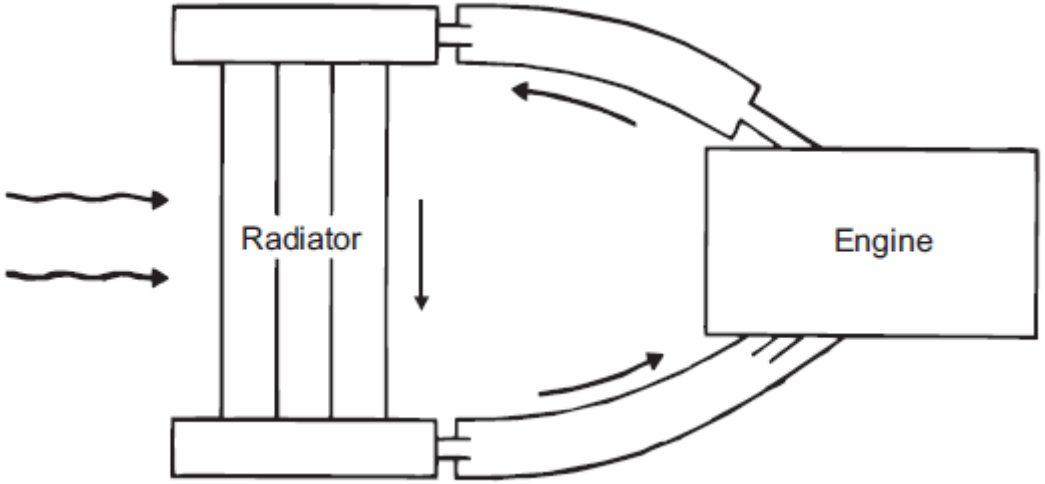
L-13

Cooling System

Types

- Direct Or Non-Return System :This is suitable for large installations and where plen water is available.
- The water from a storage tank is directly supplied to the engine cylinder.
- The hot water is not cooled for reuse but simply discharges.
- The low H.P. engine, coupled with the irrigation pump is an example
- Thermo - Syphone System :This system works on the principle that hot water being lighter rises up and the cold water being heavier goes down.
- In this system the radiator is placed at a higher level than the engine for the easy flow of water towards the engine.
- Heat is conducted to the water jackets from where it is taken away due to convection by the circulating water. As the water jacket becomes hot, it rises to the top of the radiator.
- Cold water from the radiator takes the place of the rising hot water and in this way a circulation of water is set up m the system. This helps in keeping the engine at working temperature.

Cooling System



Thermo-Syphone

Types

- Hopper System :This also works on the same principle as the thermo-syphone system. In this there is a hopper on a jacket containing water, which surrounds the engine cylinder. In this system, as soon as water starts boiling, it is replaced by cold water. An engine fitted with this system cannot run for several hours without it being refilled with water.

Cooling System

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Pump / Forced Circulation System

- This system is similar in construction to the thermo-syphone system except that it makes use of a centrifugal pump to circulate the water throughout the water jackets and radiator.
- The water flows from the lower portion of the radiator to the water jacket of the engine through the centrifugal pump.
- After the circulation water comes back to the radiator, it loses its heat by the process of radiation.
- This system is employed in cars, trucks, tractors, etc

Cooling System

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- **Antifreeze Mixture:** In western countries if the water used in the radiator freezes because of co climates, then ice formed has more volume and produces cracks in the cylinder blocks, pipes, ar radiator. So, to prevent freezing antifreeze mixtures or solutions are added in the cooling water.
- The ideal antifreeze solutions should have the following properties :
- It should dissolve in water easily.
- It should not evaporate.
- It should not deposit any foreign matter in cooling system.
- It should not have any harmful effect on any part of cooling system.
- It should be cheap and easily available.
- It should not corrode the system

Examples:

- Methyl, ethyl and isopropyl alcohols.
- A solution of alcohol and water.
- Ethylene Glycol.
- A solution of water and Ethylene Glycol.
- Glycerin along with water, etc.

Cooling System

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- **Advantages**
- Uniform cooling of cylinder, cylinder head and valves.
- Specific fuel consumption of engine improves by using water cooling system.
- If we employ water cooling system, then engine need not be provided at the front end of moving vehicle.
- Engine is less noisy as compared with air cooled engines, as it has water for damping noise.
- **Disadvantages**
- It depends upon the supply of water.
- The water pump which circulates water absorbs considerable power.
- If the water cooling system fails then it will result in severe damage of
- engine.
- The water cooling system is costlier as it has more number of parts.
- it requires more maintenance and care for its parts.

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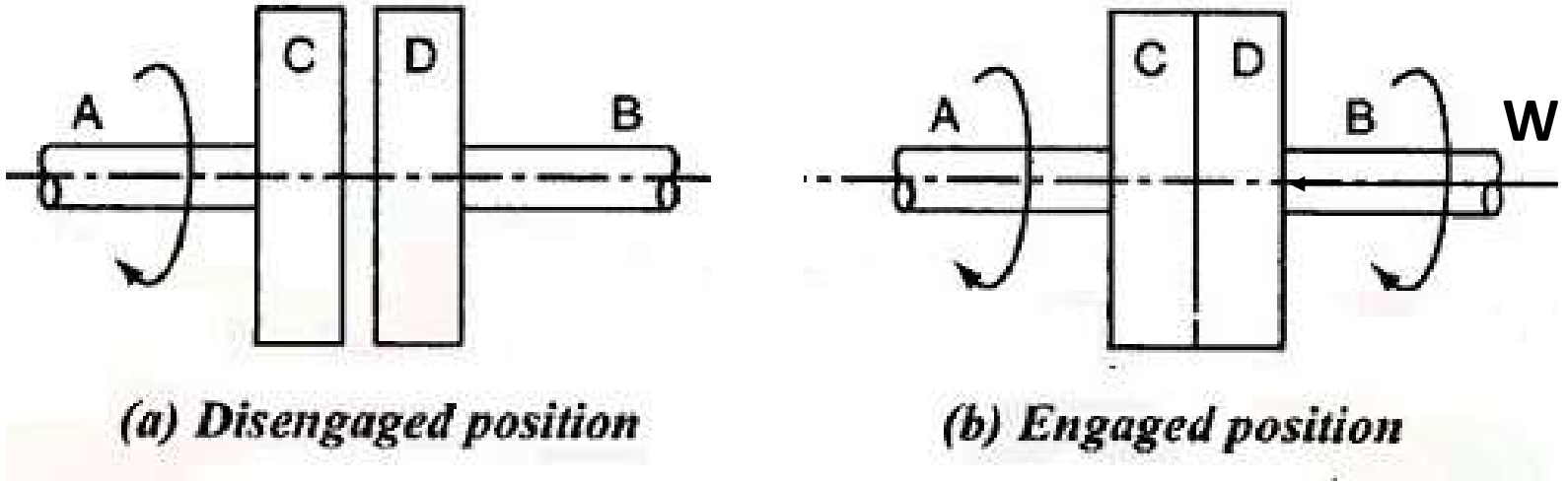
Unit 2

Clutch

- Definition
- Requirement of clutch
  - Torque transmission
  - Gradual engagement
  - Heat dissipation
  - Dynamics balancing
  - Vibration damping
  - Size
  - Inertia
  - Clutch free pedal play
  - Ease of operation

Clutch

- Types of clutches
  - Friction clutch
  - Fluid flywheel
- Principal of friction clutch

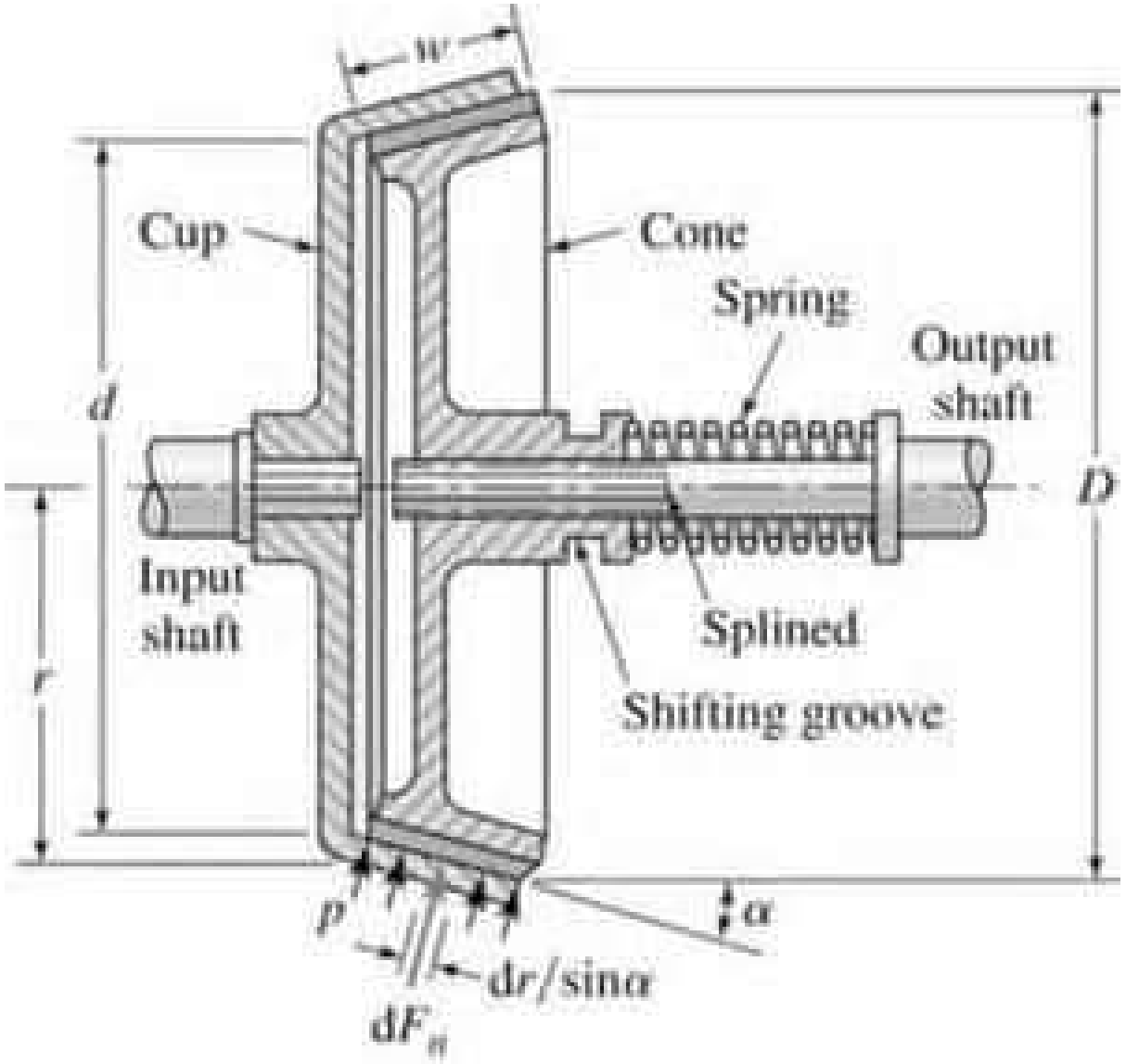


(a) Disengaged position *(b) Engaged position*

Friction Clutch

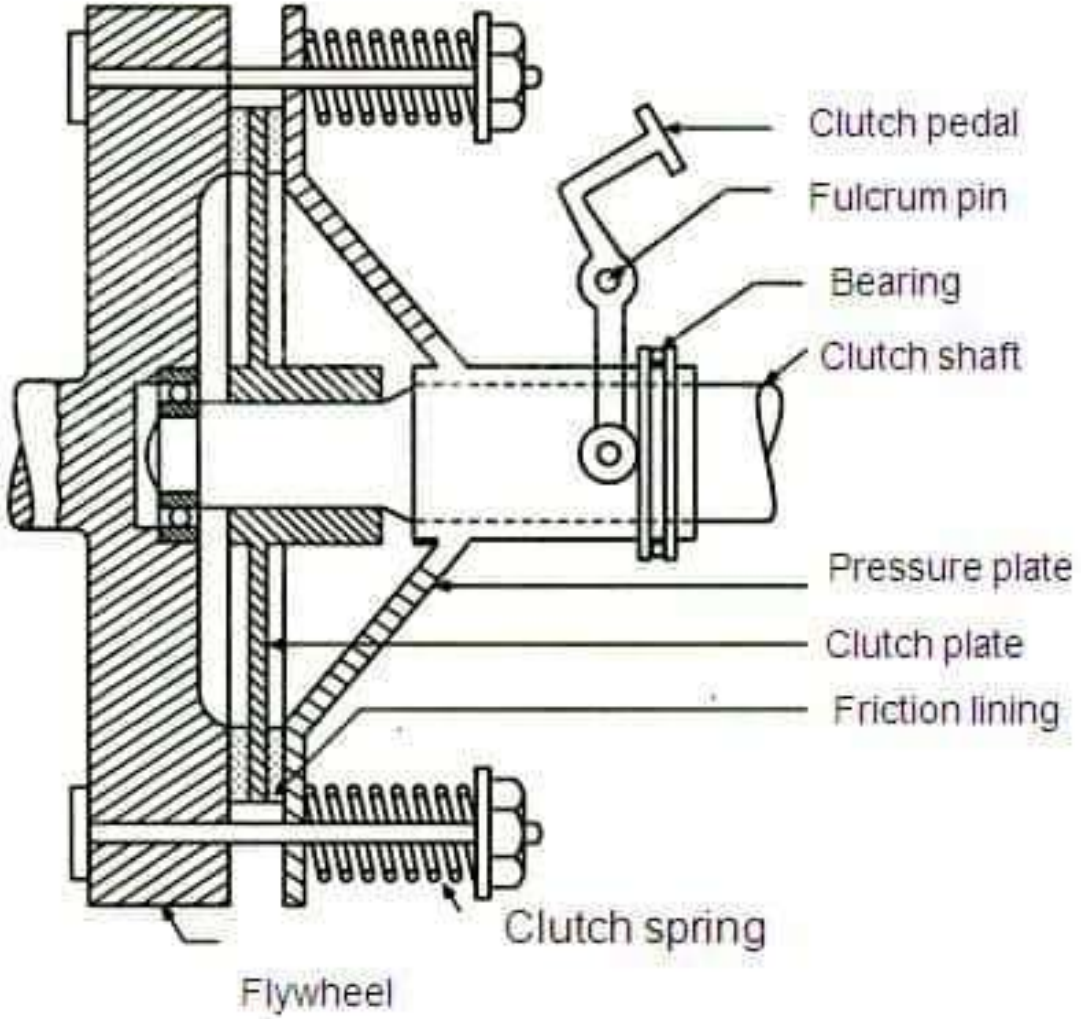
- Cone Clutch
- Single Plate clutch
- Multi Plate Clutch
- Semi Centrifugal Clutch
- Centrifugal Clutch

Cone Clutch



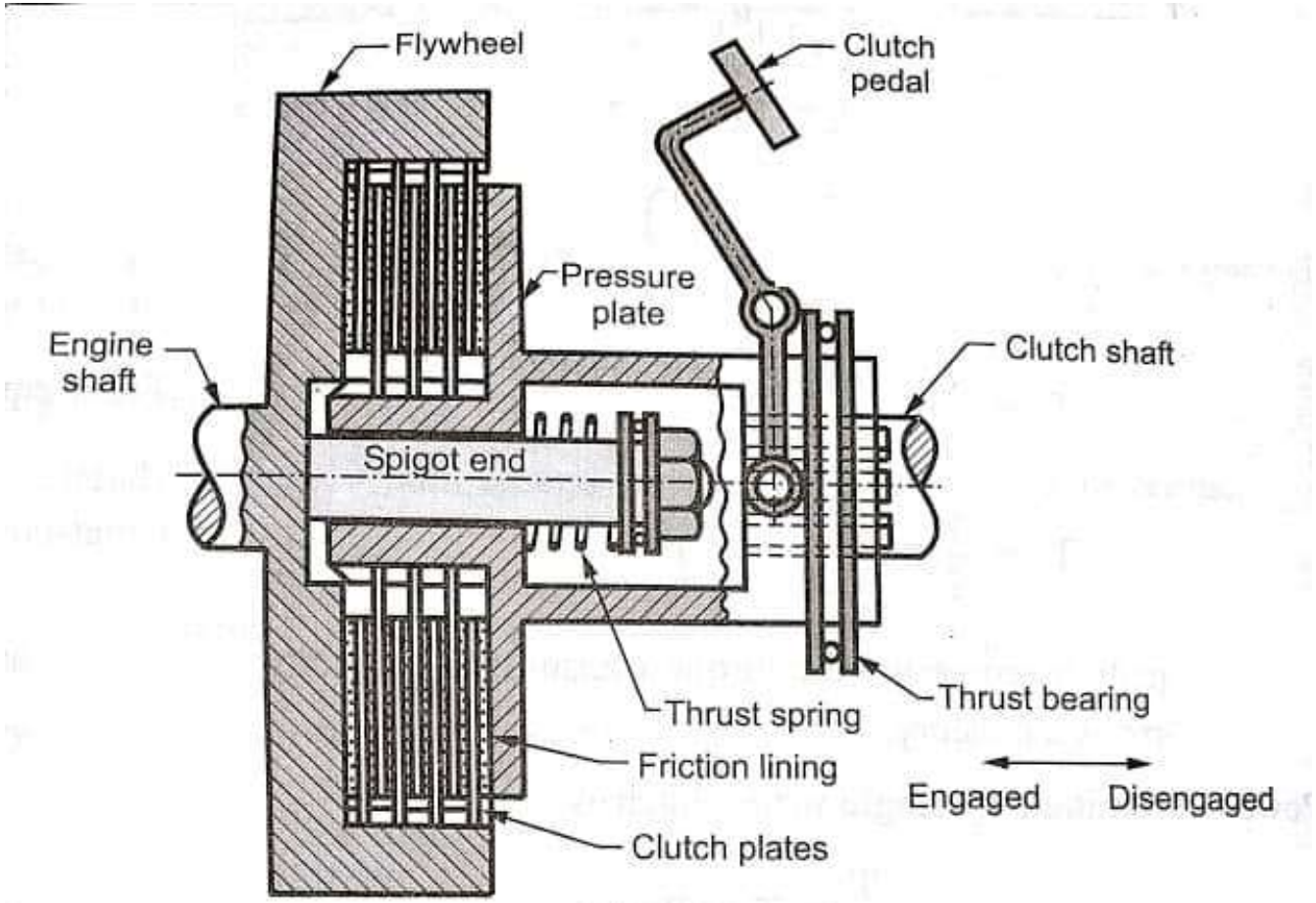
- Construction
- Working
- Advantages
- Disadvantages

Single Plate Clutch



- Construction
- Working
- Advantages
- Disadvantages

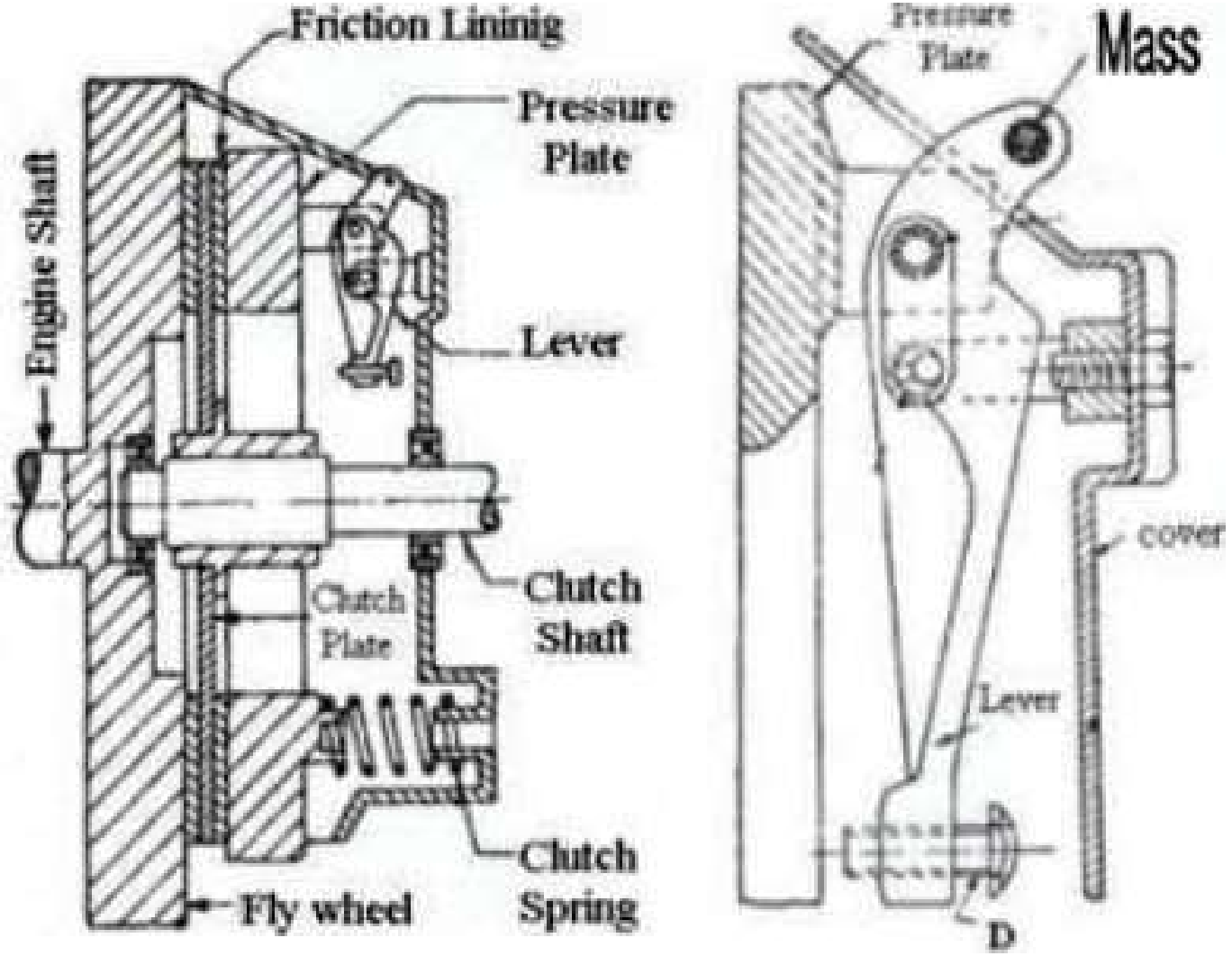
Multi Plate Clutch



Multi-plate clutch

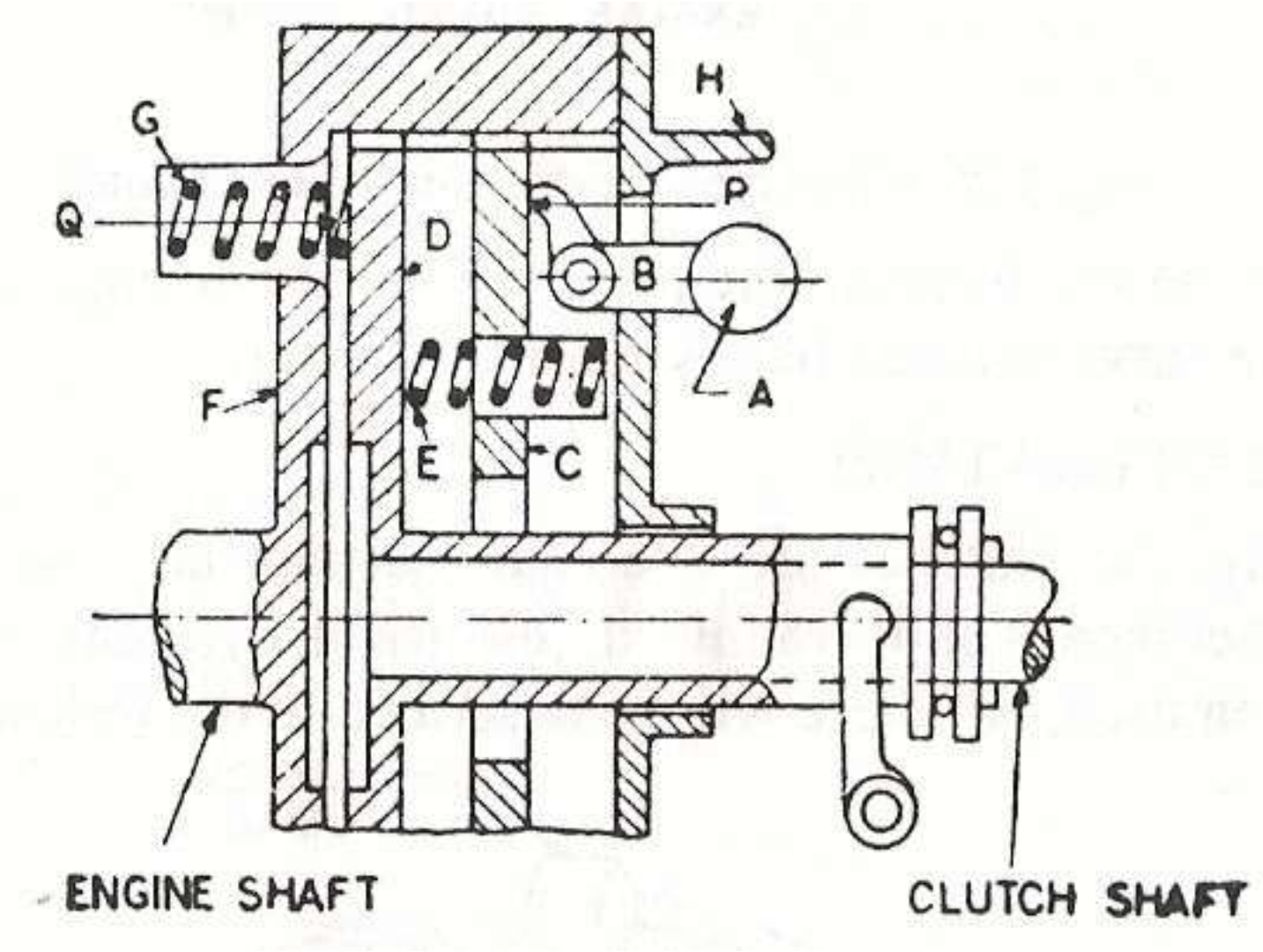
- Construction
- Working
- Advantages
- Disadvantages

Semi Centrifugal Clutch



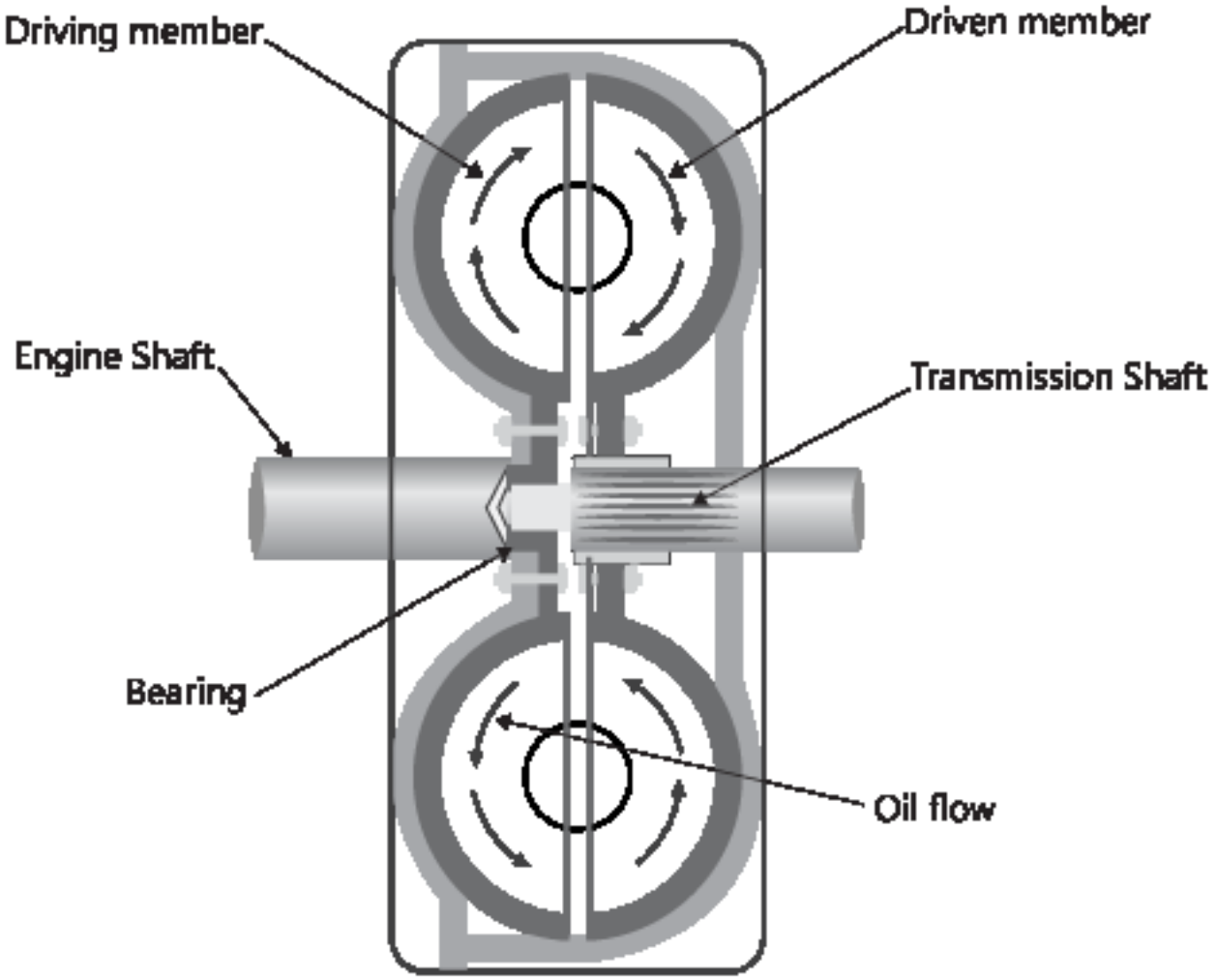
- Construction
- Working
- Advantages

Centrifugal Clutch



- Construction
- Working
- Advantages
- Disadvantages

Fluid Flywheel

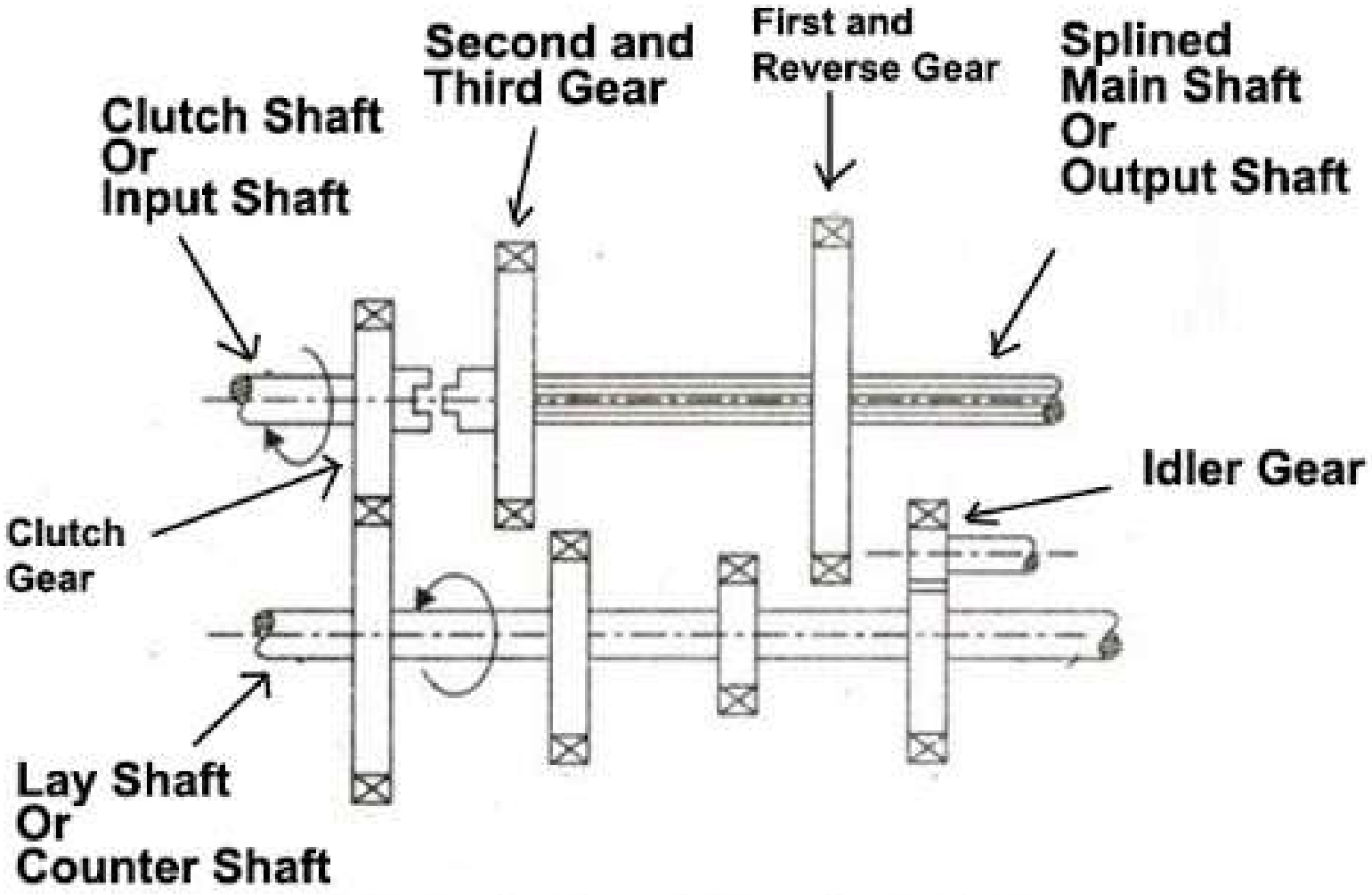


- Construction
- Working
- Advantages
- Disadvantages

Manual Transmission

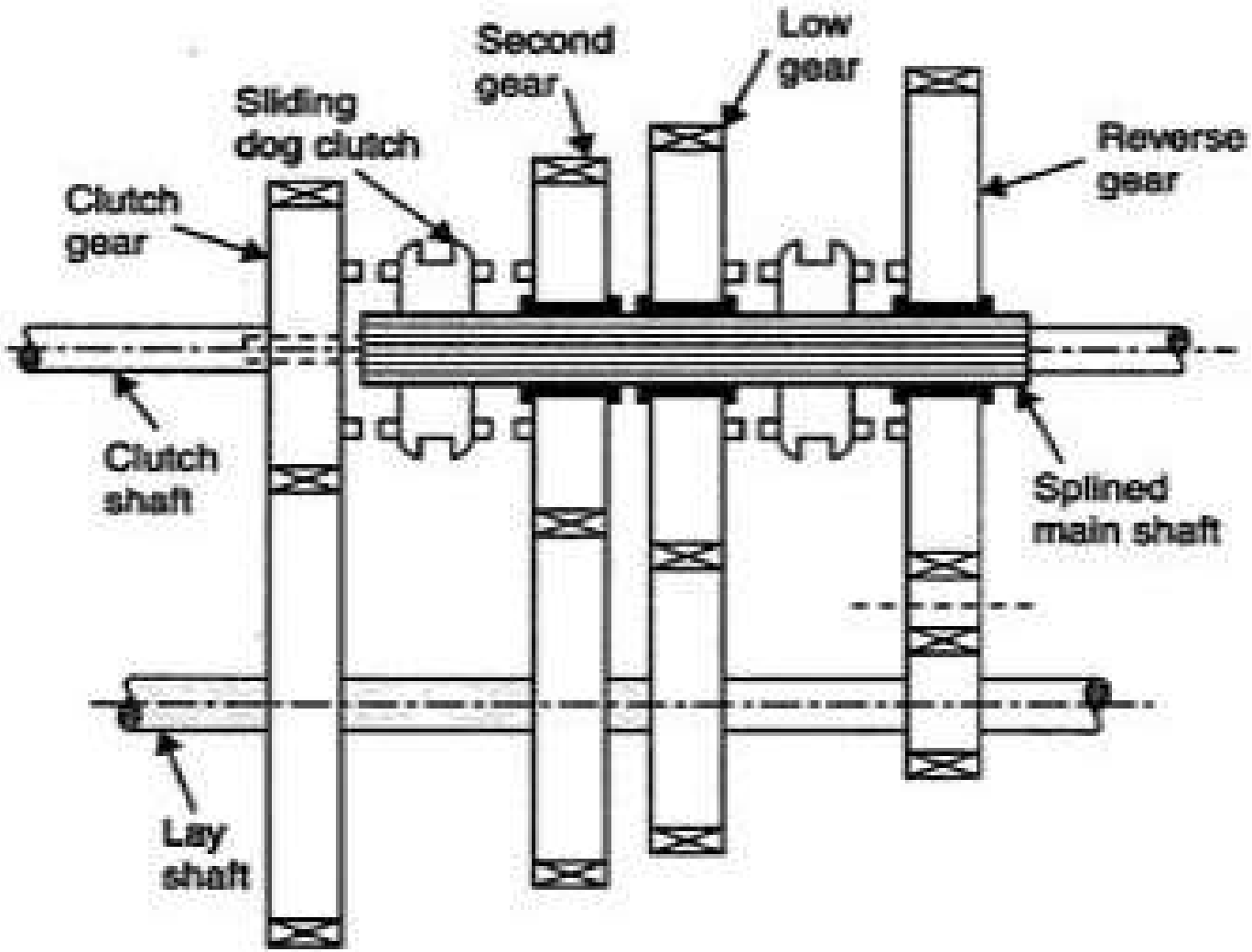
- Function of Transmission
- Necessity of Transmission
  - Resistance to vehicle motion
  - Tractive effort
  - Transmission necessity
- Types of Transmission
  - Manual
  - Automatic

Sliding Mesh Gear Box



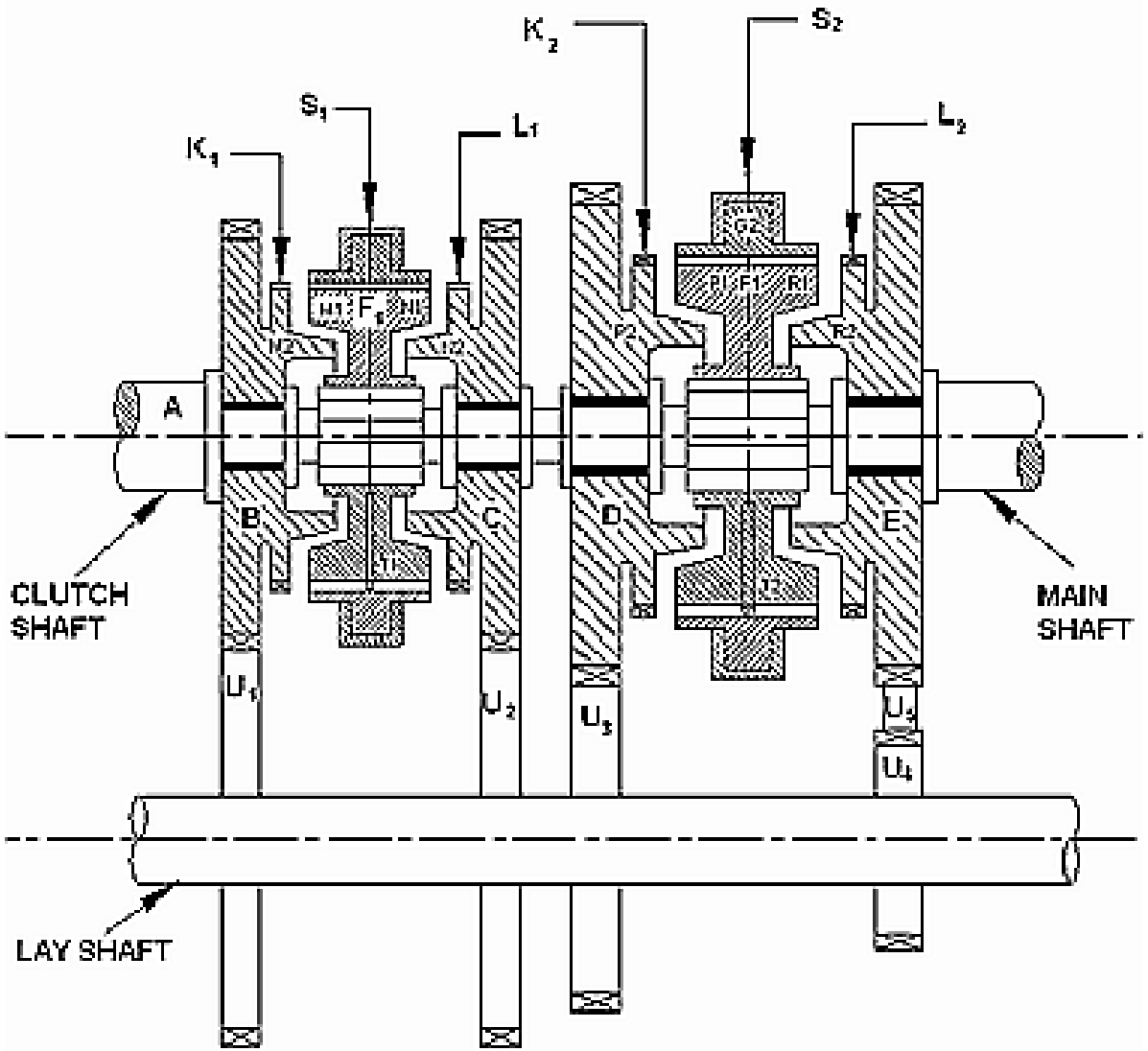
- Constructi
- Working
- Advantages
- Disadvantages

Constant Mesh Gear Box



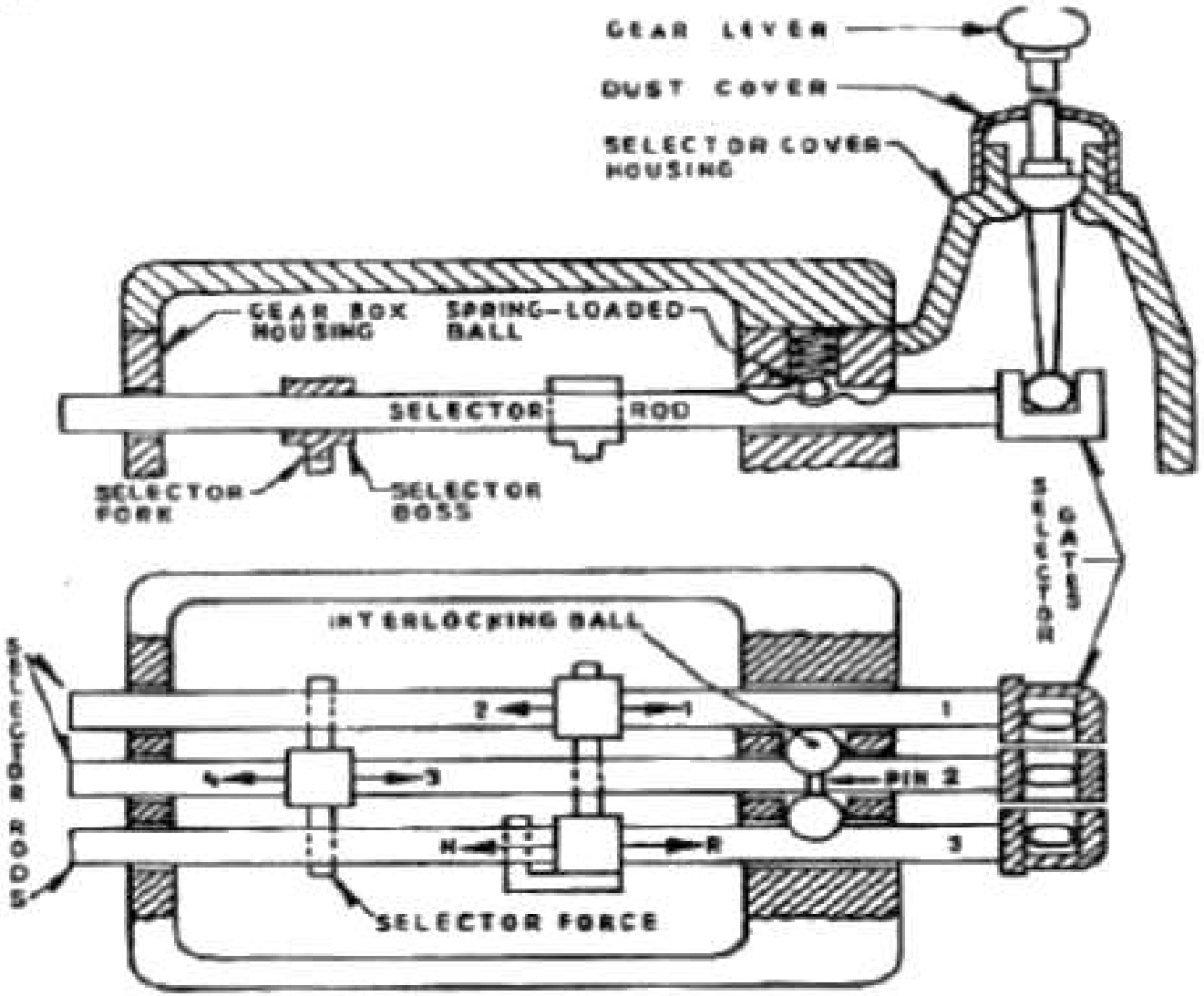
- Construction
- Working
- Advantages
- Disadvantages

Synchromesh Gear Box



- Construction
- Working
- Advantages
- Disadvantages

Gear Selector Mechanism Box



Transfer Box

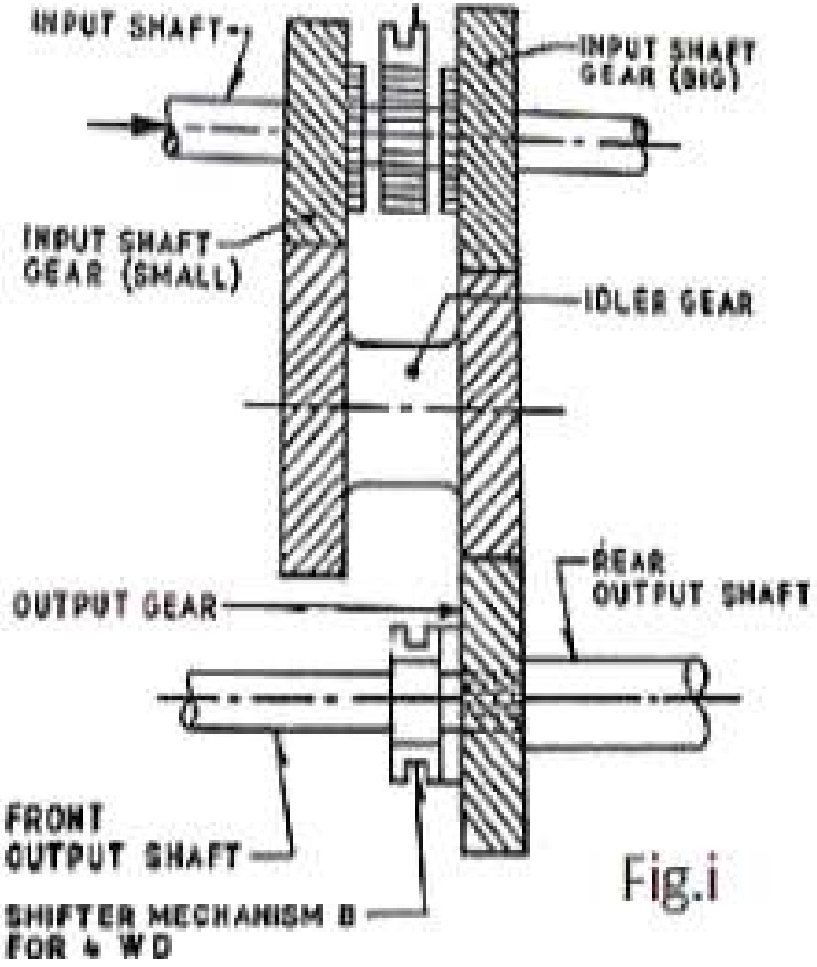


Fig.i

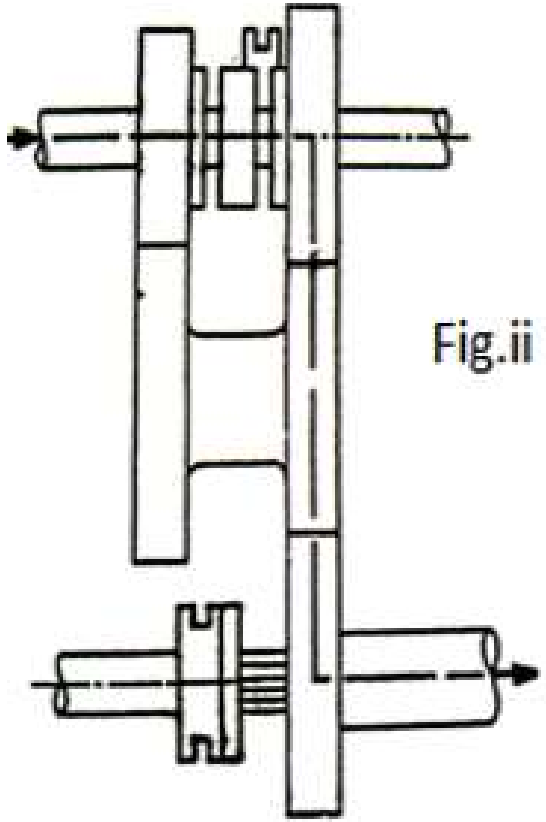


Fig.ii

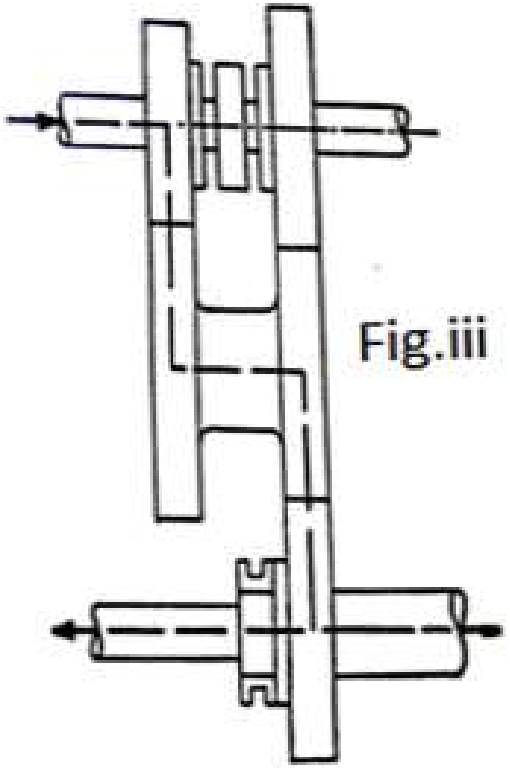
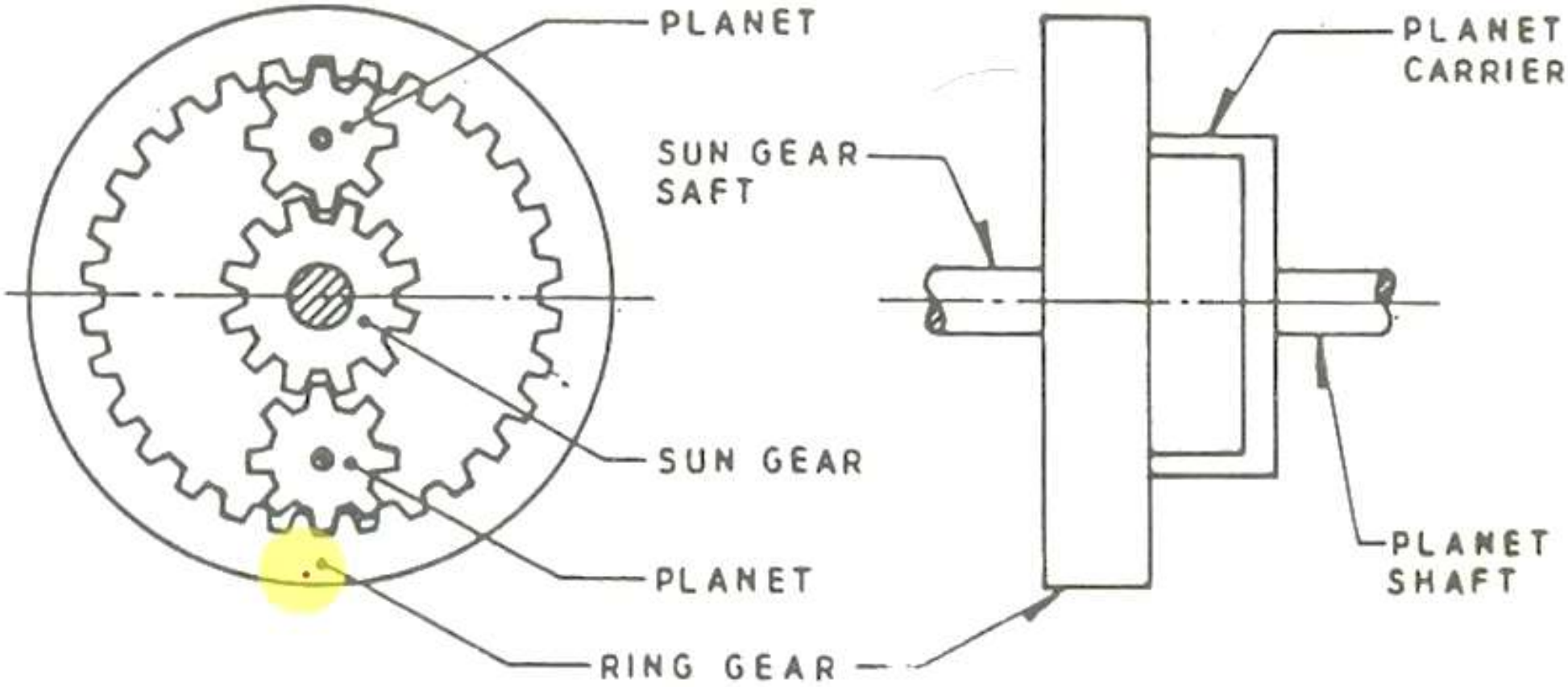


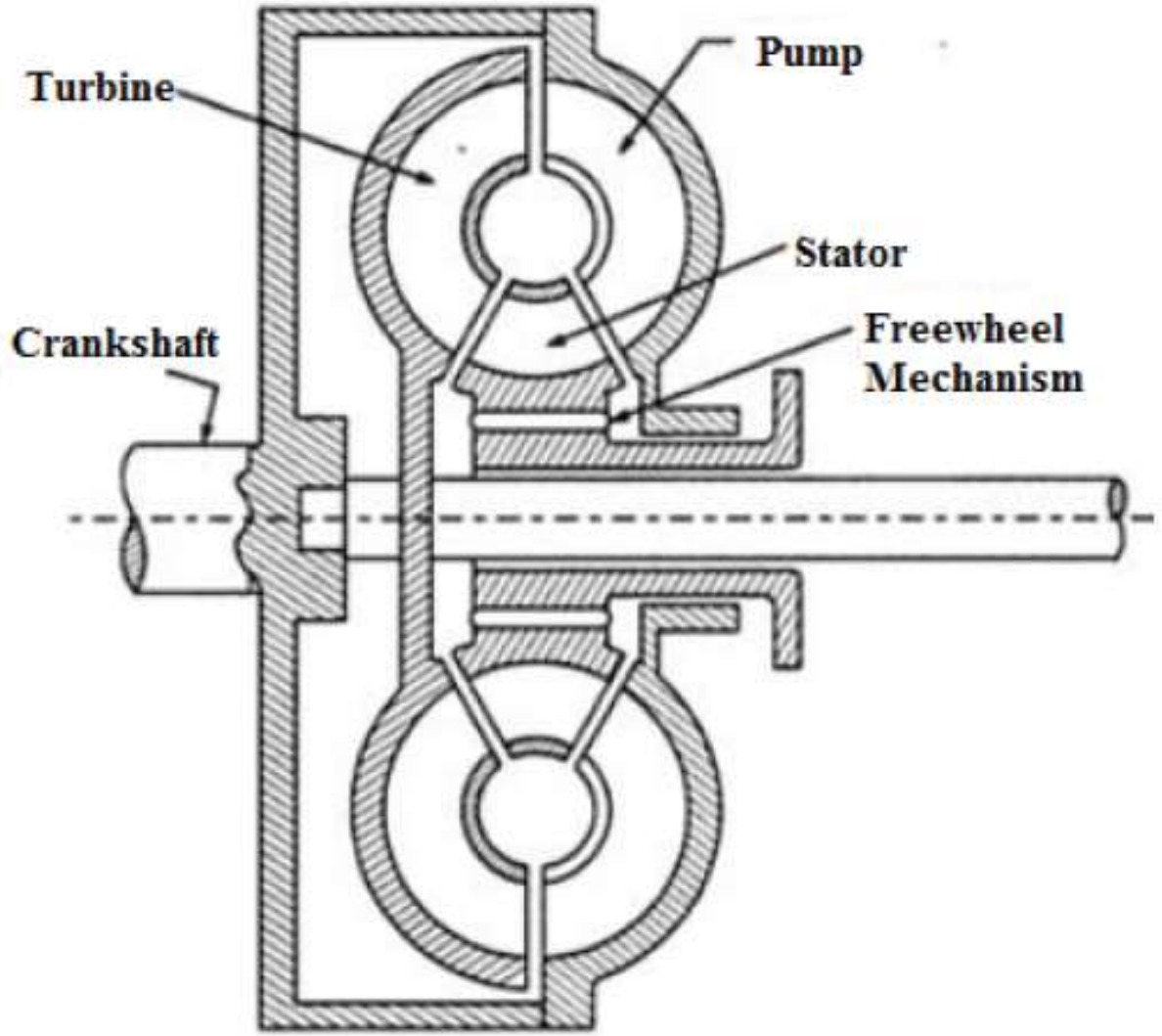
Fig.iii

Epicyclic Gear Box



Simple epicyclic gear set.

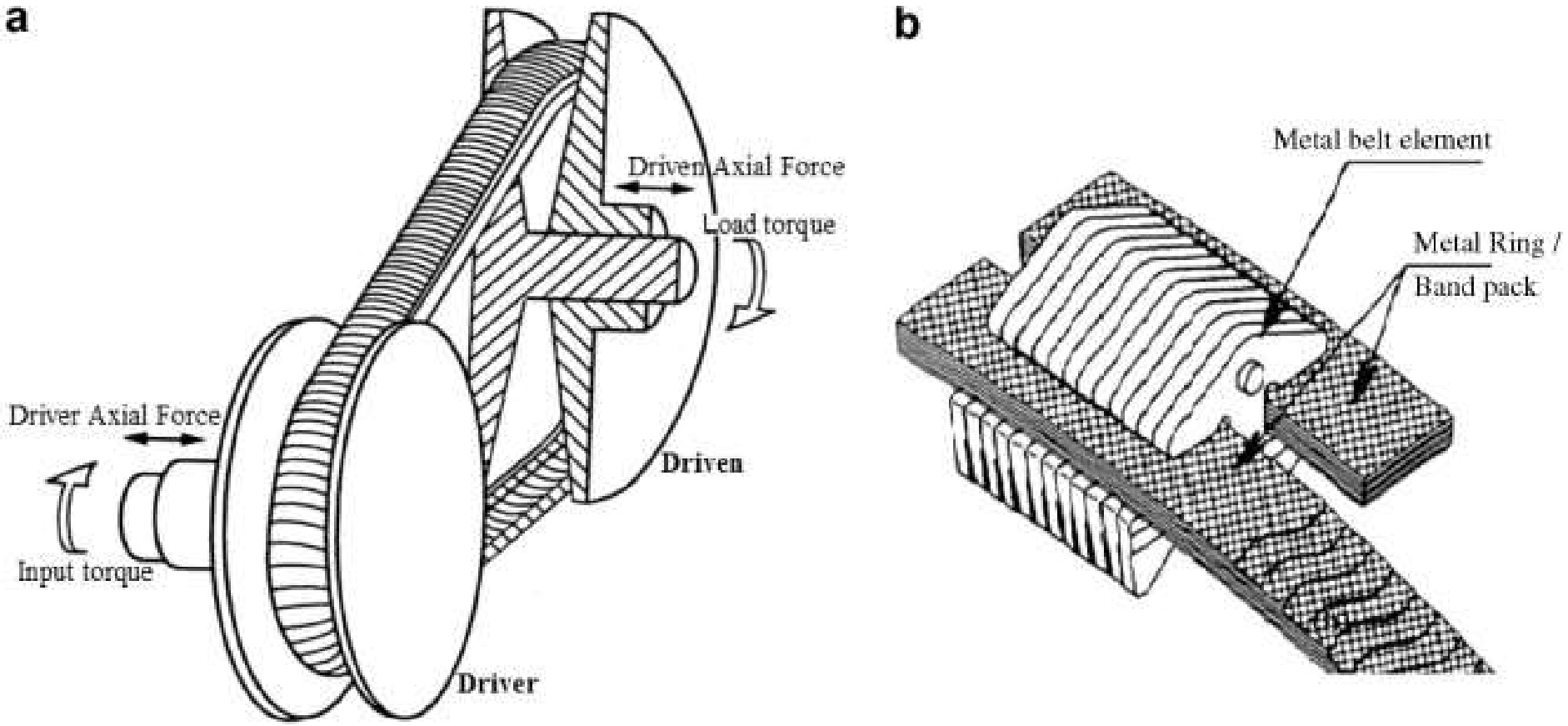
Torque Convertor



- Construction
- Working
- Advantages
- Disadvantages

Continuously variable Transmission

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Propeller Shaft

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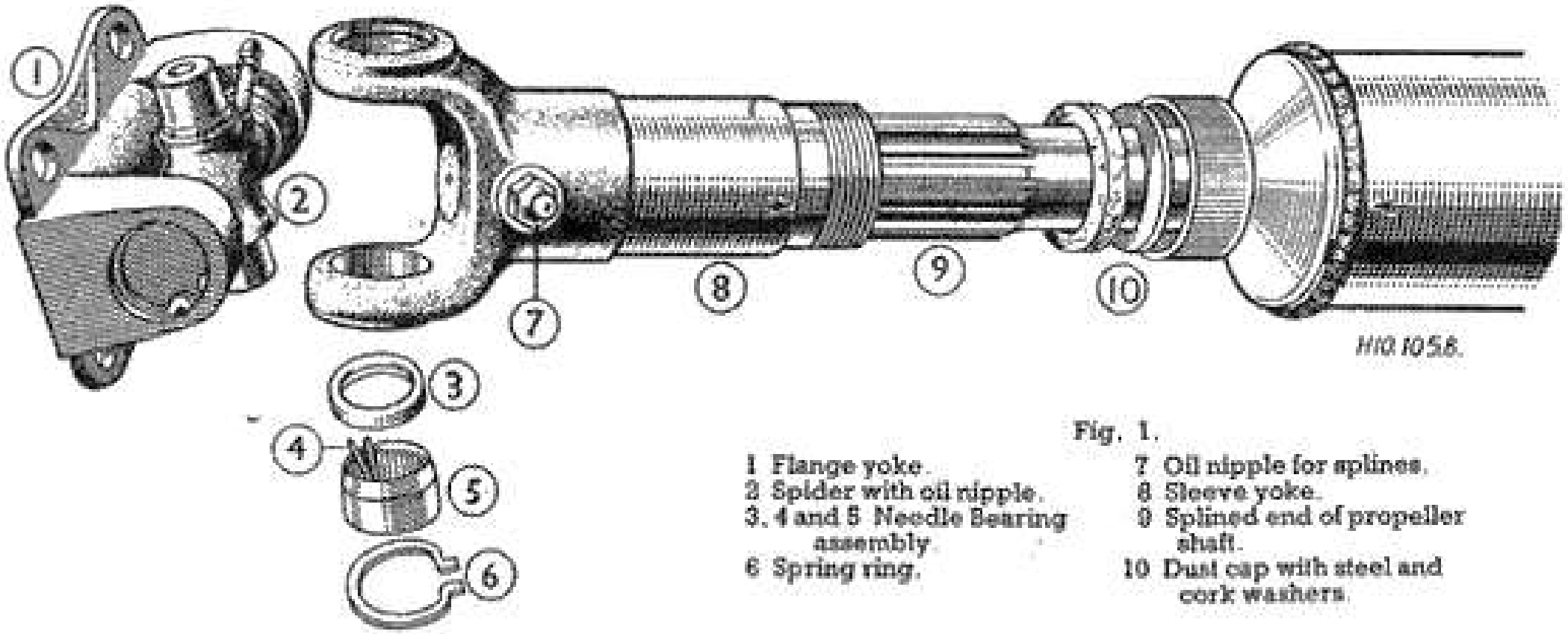
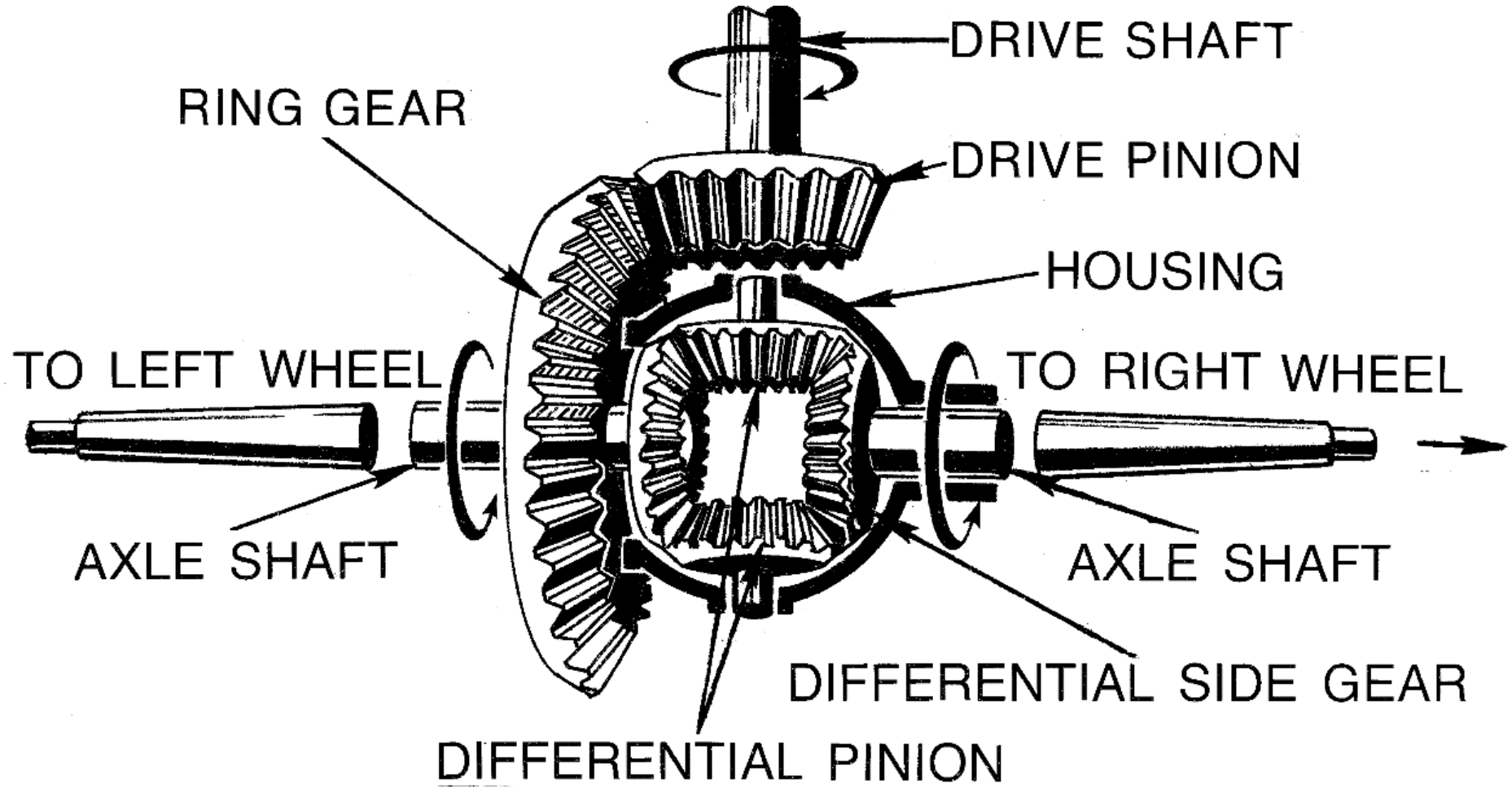


Fig. 1.

1 Flange yoke.
2 Spider with oil nipple.
3, 4 and 5 Needle Bearing assembly.
6 Spring ring.
7 Oil nipple for splines.
8 Sleeve yoke.
9 Splined end of propeller shaft.
10 Dust cap with steel and cork washers.

Differential

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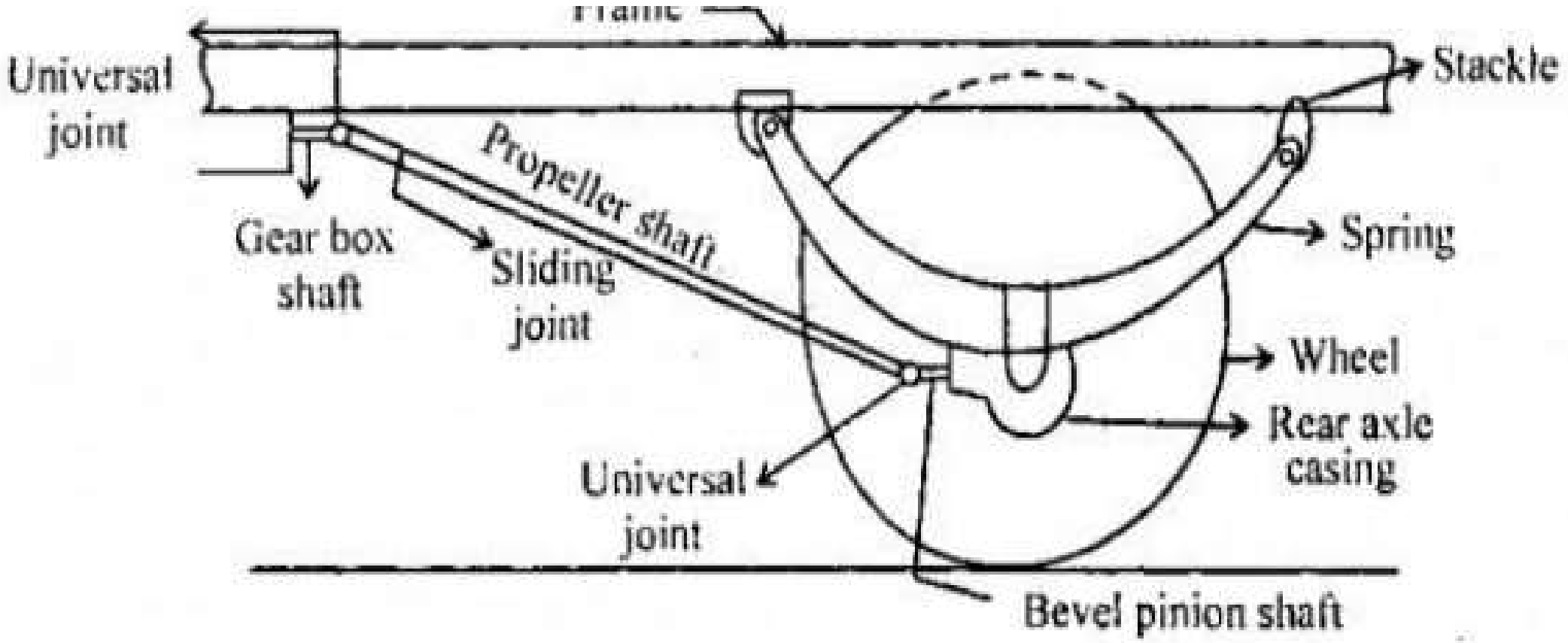
Rear Axle

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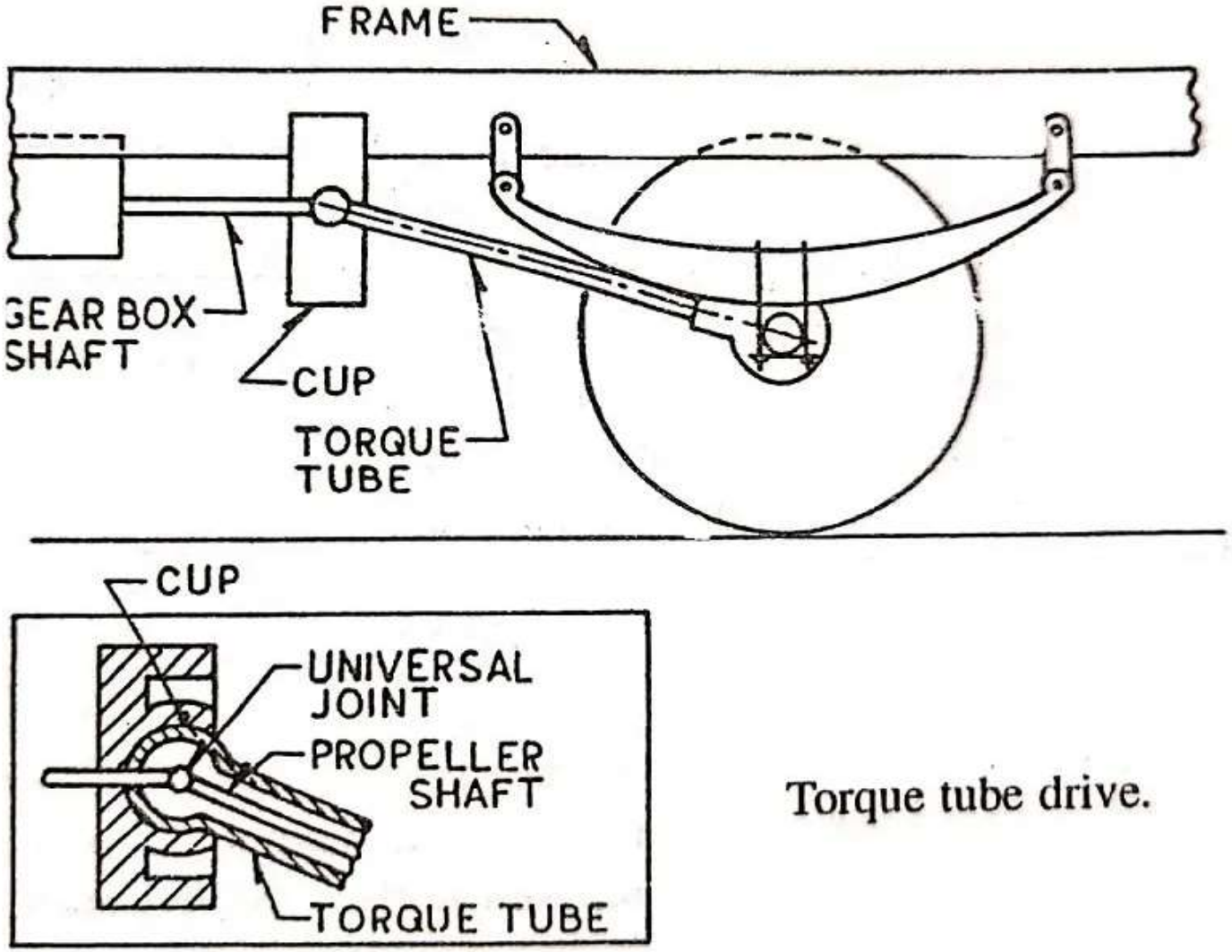
- Various Forces & Torque Experienced by it
  - Weight of the body
  - Driving Thrust
  - Torque Reaction
- Hotchkiss Drive
- Torque Tube Drive

Hotchkiss Drive

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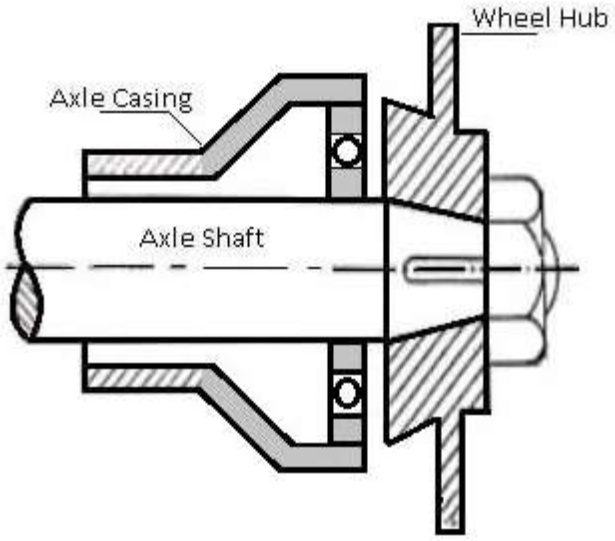
Torque Tube Drive



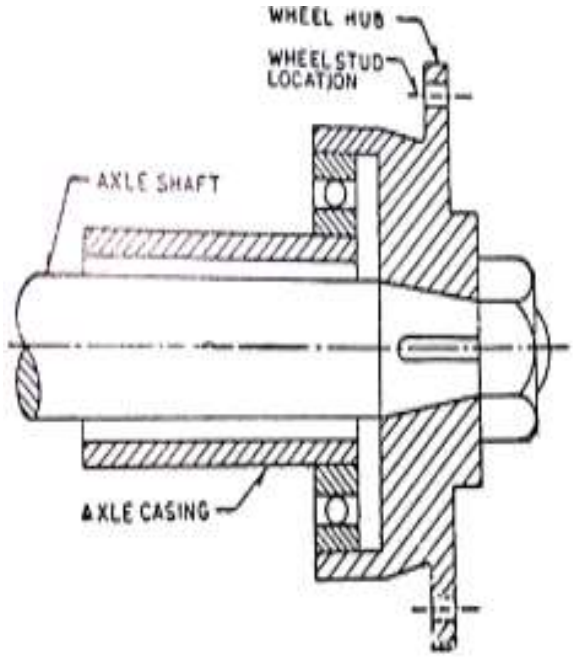
Torque tube drive.

Rear Axle Shaft Supporting

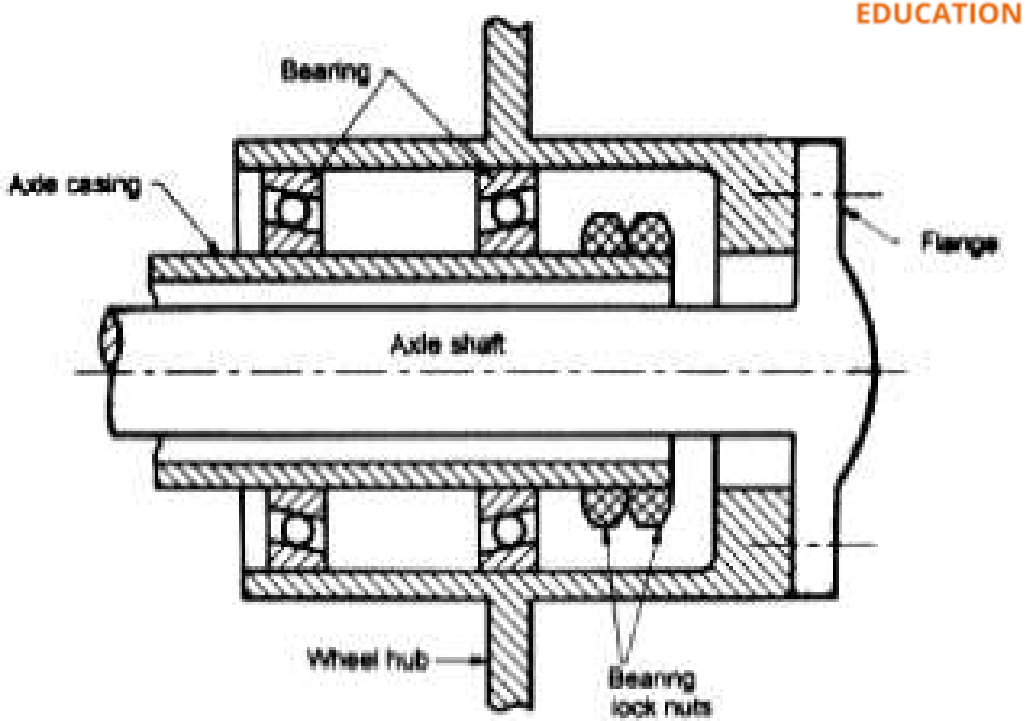
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Semi-Floating Axle



Three Quarter Floating Axle



Full floating axle

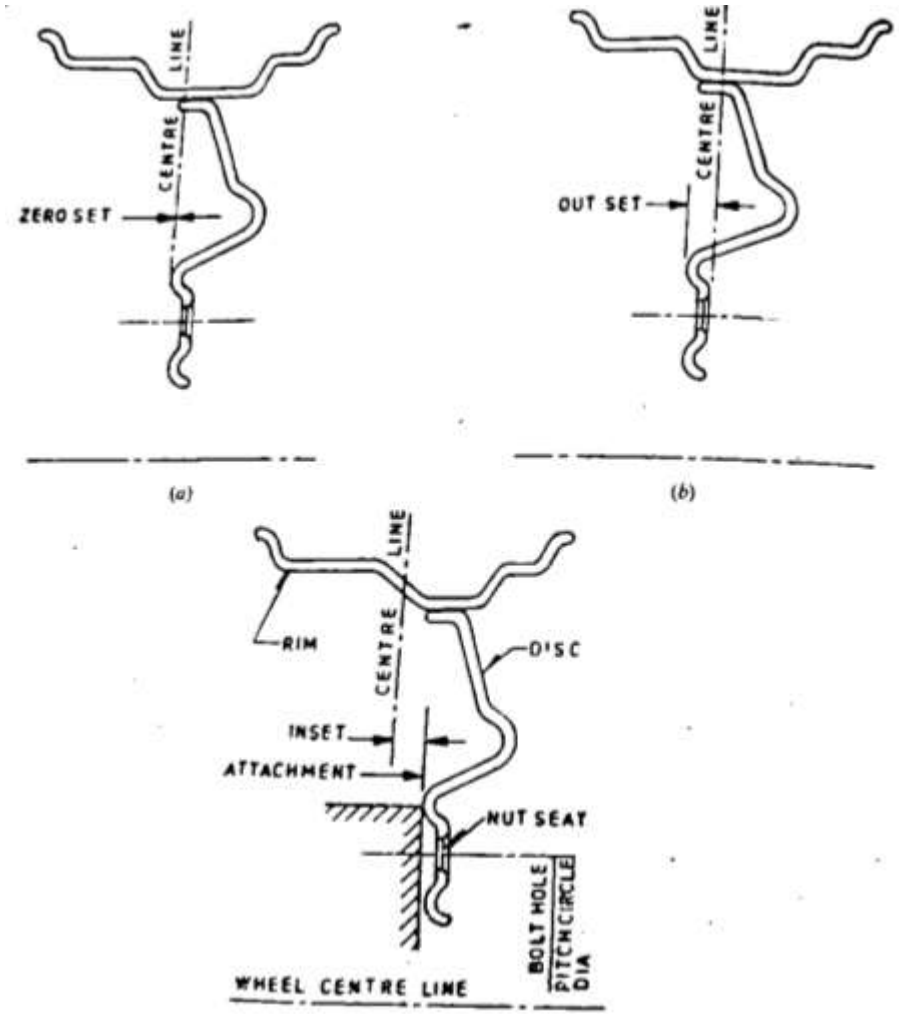
Wheels & Tyre

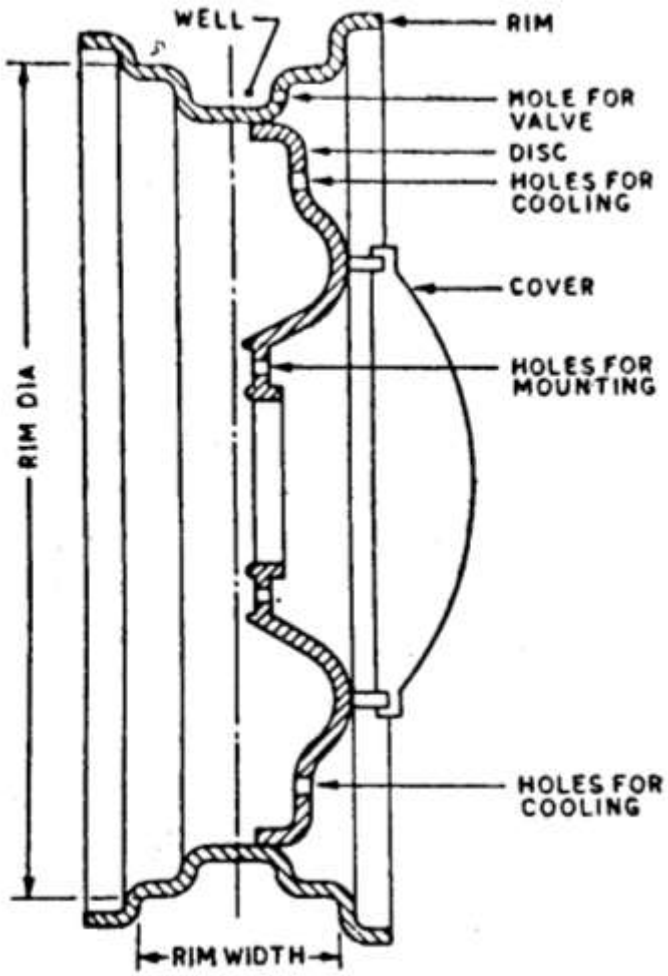
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- Requirements of Automobile Wheel
- Types
- Wheel Dimensions
- Tyre
- Desirable properties of tyre
- Types of tyres

Types of wheel

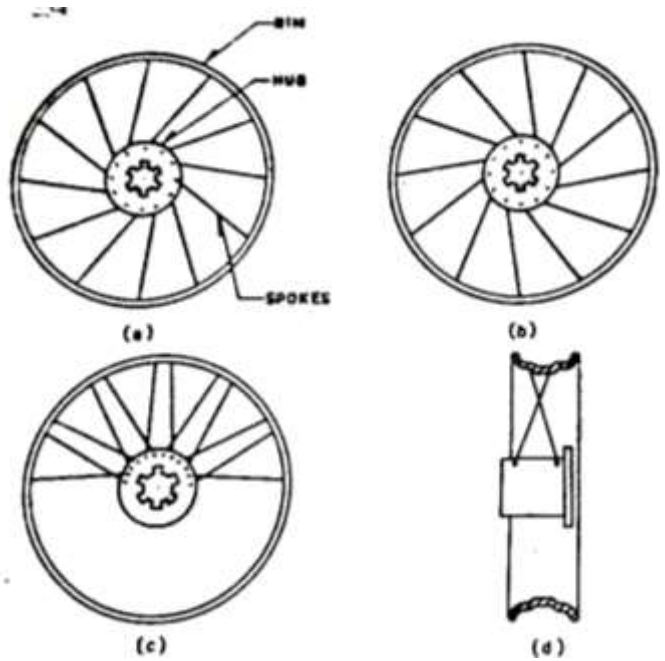
- Disc wheel

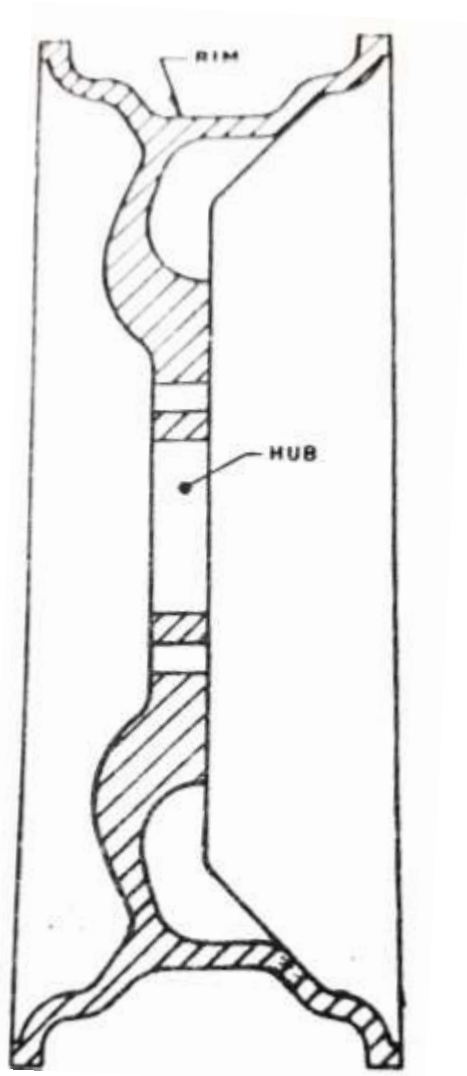




Types of wheel

- Wire Wheel
- Light Alloy or forged Wheel



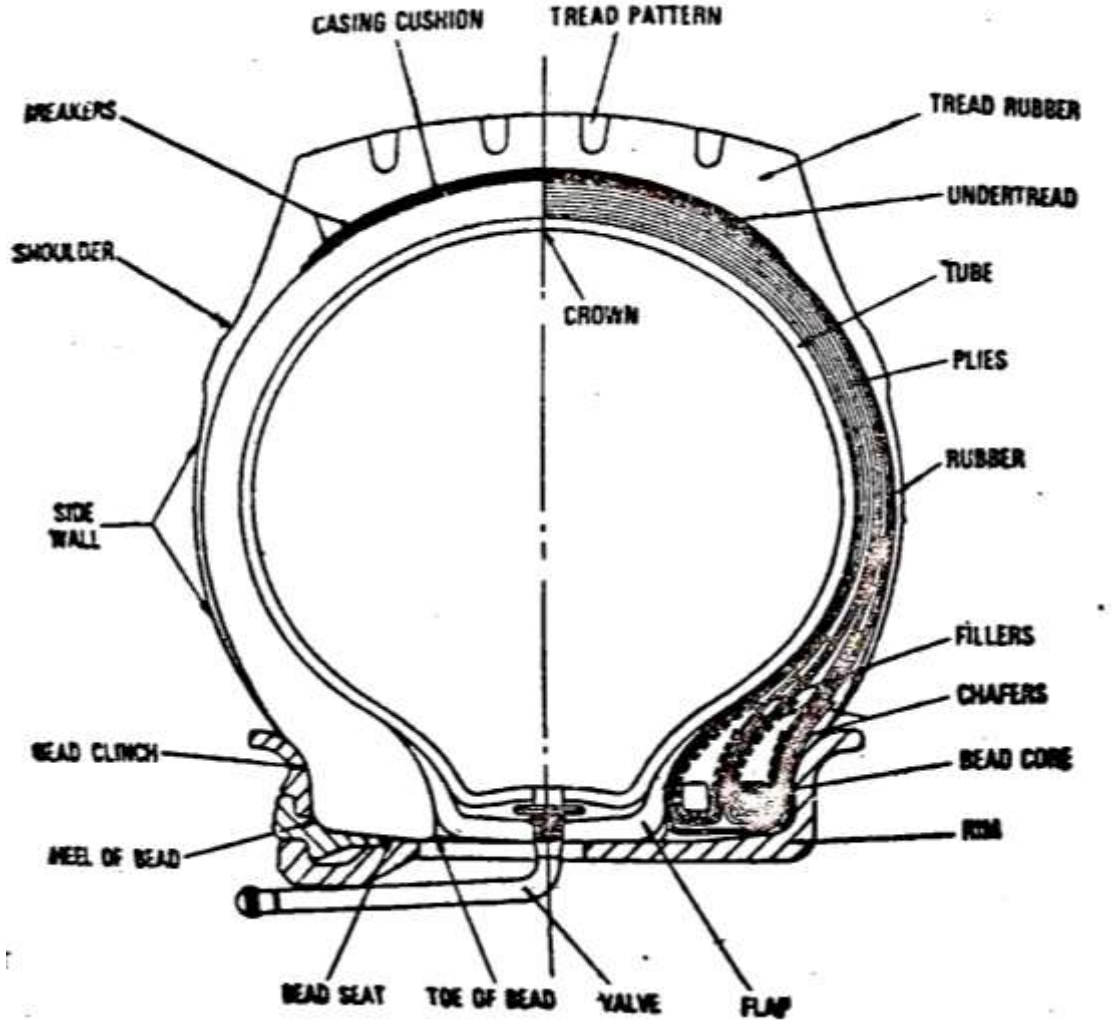


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Tyre

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Function of tyre



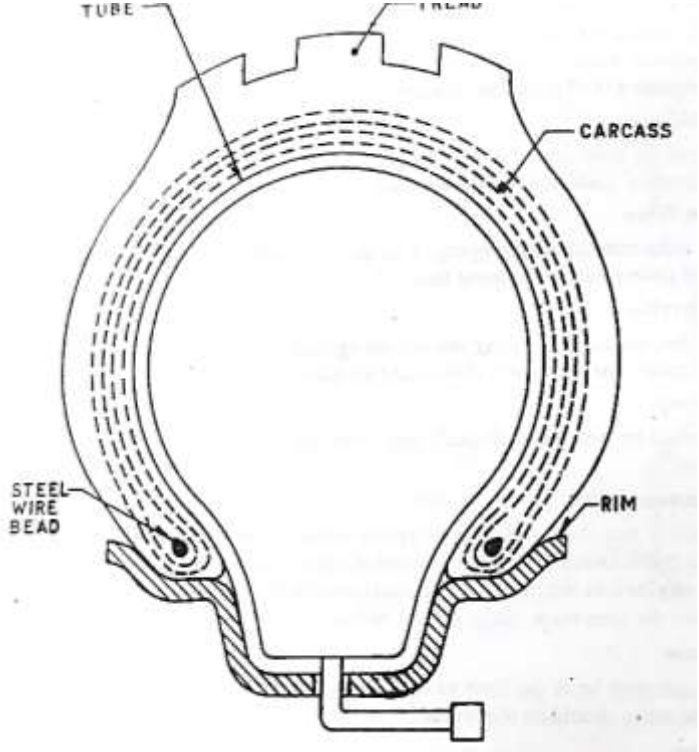
Tyre Properties

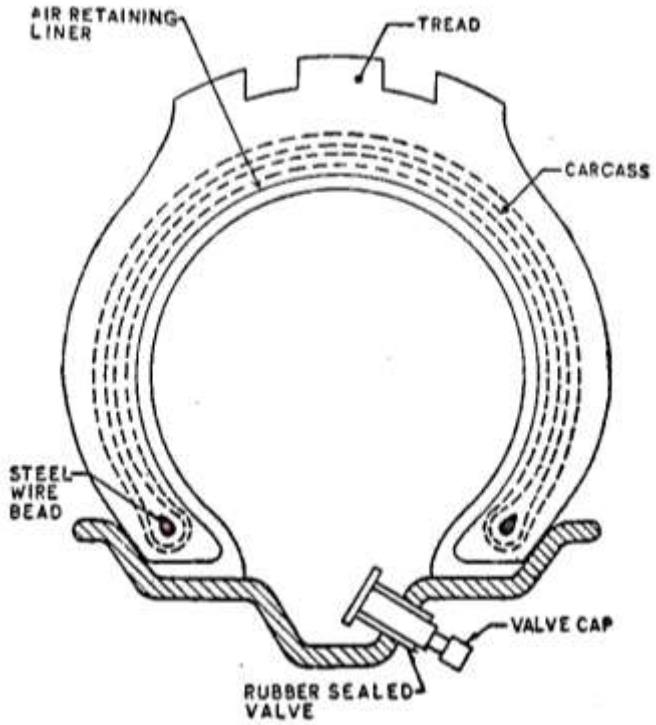
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- Non Skidding
- Uniform Wear
- Load Carrying
- Cushioning
- Power Consumption
- Tyre noise
- Balancing

Types of tyre

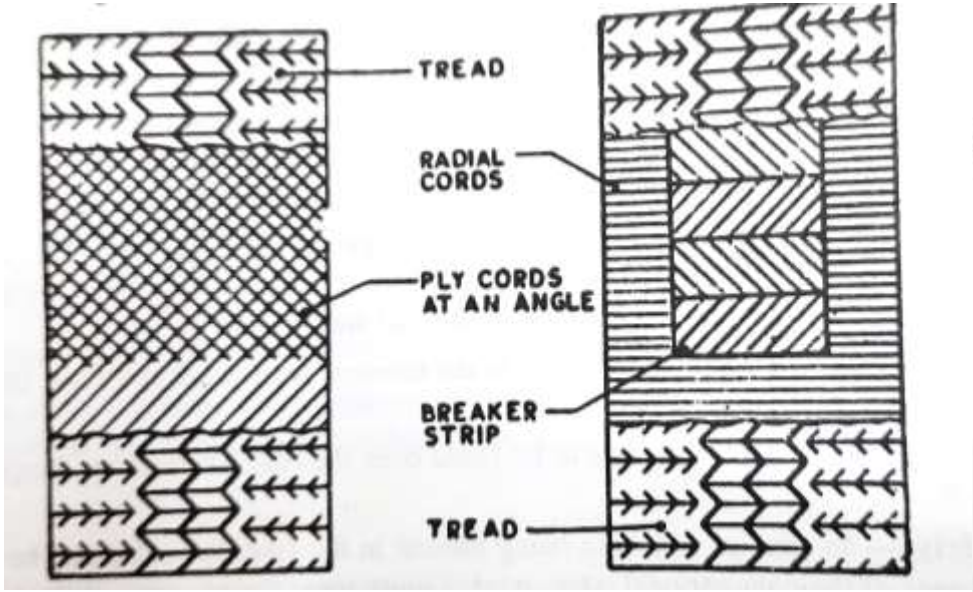
- Conventional tubed tyre
- Tubeless tyre
- Comparison of both

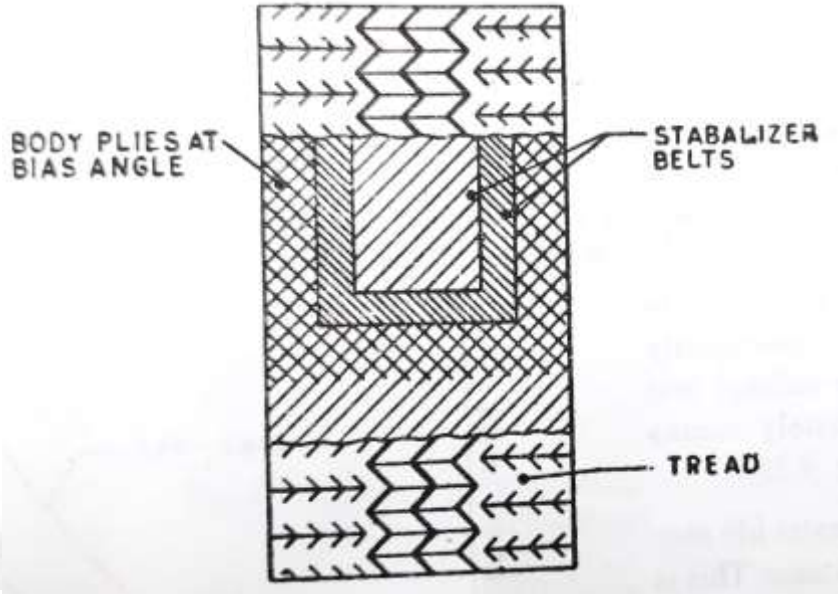




Carcass Types

- Cross ply or Bias ply
- Radial Ply
- Belted Bias ply
- Comparison of radial & bias ply





Tyre

- Tyre Material
- Tread Design
  - Grip
  - Noise
  - Wear
- Tyre designation
- Tyre wear indicator

Factors affecting tyre life

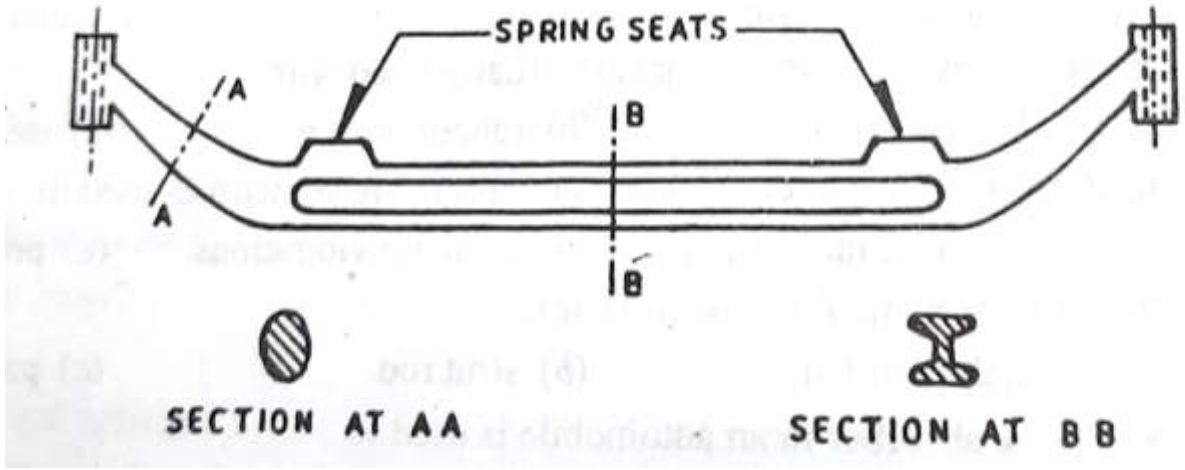
- Inflation
- Vehicle maintenance
- Manner of driving
- Miscellaneous factors

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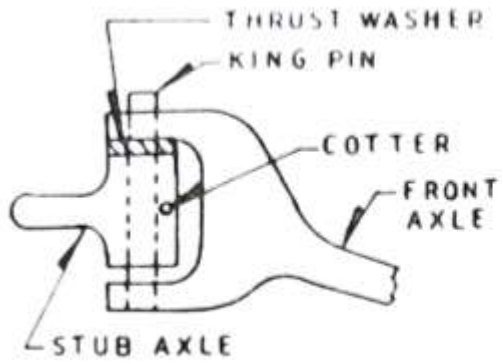
Unit 3

Front axle and steering

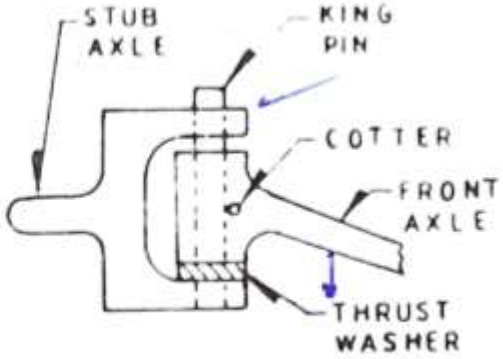
- Steering
  - Primary Function
  - Secondary Function
- Requirement of good steering
- Front Axle



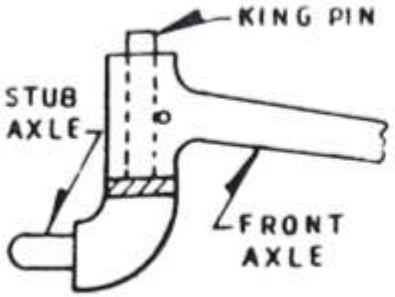
Type of Stub axles



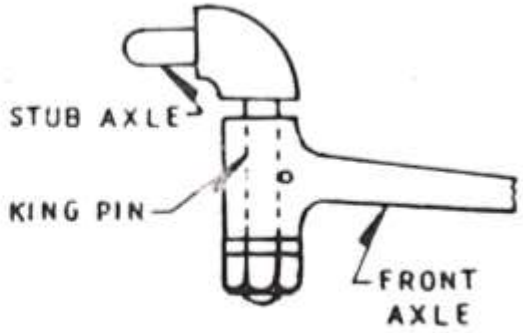
(a) ELLIOT



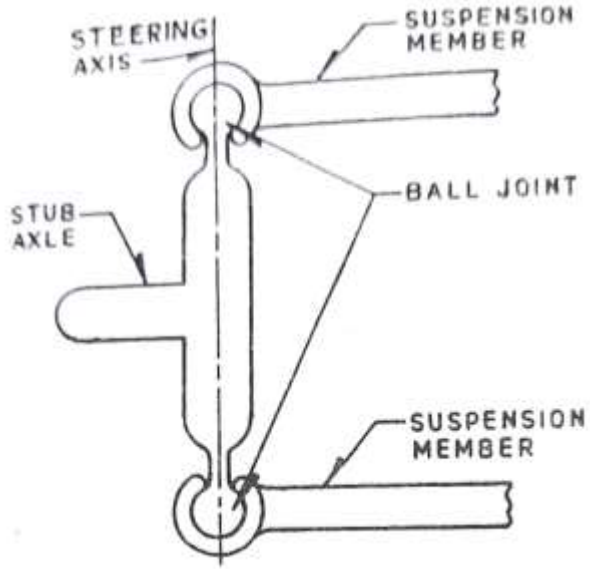
(b) REVERSED ELLIOT



(c) LAMOINE



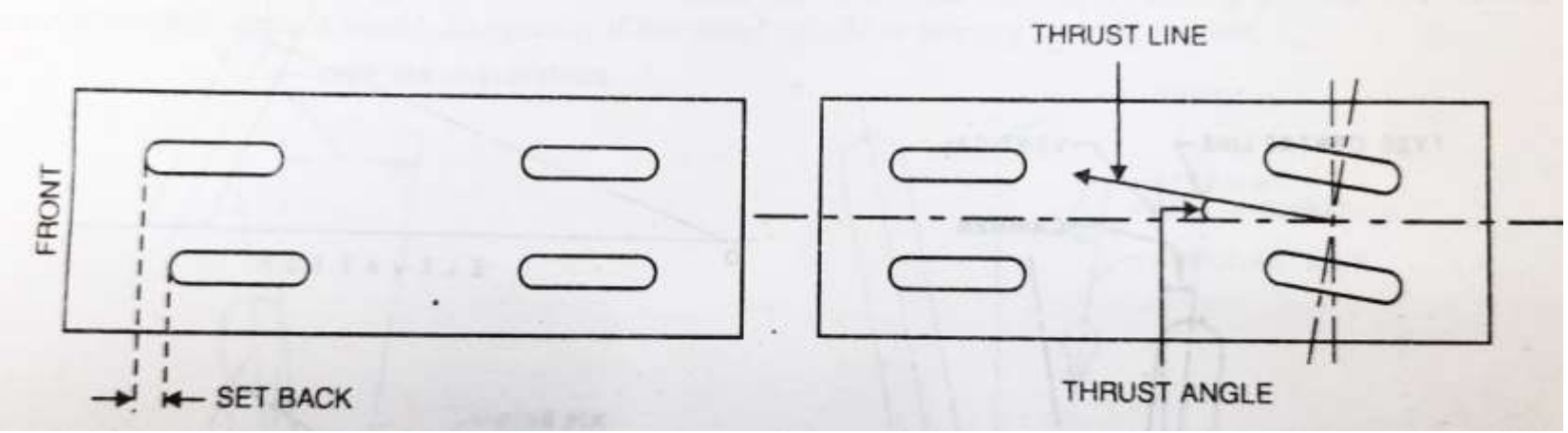
(d) REVERSED LAMOINE



Factors of Wheel & its Alignment

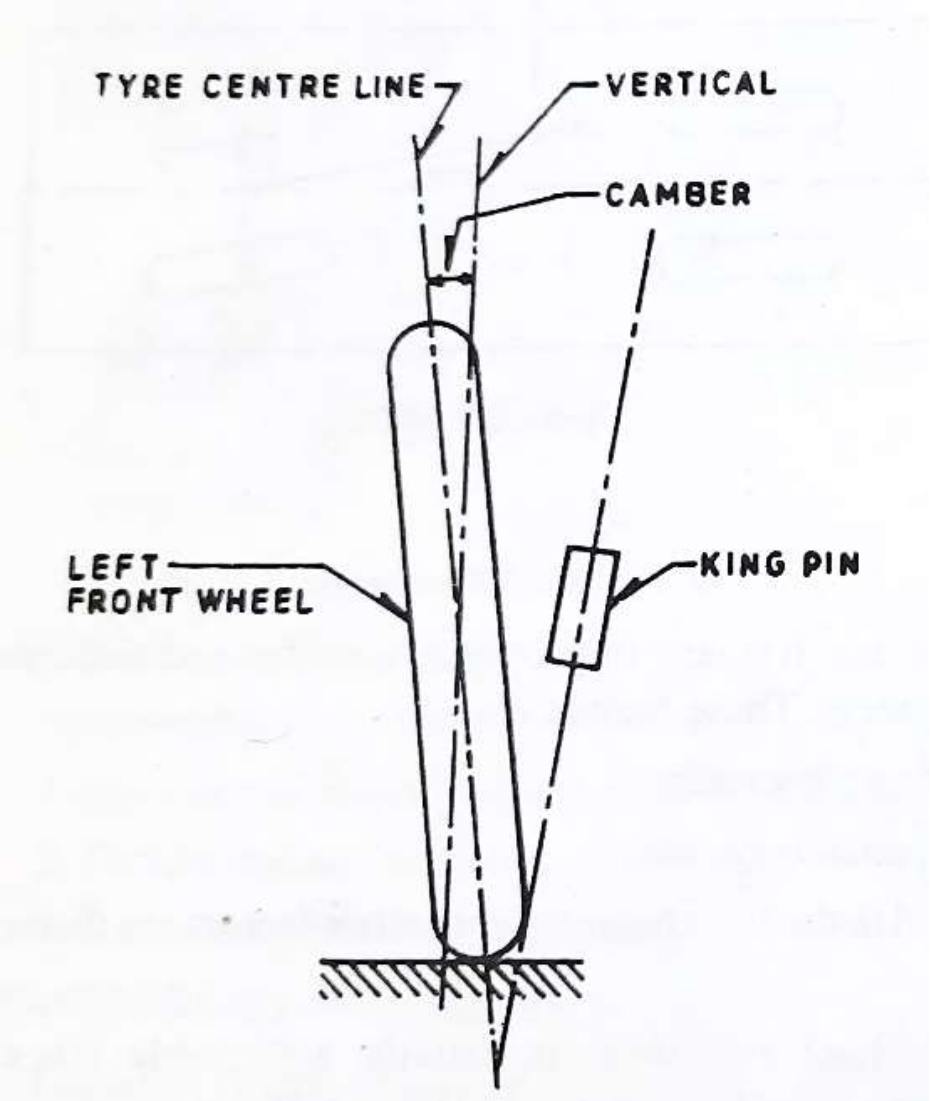
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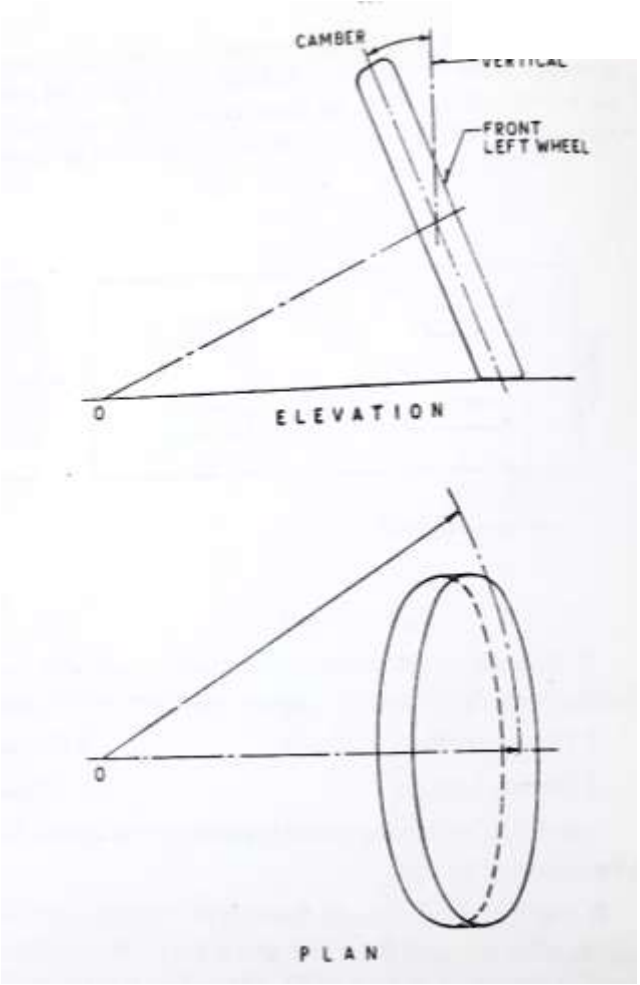
- Balancing of Wheel
- Inflation of tyre
- Brake Adjustment
- Set Back
- Thrust Angle



Steering Geometry

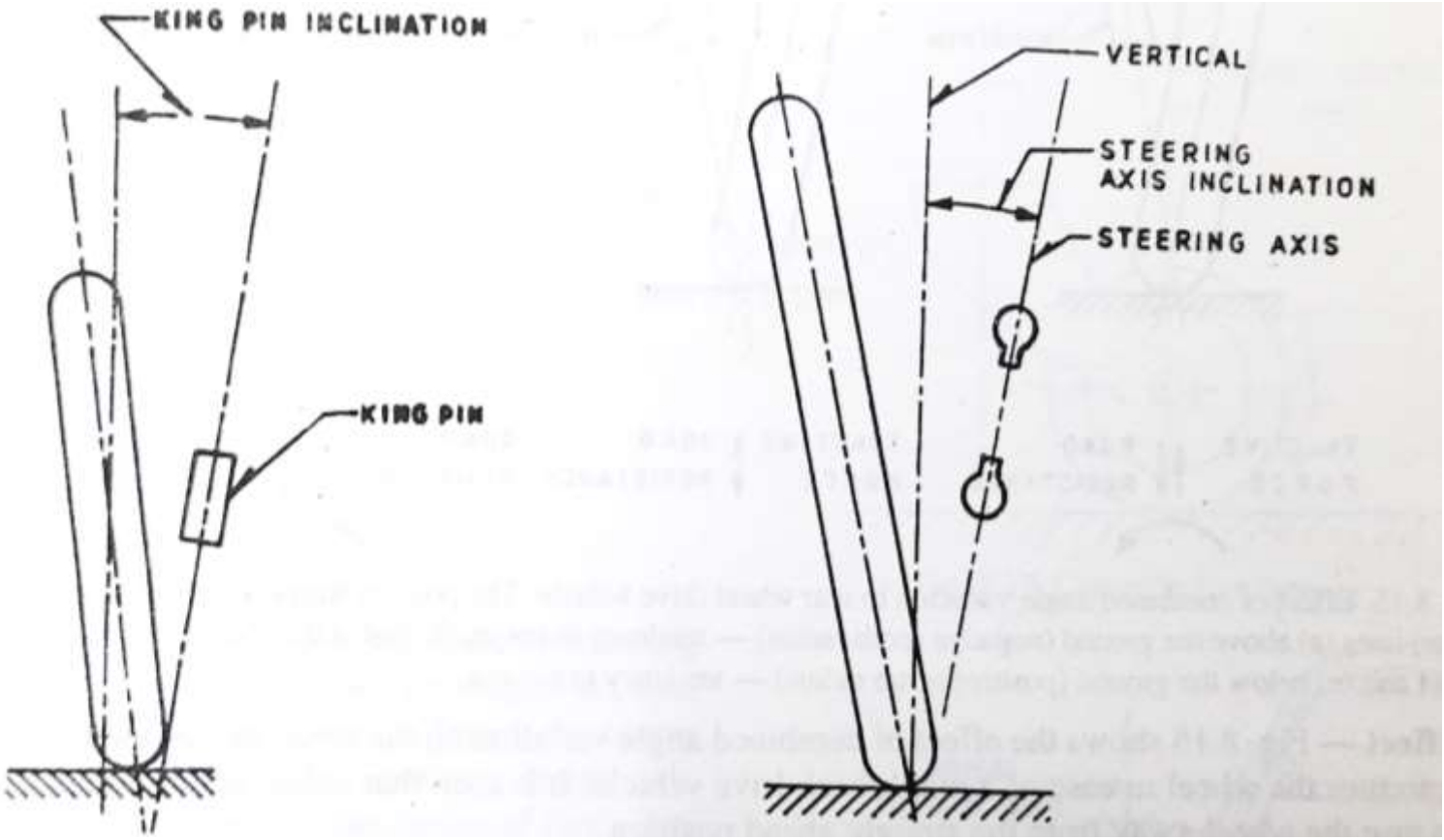
- Camber
- Castor
- Combine Angle & Scrub Radius
- Toe in or Toe out





Steering Geometry (Kingpin Inclination)

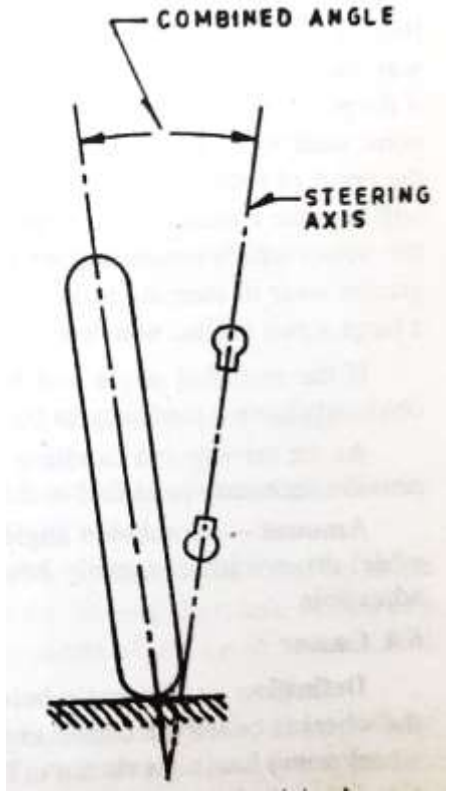
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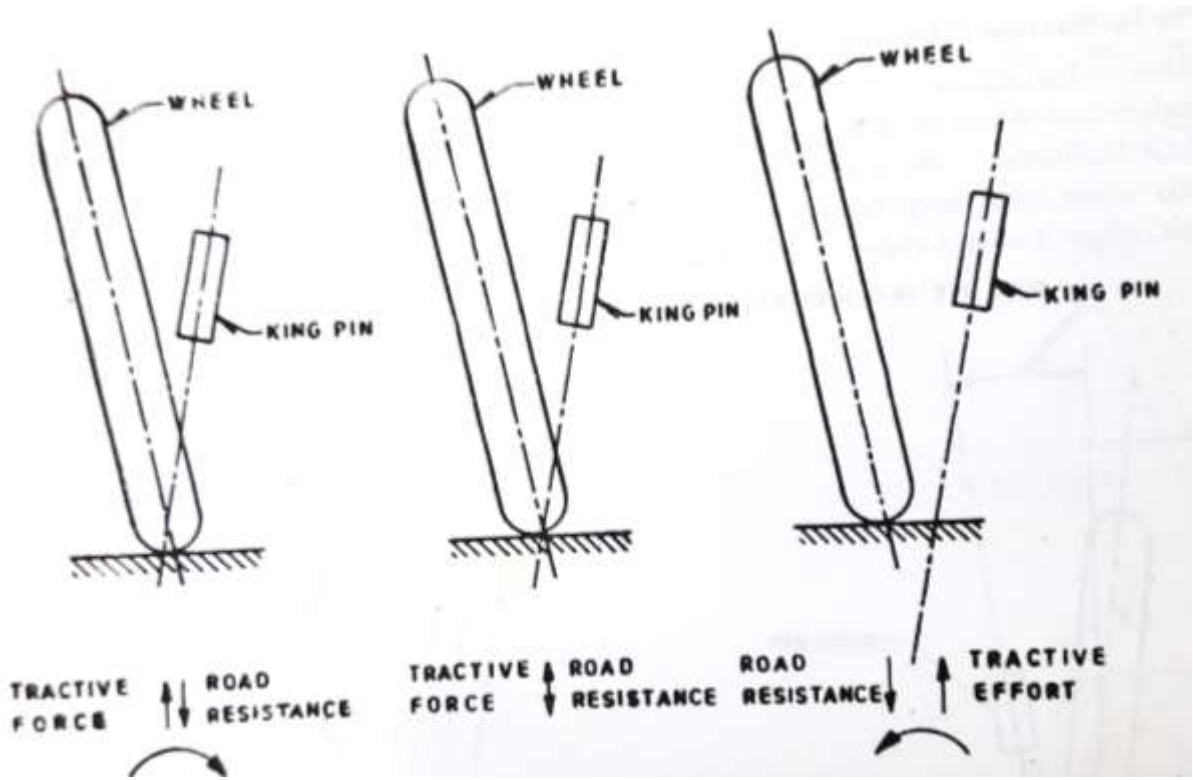


Steering Geometry

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Combine angle and Scrub Radius

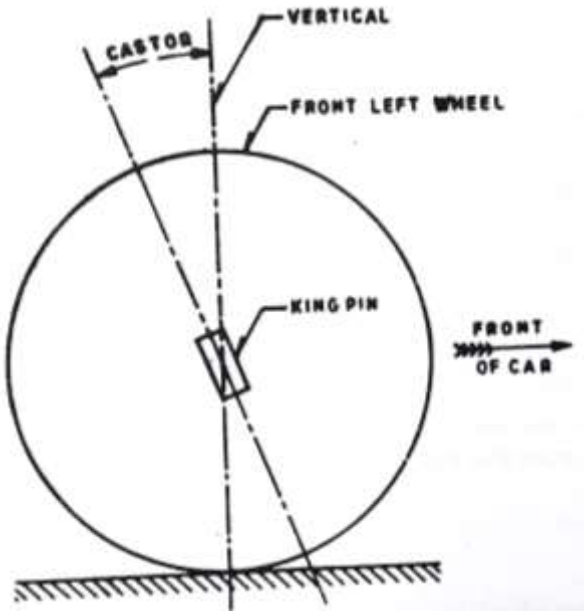


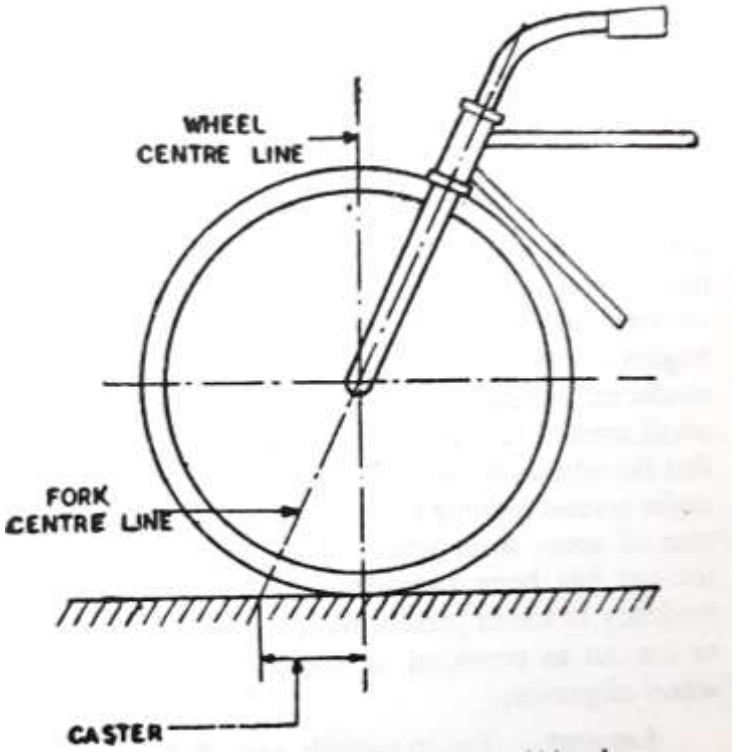


Steering Geometry

raisoni EDUCATION

Castor

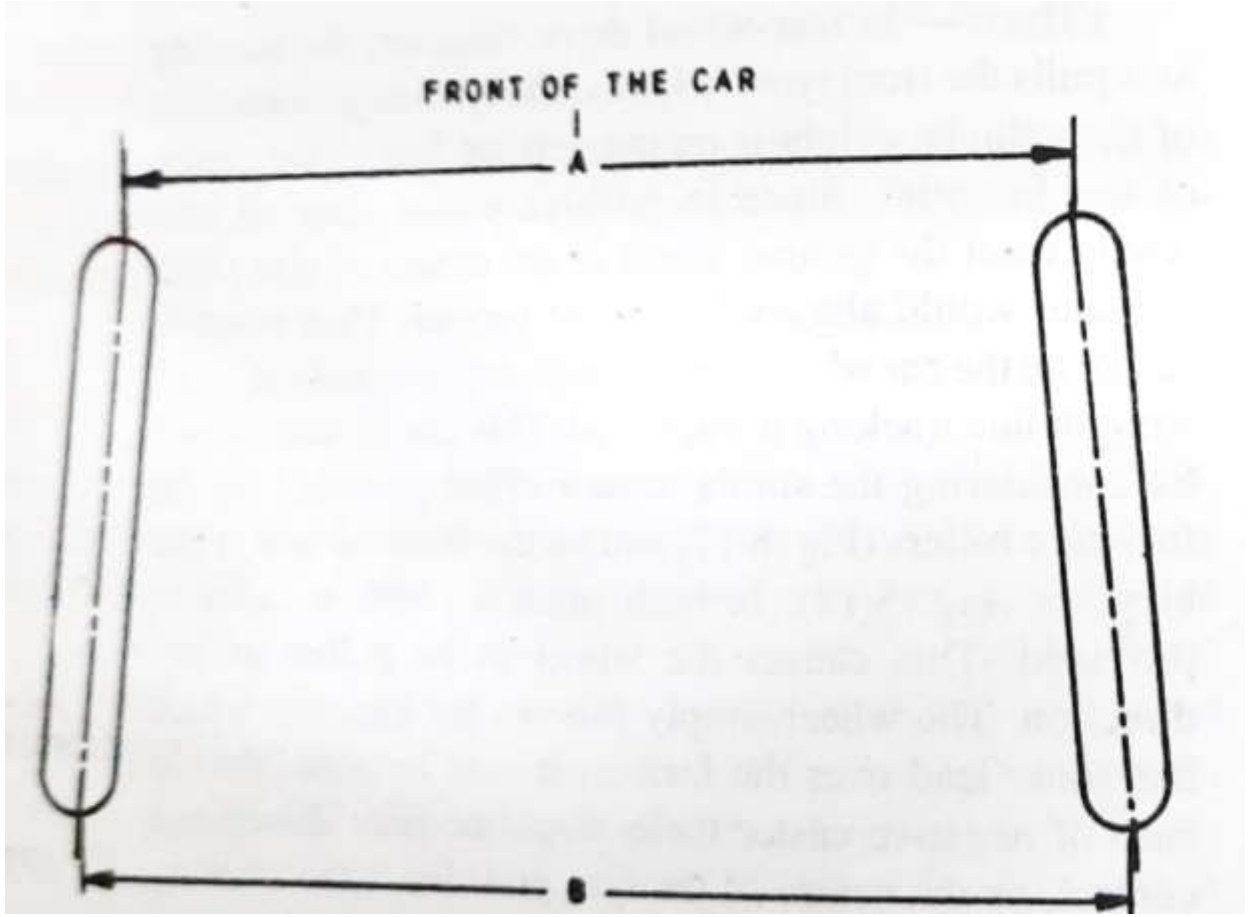




Steering Geometry

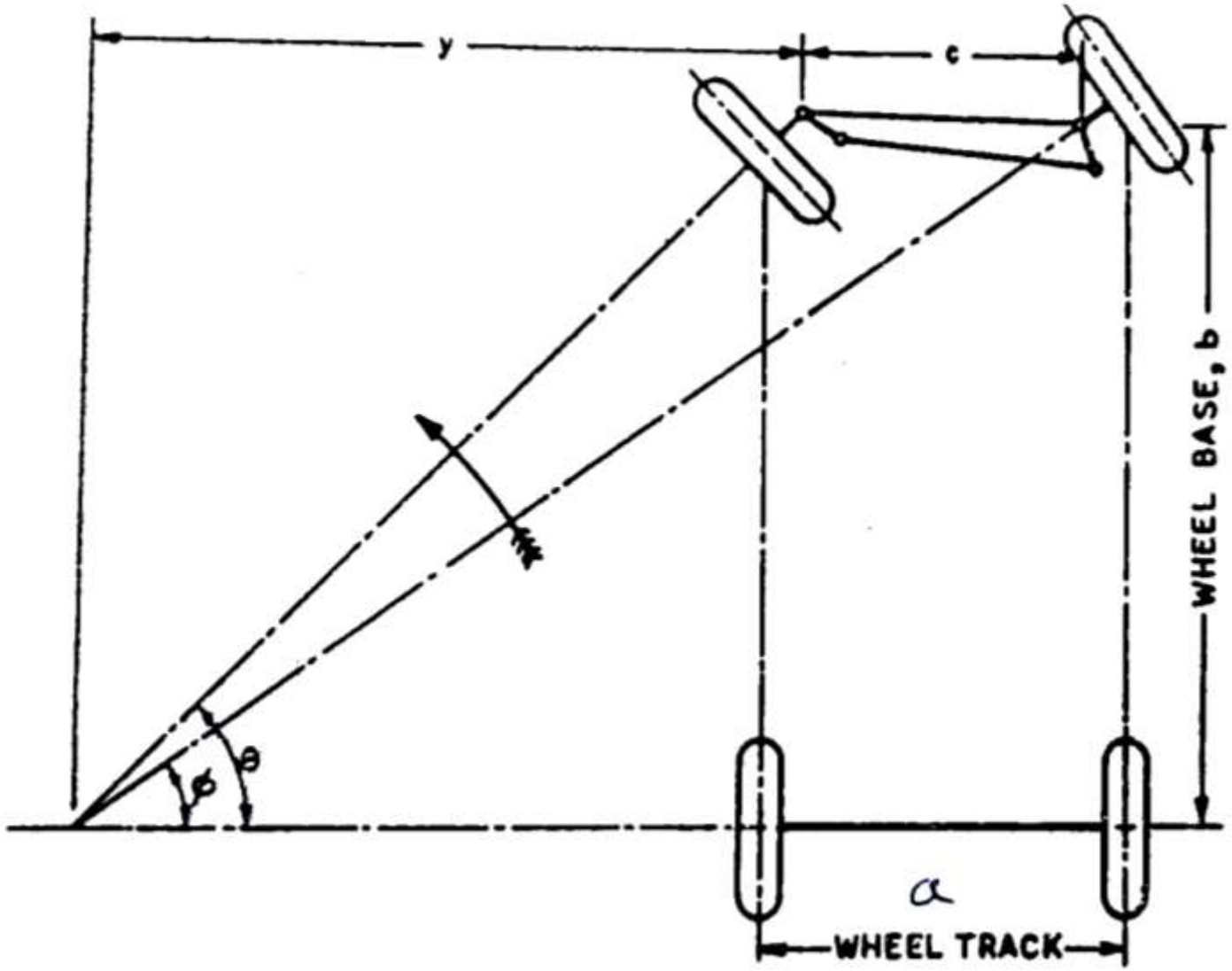
raisoni
EDUCATION

Toe in



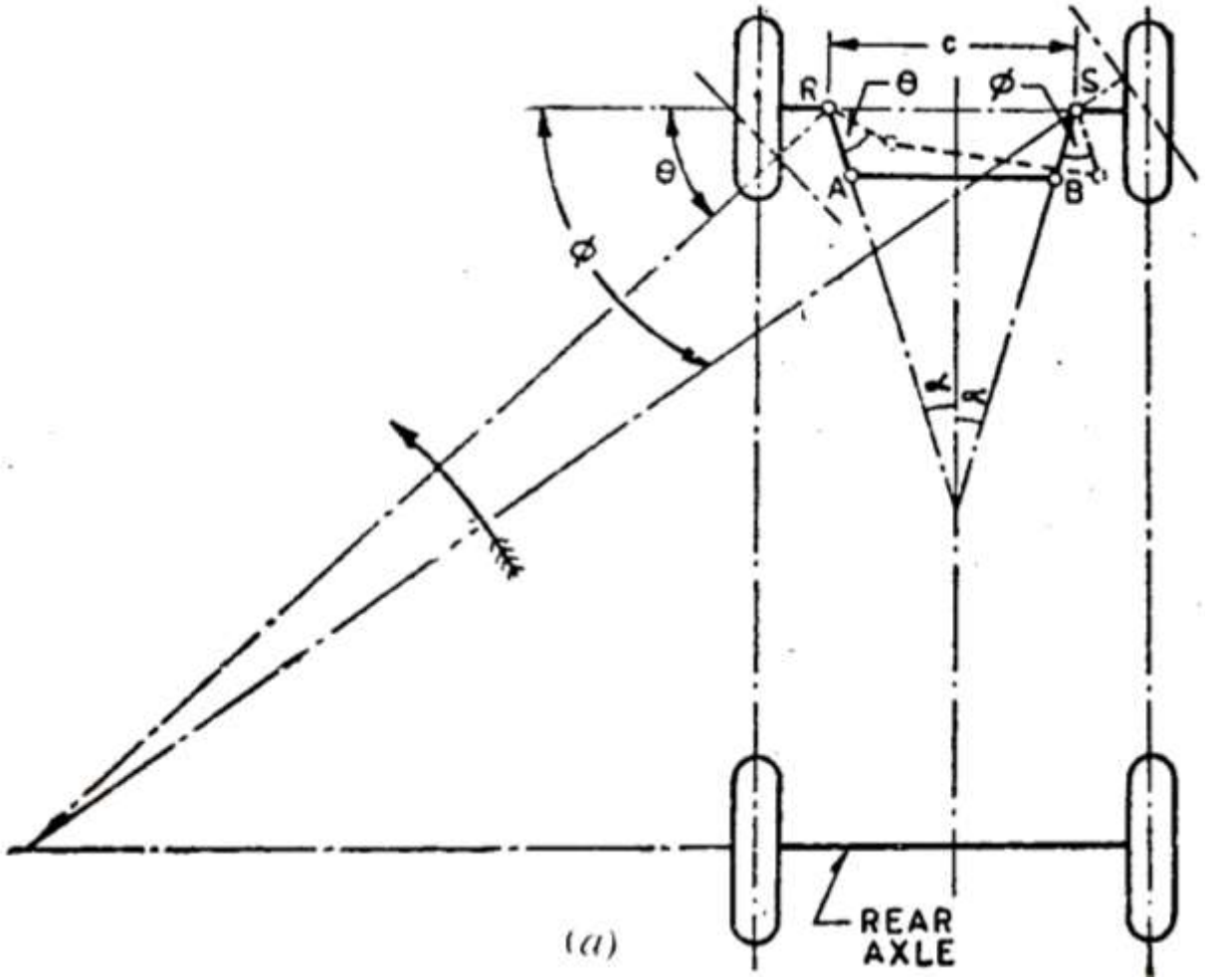
Correct Steering Angles

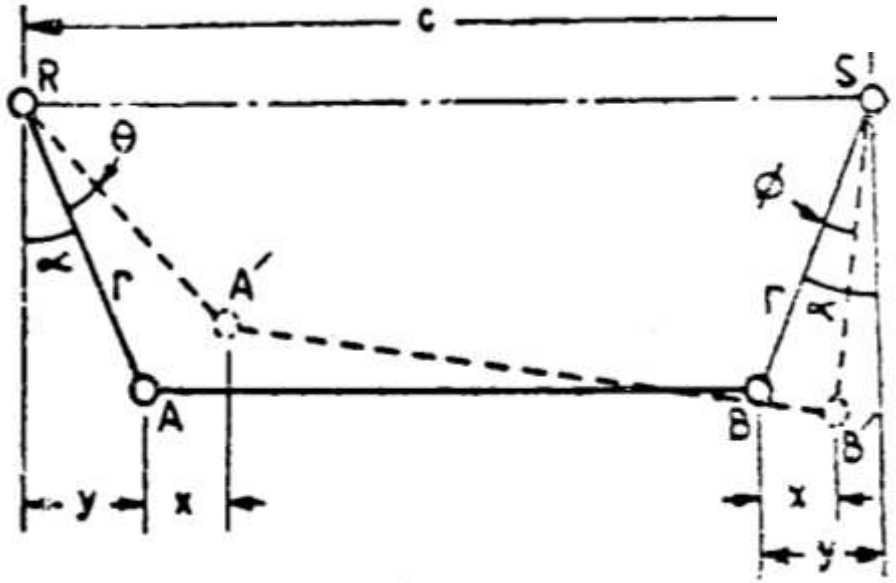
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Ackermann Steering Mechanism

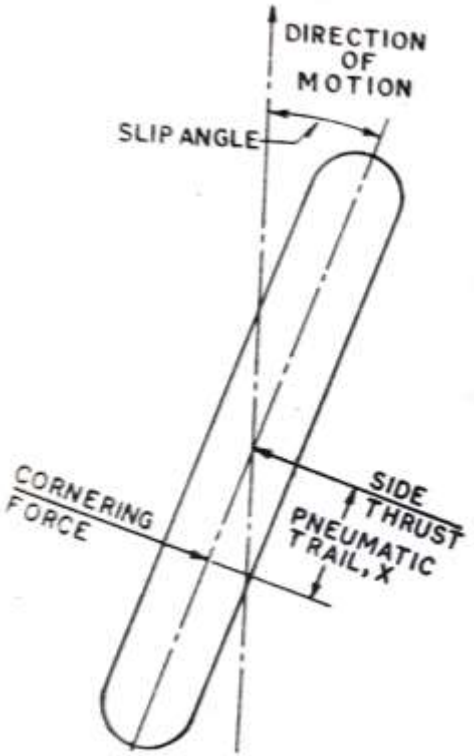
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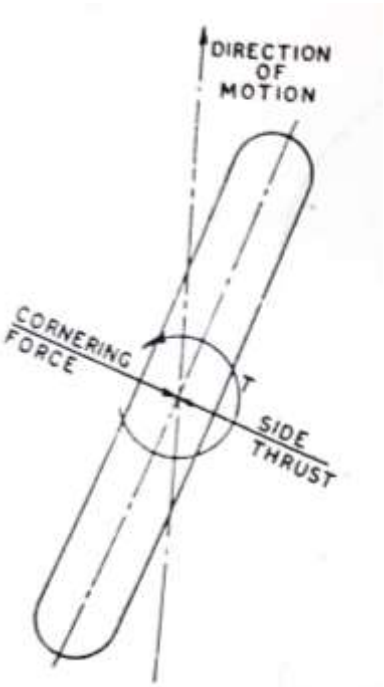


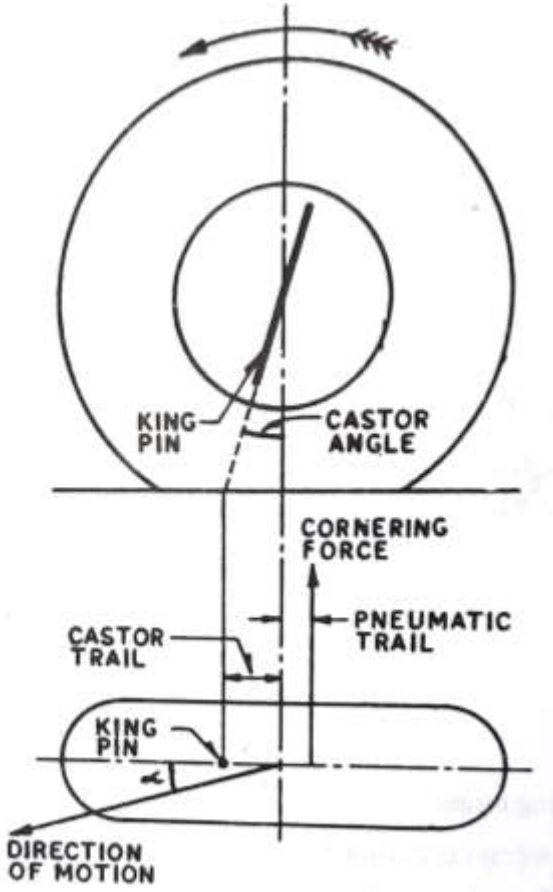


Cornering Force & Self Righting Torque

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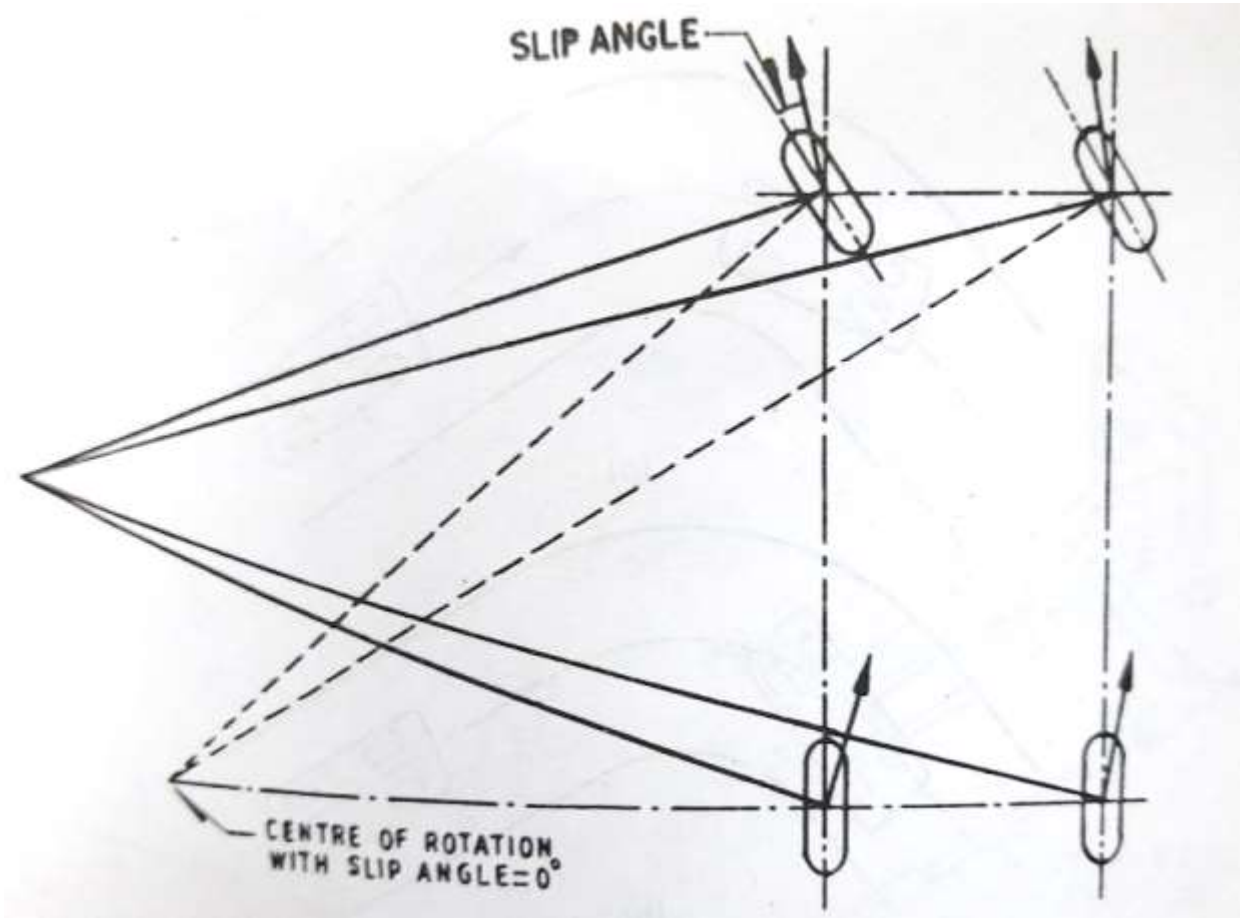


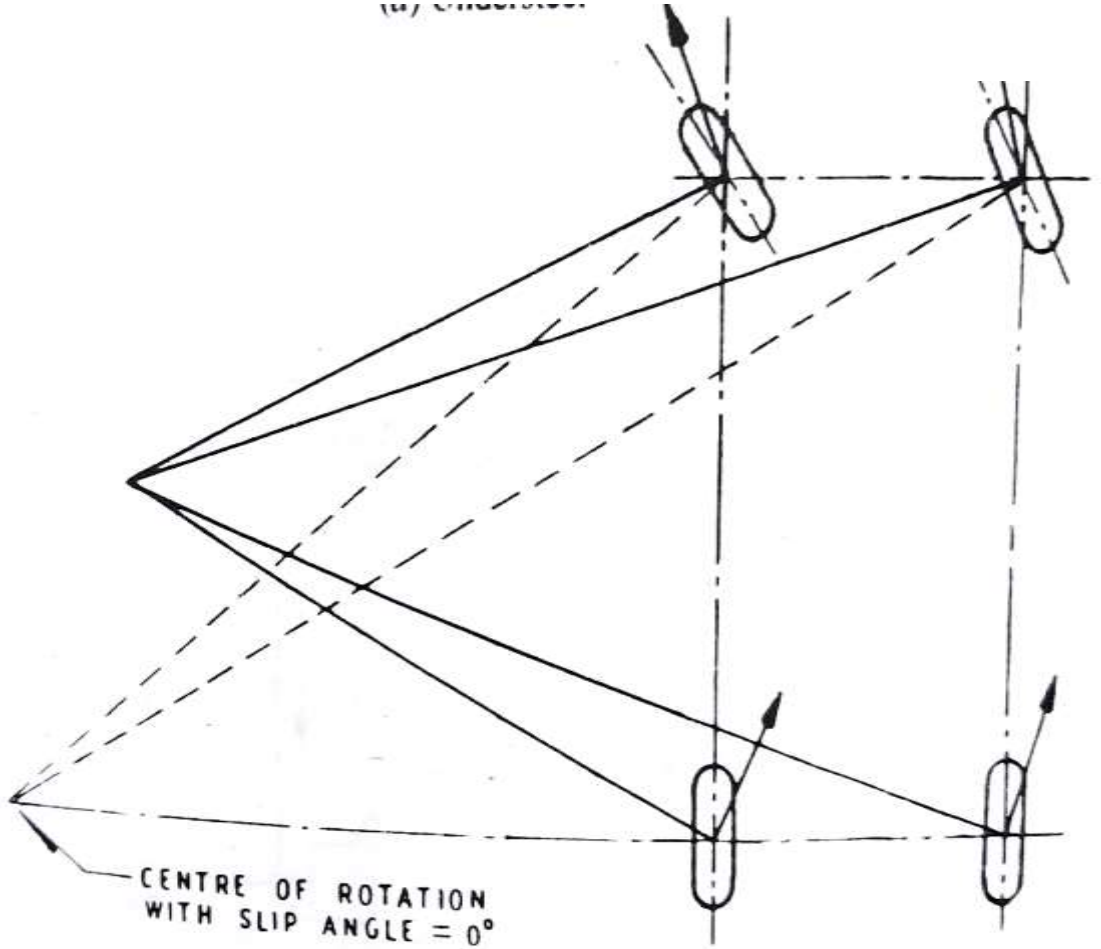




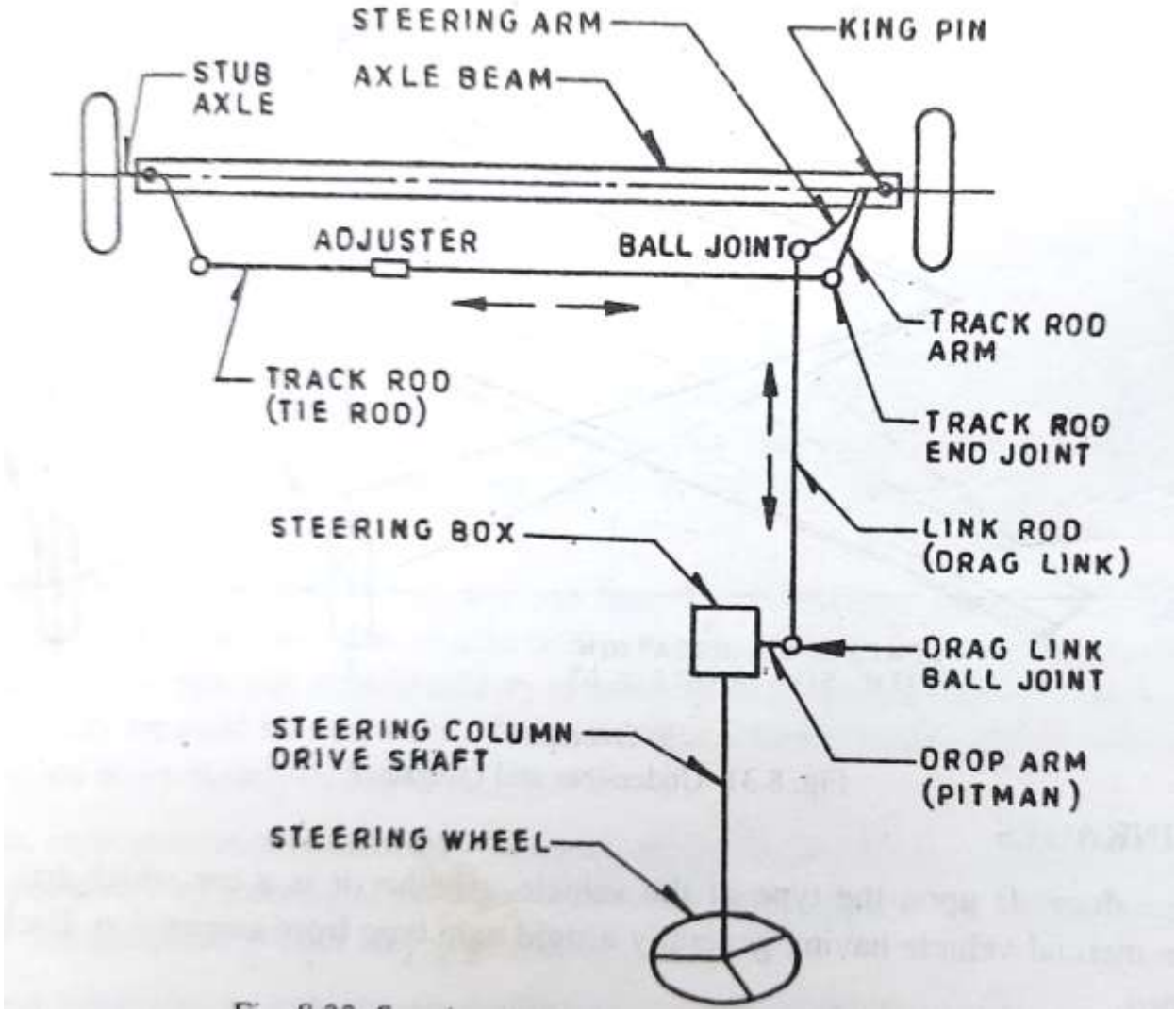
Under Steer & Over Steer

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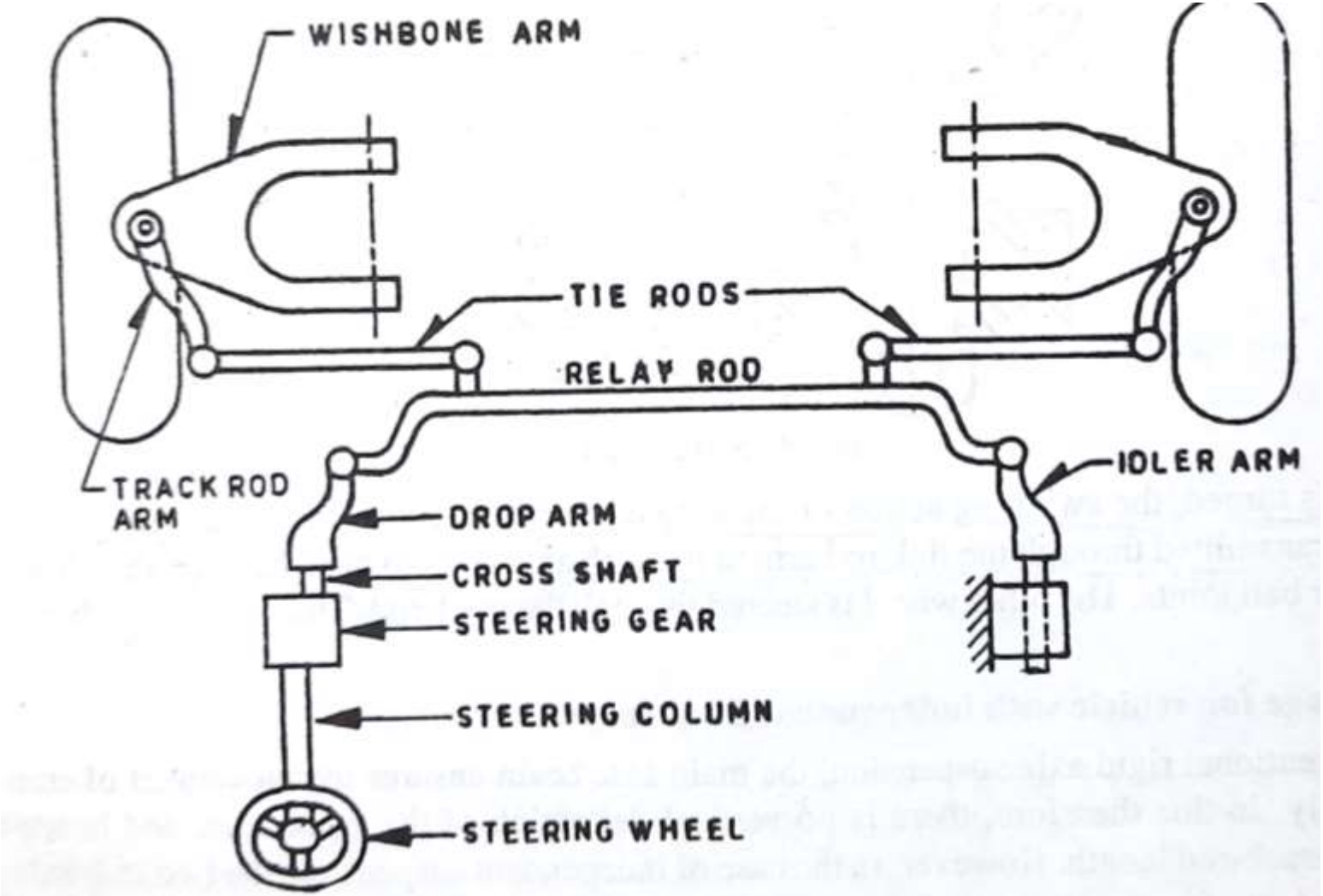


Steering linkage (Rigid axle)

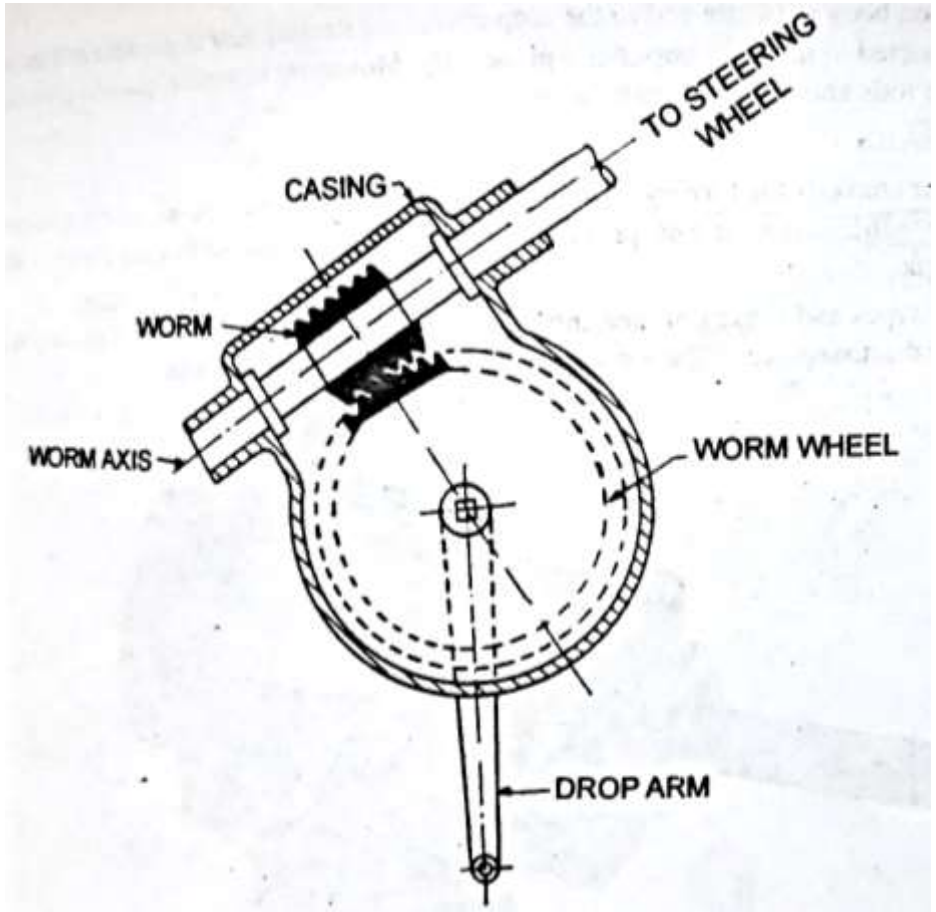


Steering linkage (independent suspension)

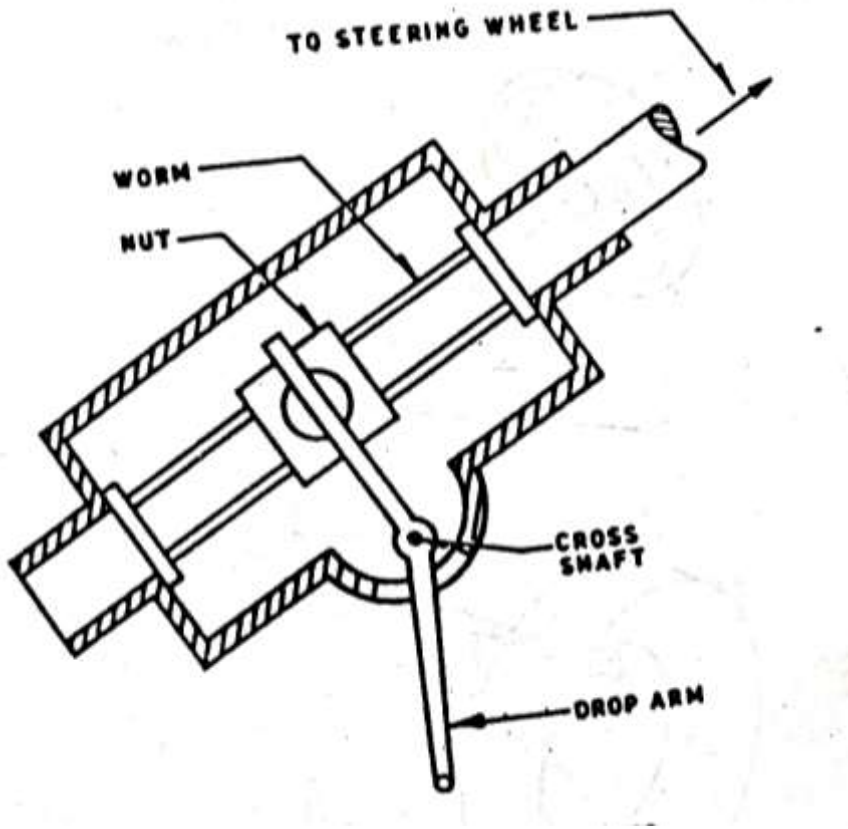
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Steering Gear



Worm & Wheel Steering gear

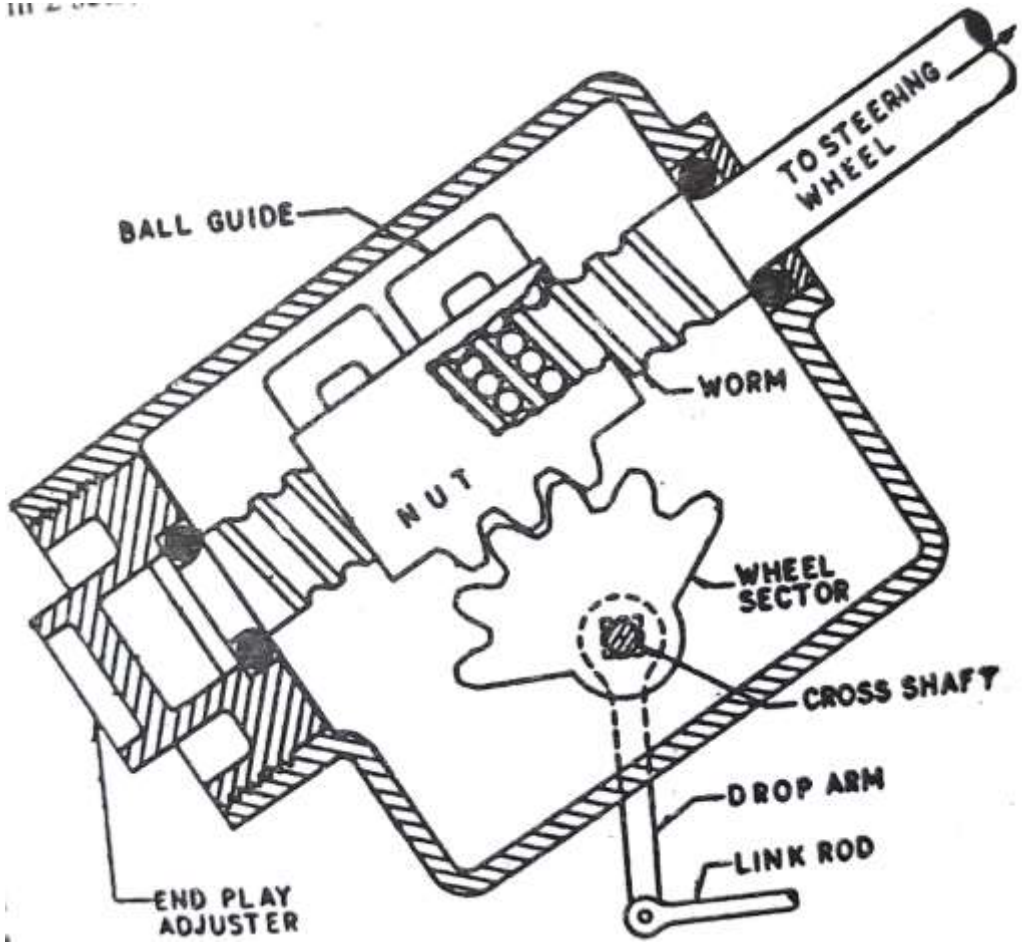


Worm & nut steering gear

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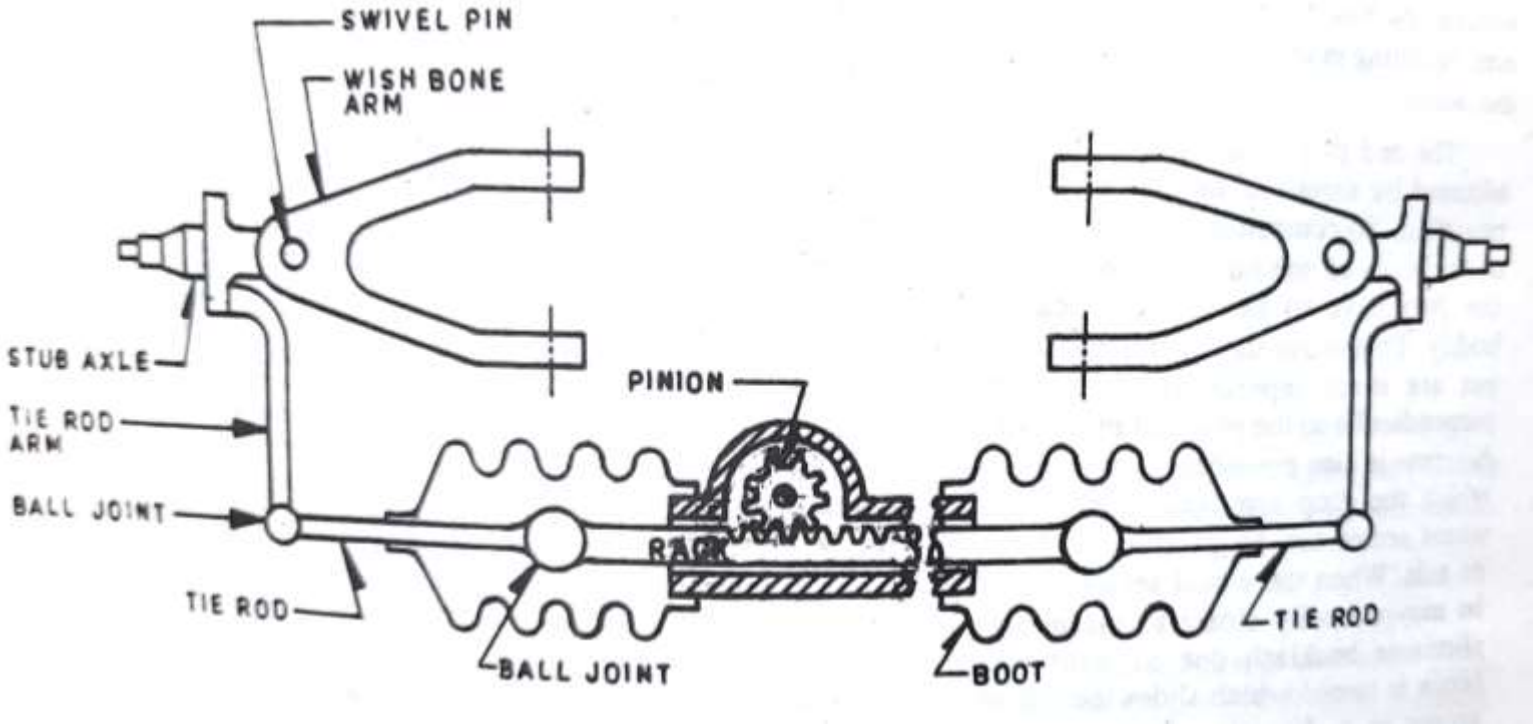
Recirculating Ball type Steering Gear

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Rack and Pinion Steering Gear

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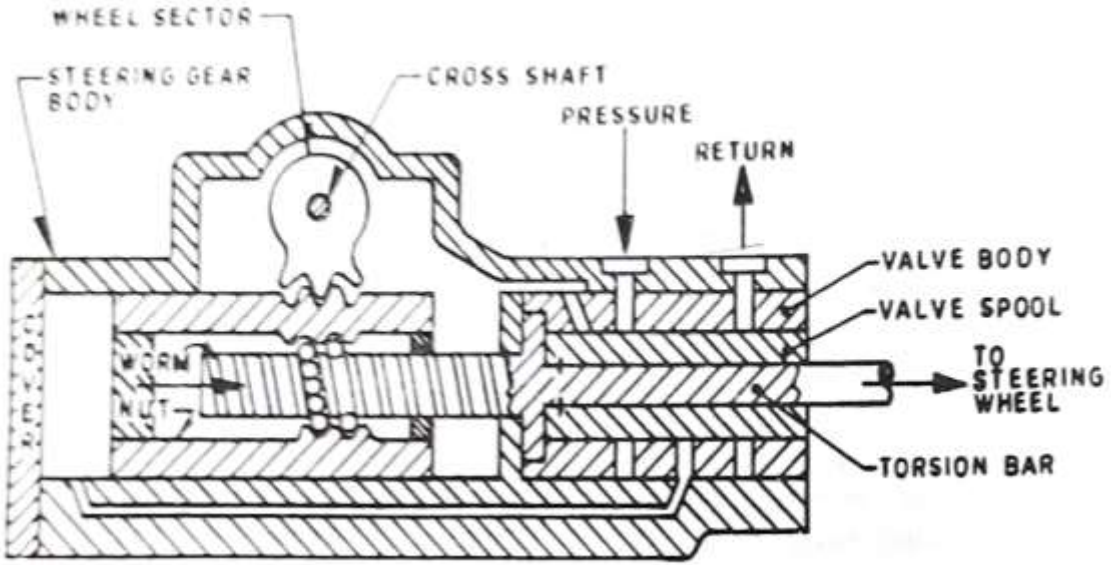
Steering Columns

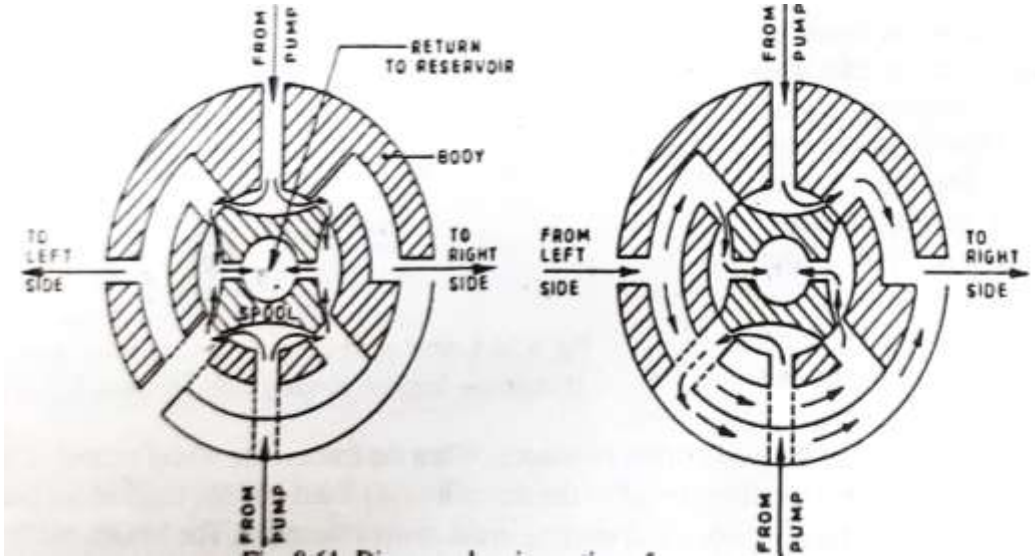
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- Steering Ratio
- Reversibility
  - Advantages
  - Disadvantage
- Special Steering Columns
  - Energy Absorbing
  - Tilt Wheel
  - Tilt and Telescopic
  - Anti – theft lock

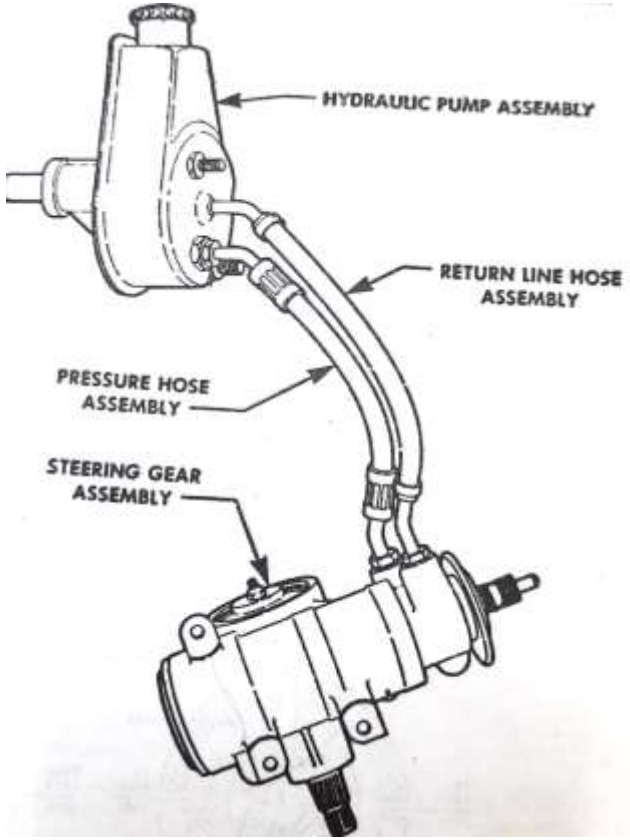
Power Steering

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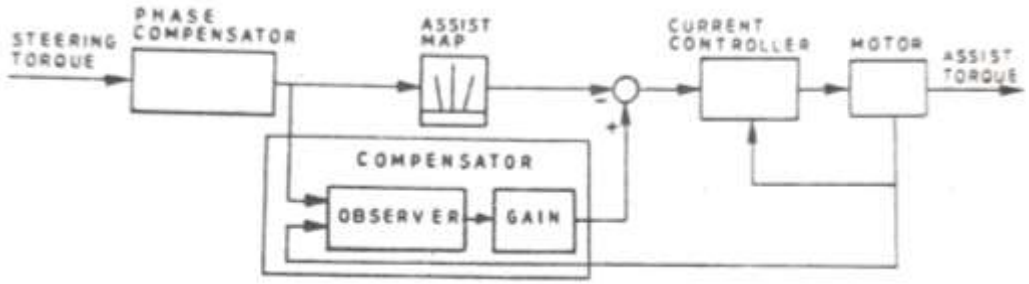


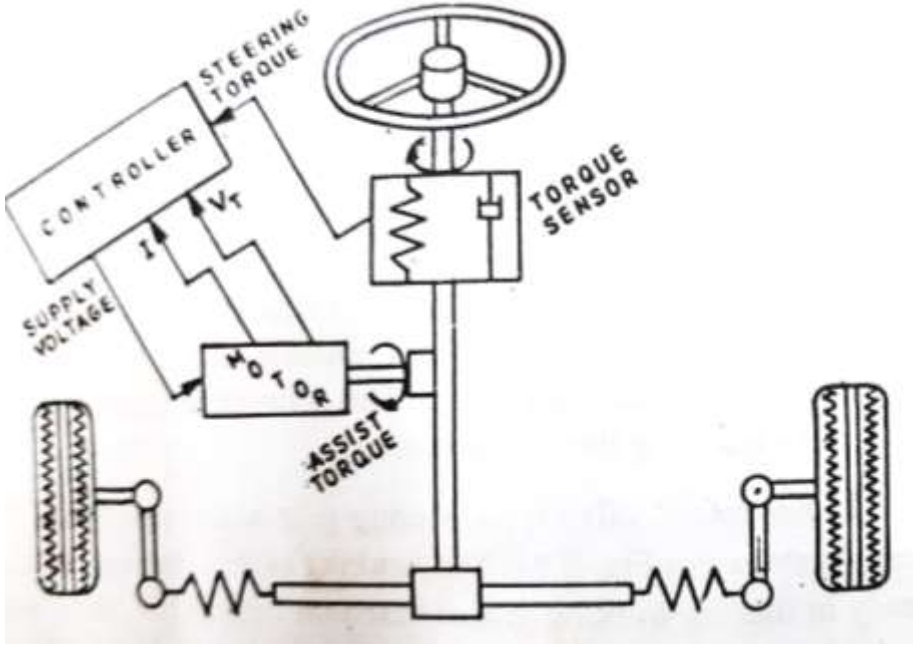
- Advantage
- Construction
- Working



Electronic Steering

- Advantage
- Construction
- Working





Suspension System

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- Objectives of Suspension
  - To prevent the road shocks from being transmitted to the vehicle components
  - To safeguard the occupants from road shocks
  - To preserve the stability of the vehicle in pitching, rolling while in motion
- Basic Considerations
  - Vertical Loading
  - Rolling
  - Brake Dip
  - Side Thrust
  - Unsprung Weight
- Function of Suspension

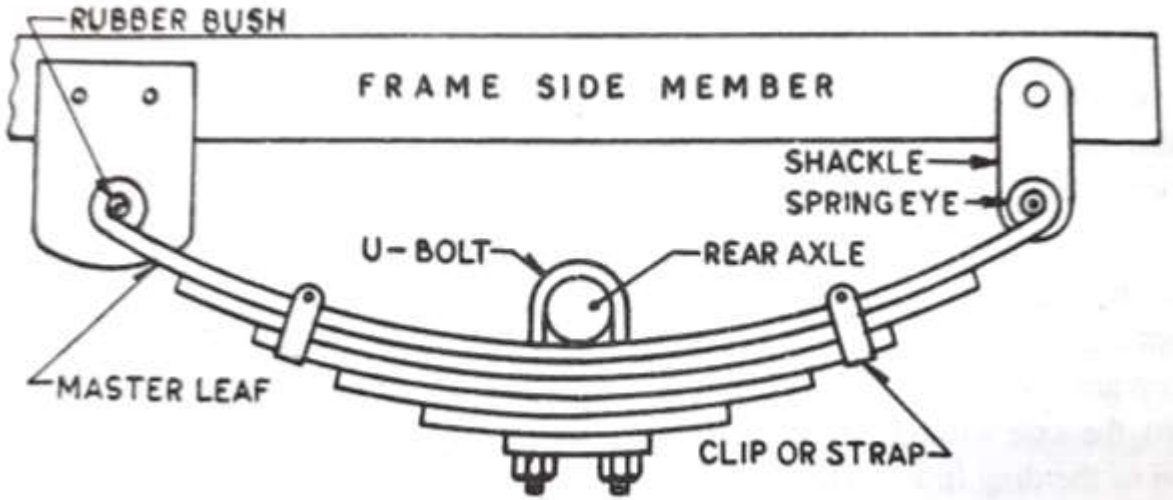
Types of Suspension Spring

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- Steel Spring
  - Leaf Spring
  - Tapered Leaf Spring
  - Coil Spring
  - Torsion Bar
- Plastic Spring
- Air Spring
- Hydraulic Spring
- Rubber Spring
  - Compression Spring
  - Compression shear Spring
  - Steel reinforced spring
  - Progressive spring
  - Torsional Shear Spring

Leaf Spring

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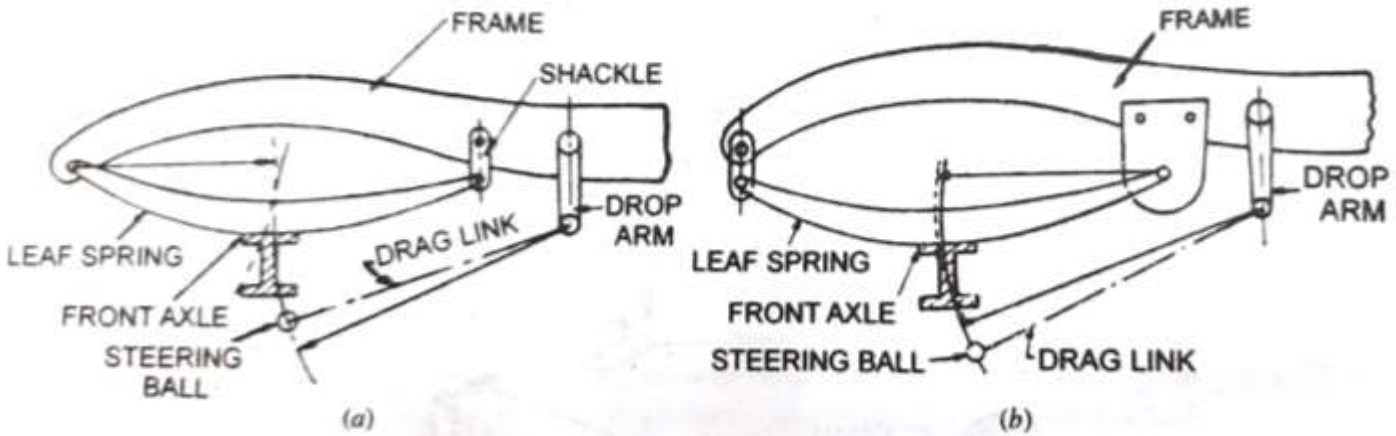
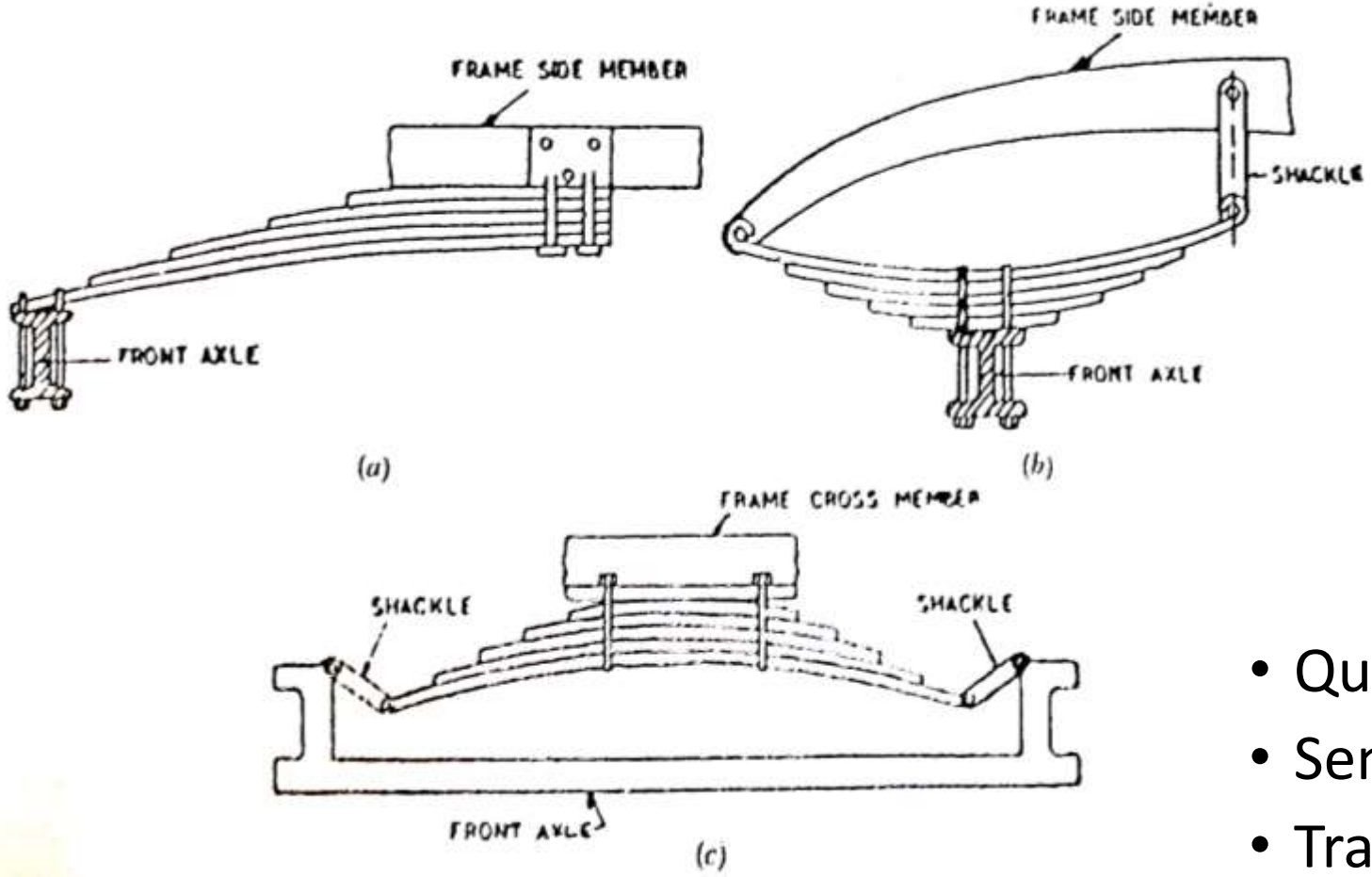


Fig. 7.4. Shackle positioning (*a*) Shackle at the rear end, (*b*) Shackle at the front end.

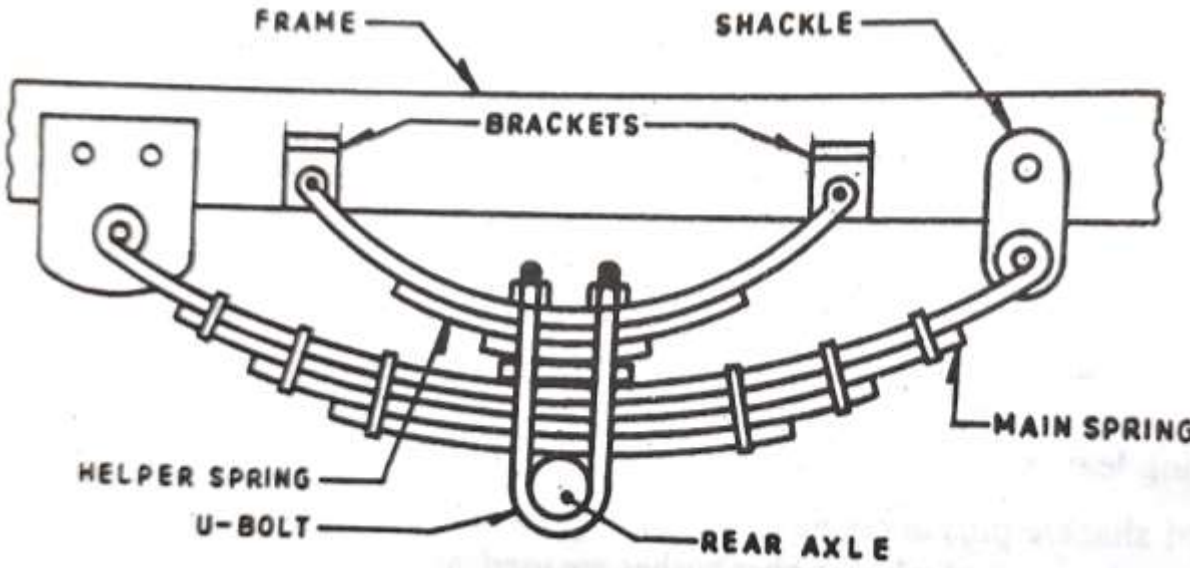
Types of leaf spring

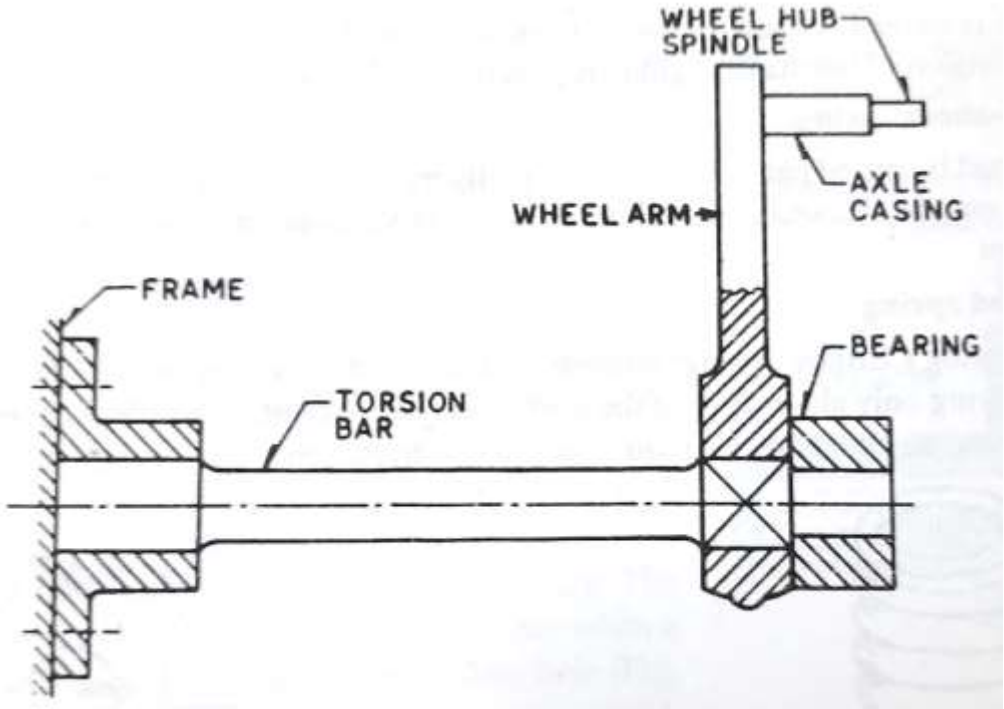


- Quarter leaf spring (a)
- Semi Elliptic (b)
- Transverse (c)

Helper Spring & Torsion Bar

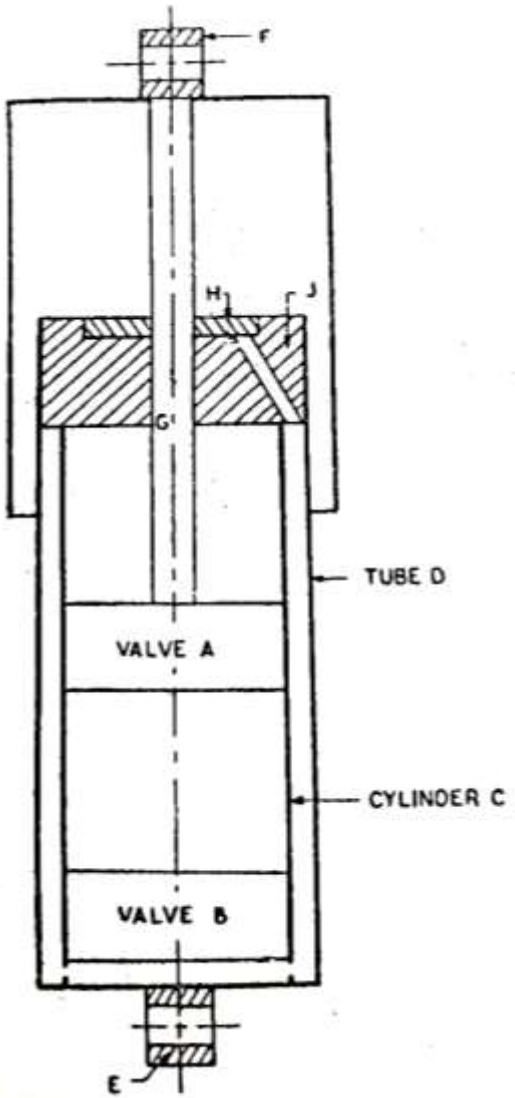
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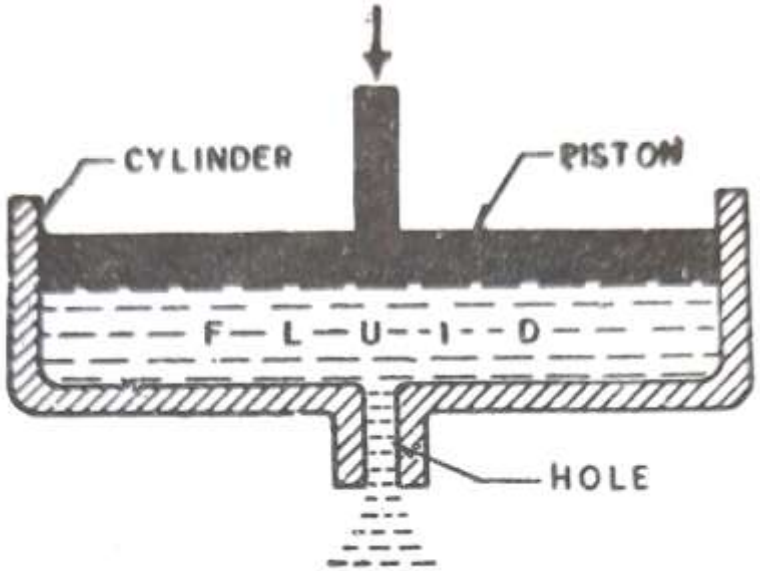




L-28

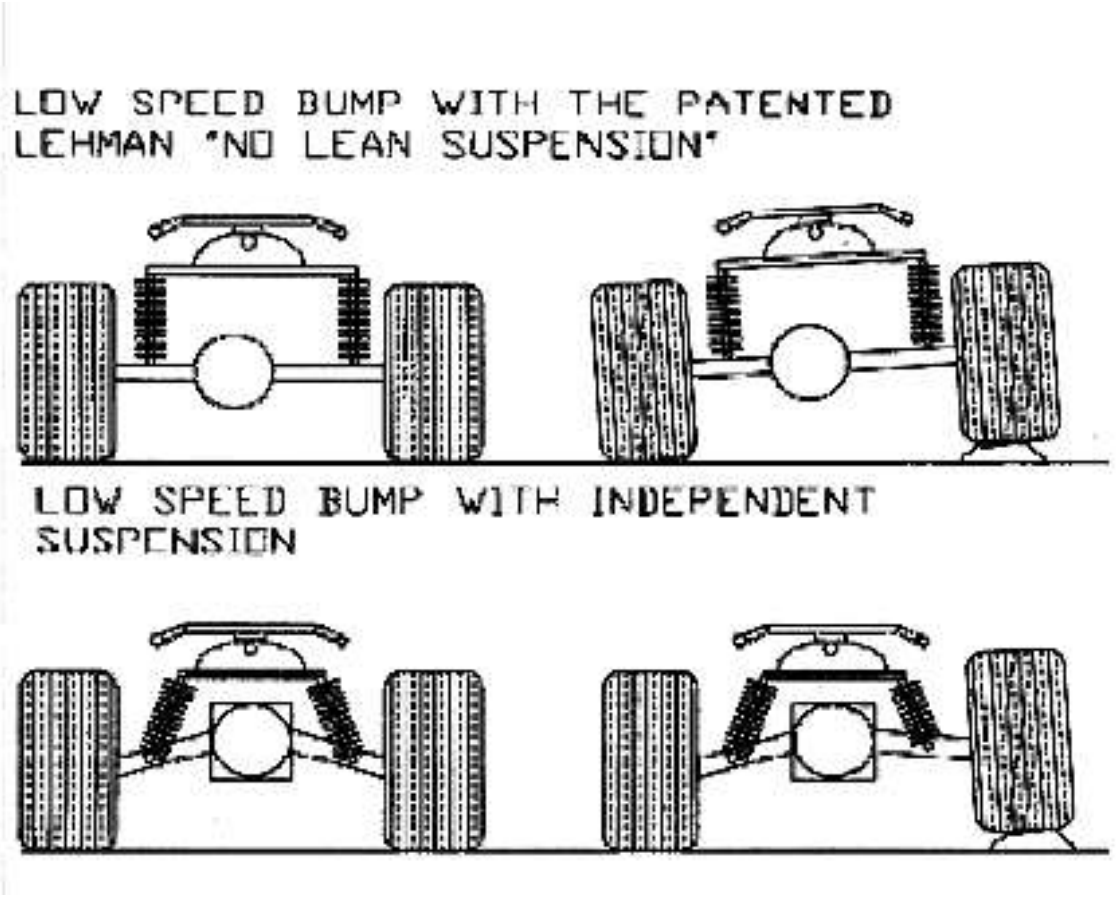
Shock Absorber





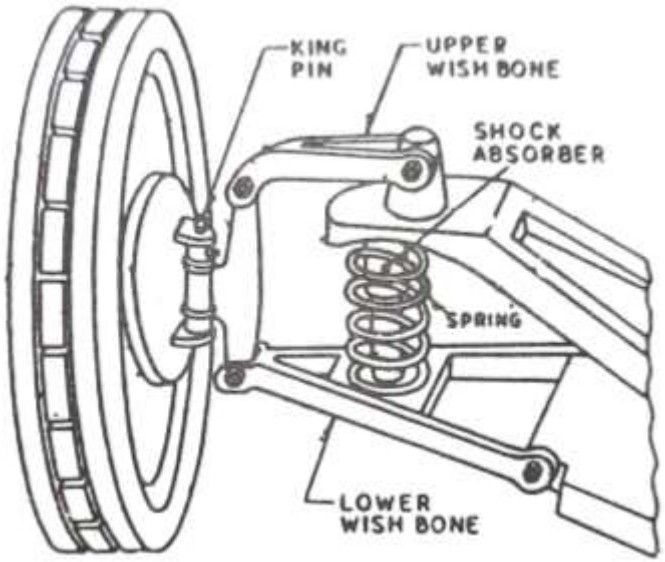
Independent Suspension System

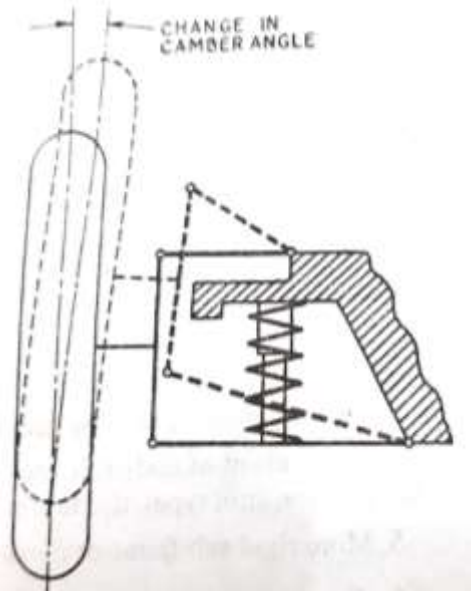
- Advantages
- Front Wheel Independent suspension
  - Wishbone
  - Mac Pherson strut type
  - Vertical Guide
  - Trailing Link
  - Swinging half axle
- Rear Wheel independent suspension

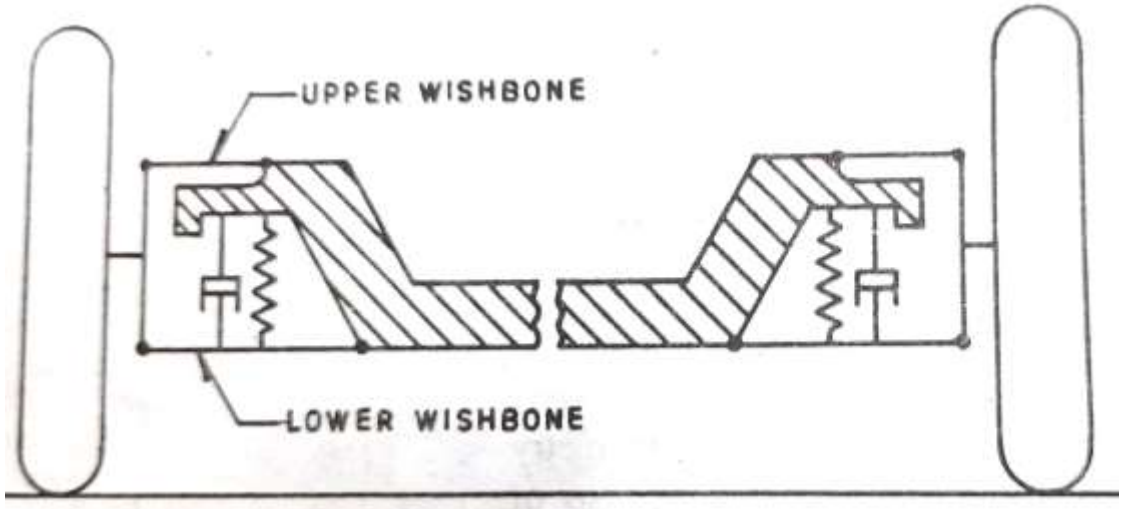


Wishbone

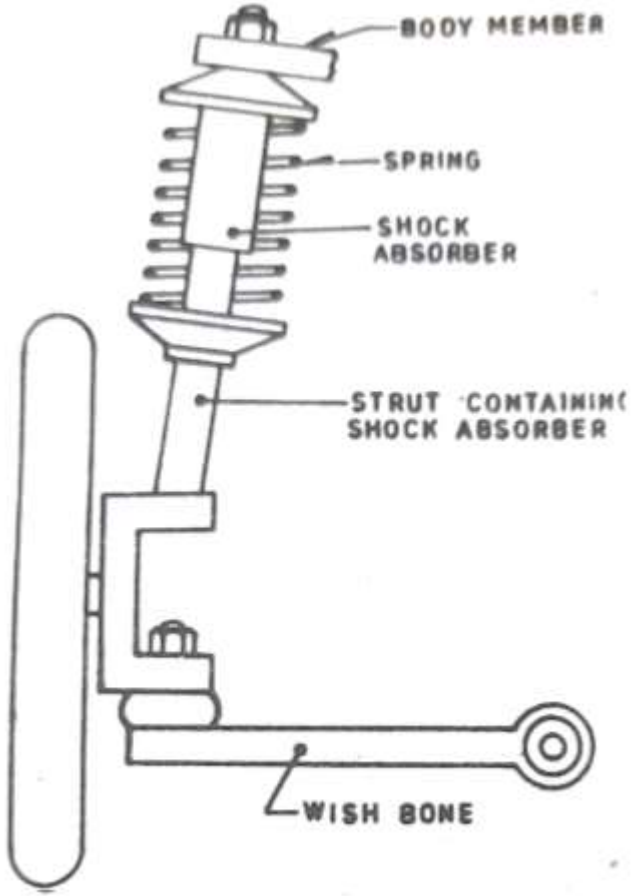
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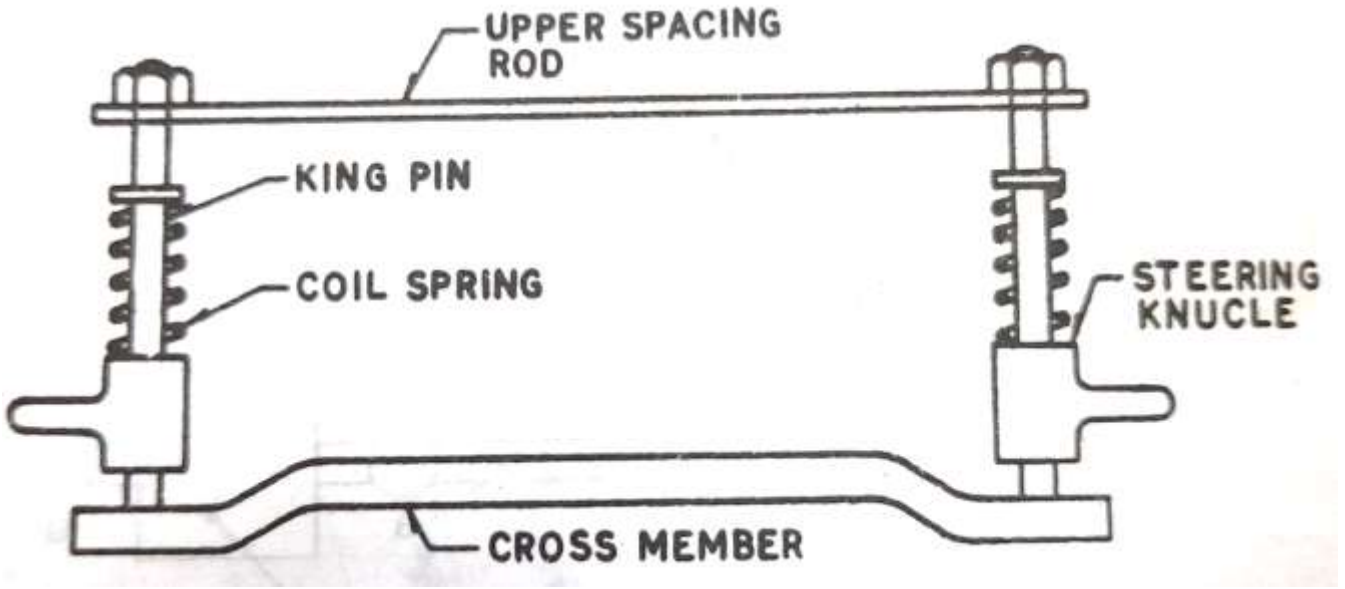




Mac Pherson Strut and Vertical Guide

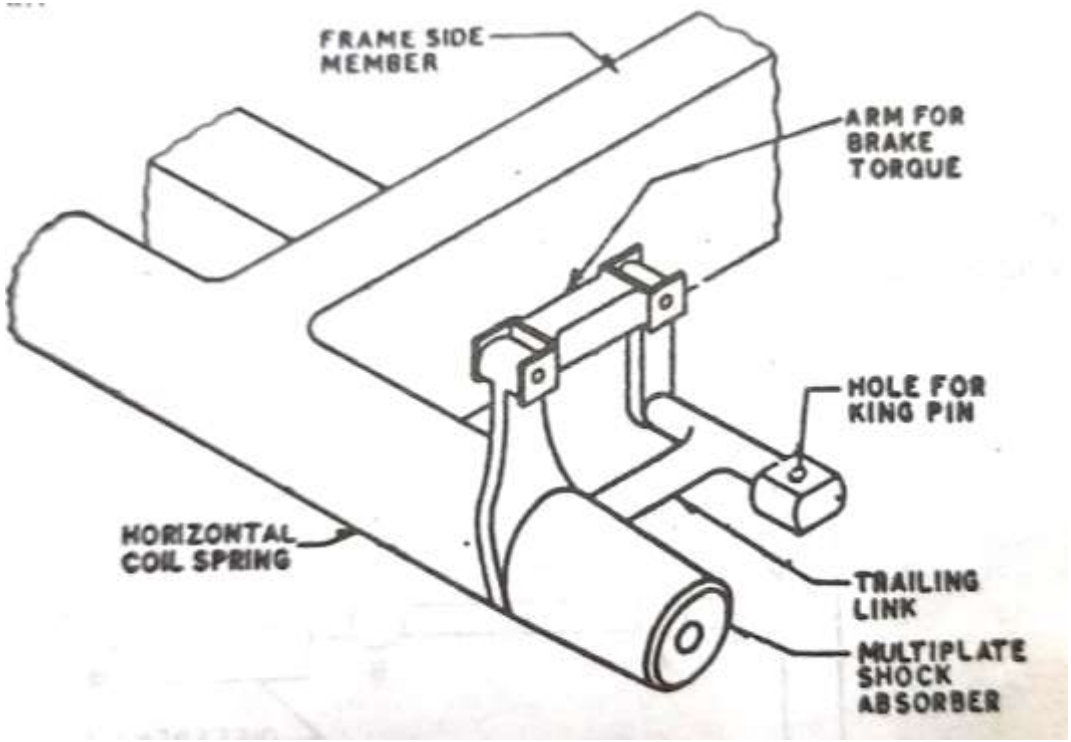


Mac Pherson

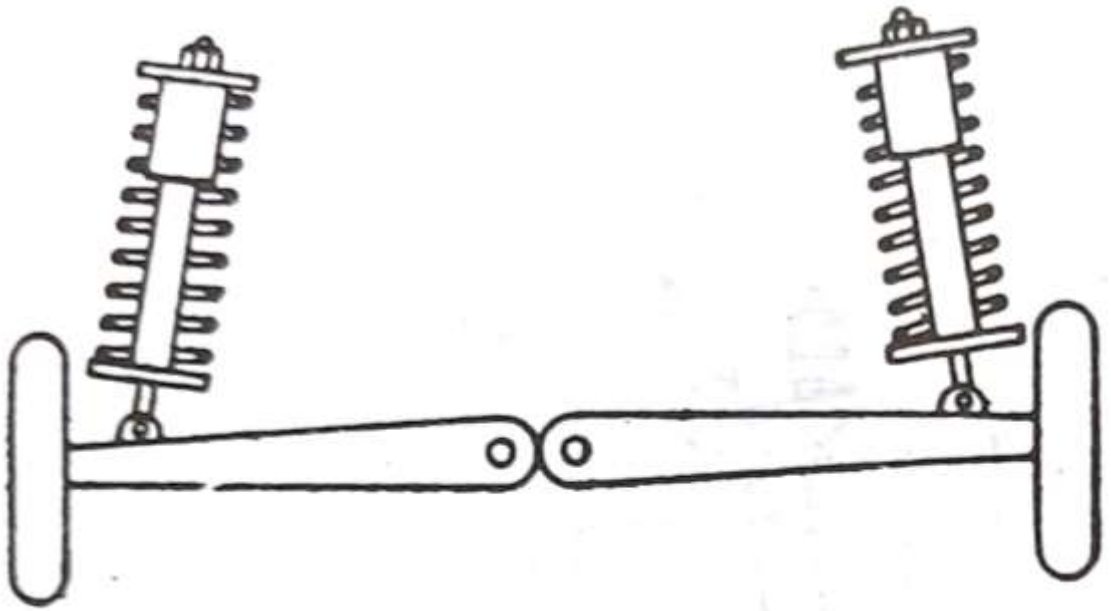


Vertical Guide

Trailing Link & Swinging half axle



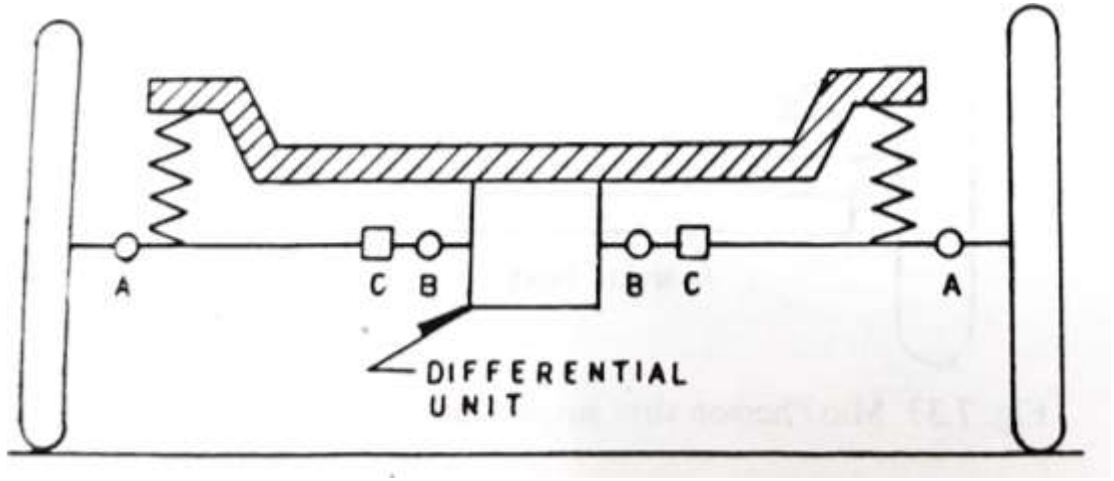
Trailing Link

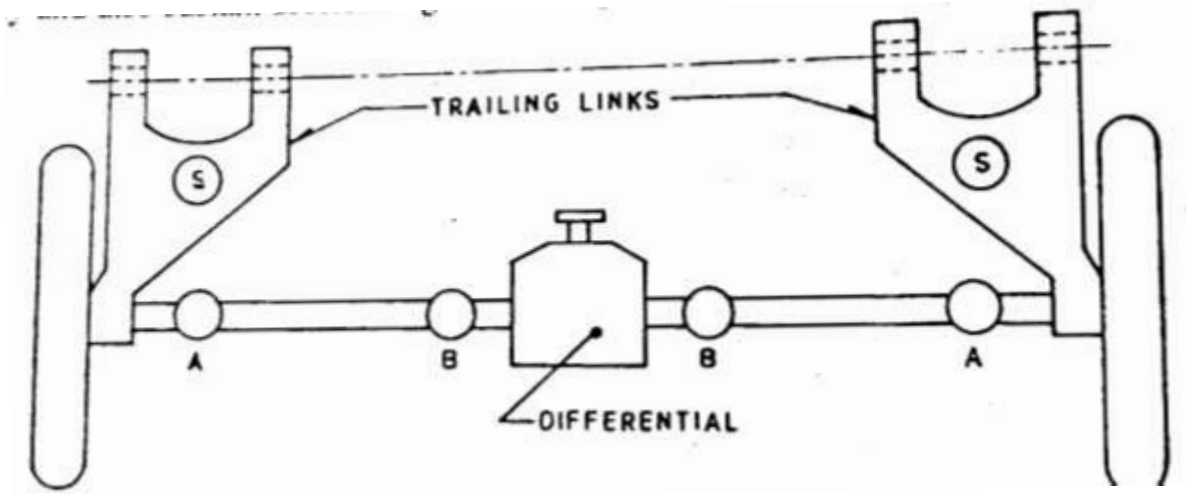


Swinging half axle

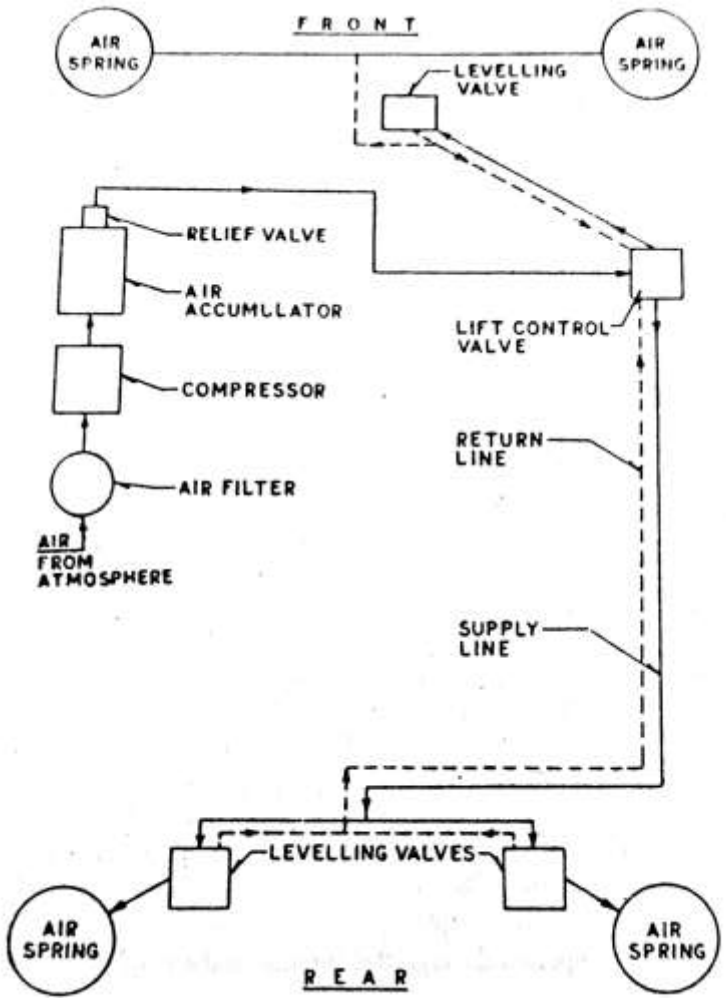
Rear Wheel (live axle)

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Air Suspension



L-29

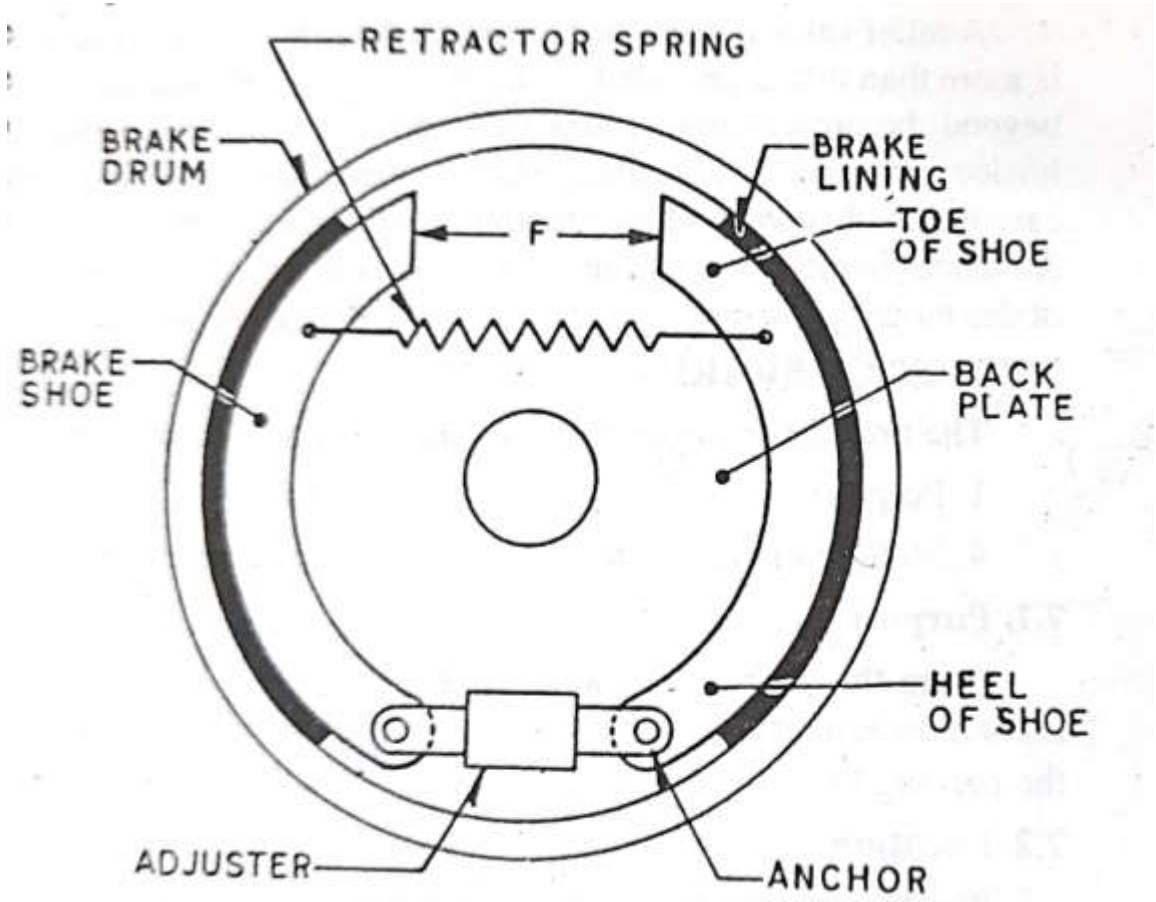
BRAKES

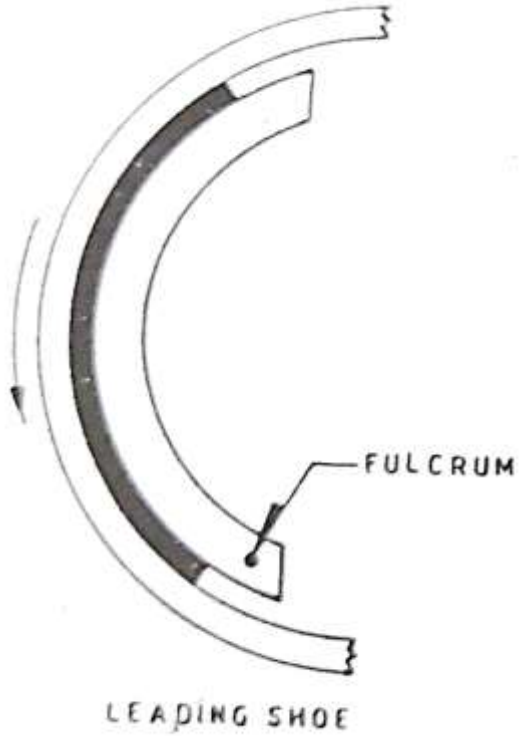
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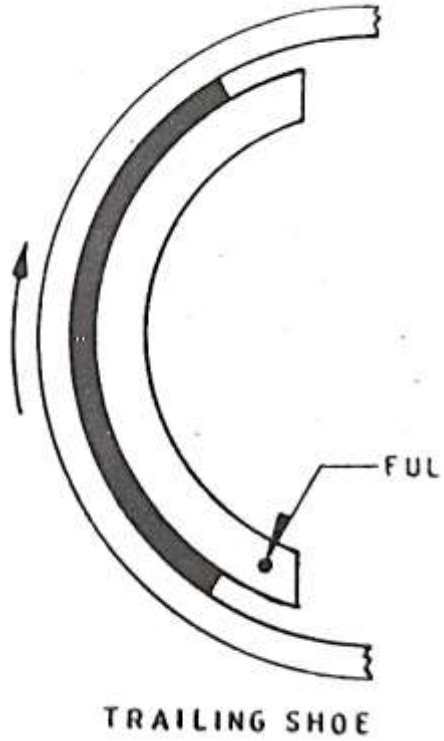
- Principle
- Brake Requirement
- Brake Efficiency & Stopping Distance
- Fading of Brakes
- Wheel Skidding
- Types of brakes
  - Purpose
  - Location
  - Construction
  - Method of actuation
  - Braking effort

Drum Brakes

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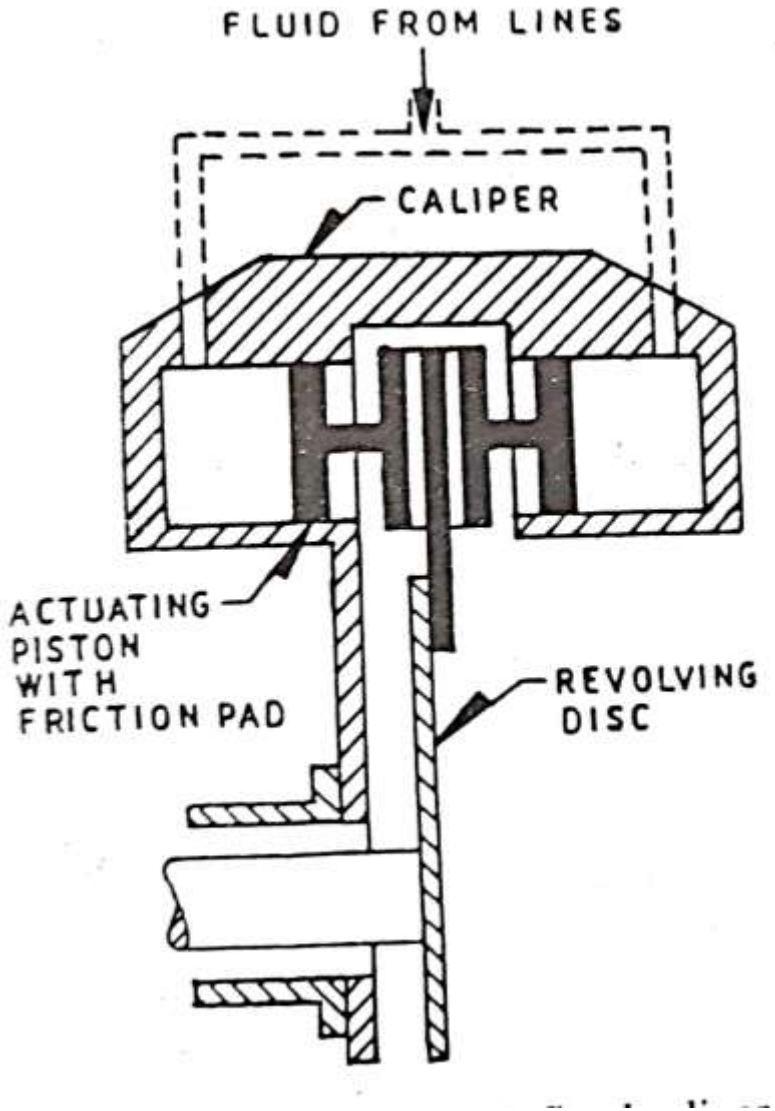






L-30

Disc Brake



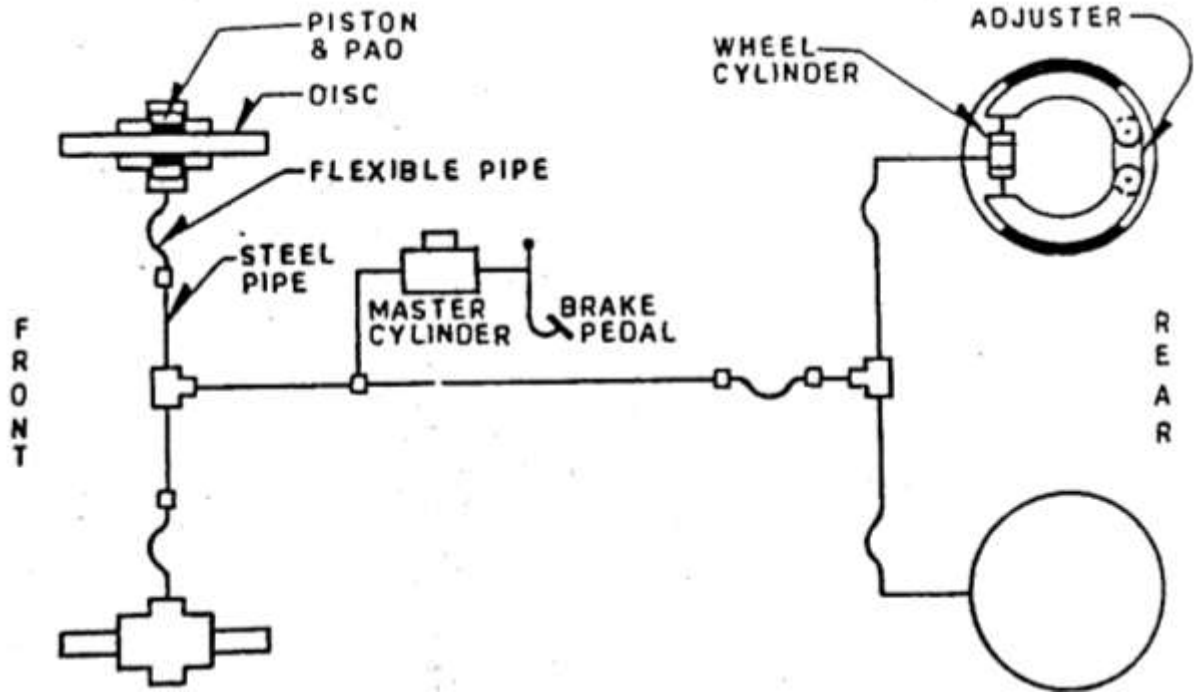
Comparison of Disc and Drum brake

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- **Cooling**
- Friction pads
- Design
- Weight
- Anti fade characteristics
- Sensitivity
- Wear
- Frictional area

Hydraulic Brakes

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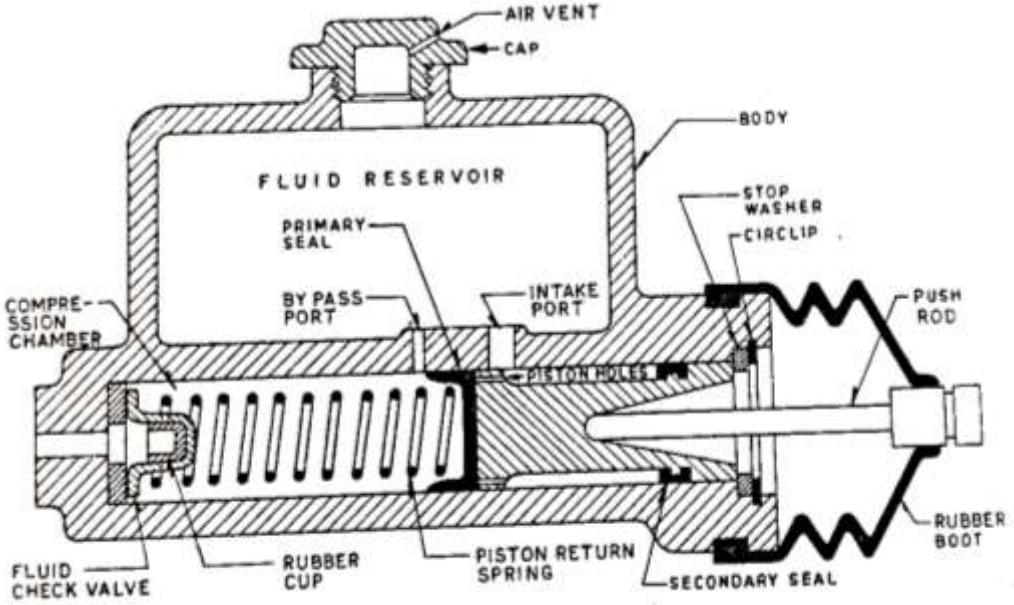
Master Cylinder

Master Cylinder:
The **master cylinder** is the **heart of the hydraulic brake system**.

The piston is connected to the **brake pedal** through the piston rod. From the reservoir, fluid enters the compression chamber through the parts as shown.

The **master cylinder** is connected to the wheel cylinder through the pipe.

The **check valve** is provided in order to give passage for entering fluid from the wheel cylinder to the master cylinder when the pedal is released.



Hydraulic Brake

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- Advantages:
- Equal braking effort to all the four wheels
- Less rate of wear (due to absence of joints compared to mechanical brakes)
- Force multiplication (or divisions) very easily just by changing the size of one piston and cylinder relative to other.
- Disadvantages:
- Even slight leakage of air into the breaking system makes it useless.
- The brake shoes are liable to get ruined if the brake fluid leaks

Hydraulic Brakes

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Brake fluid properties

- High boiling point
- Low freezing point
- Non-corrosive to rubber and metal brake parts
- Ability to lubricate rubber and metal brake system parts
- Most brake fluid is poly glycol or silicone based although a few European manufacturers have used a mineral oil based brake fluid

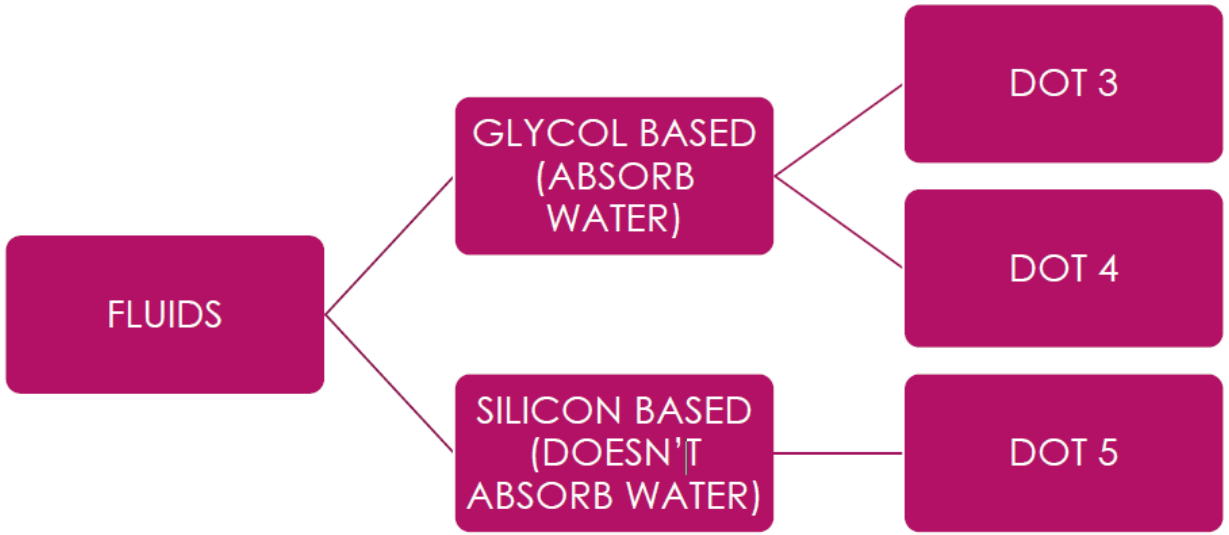
Fluid Grade	DOT 3	DOT 4	DOT 5	DOT 5.1
Fluid Type	Poly Glycol	Poly Glycol	Silicone	Poly Glycol
Boiling Point	401° F	446° F	500° F	518° F

Hydraulic Brakes

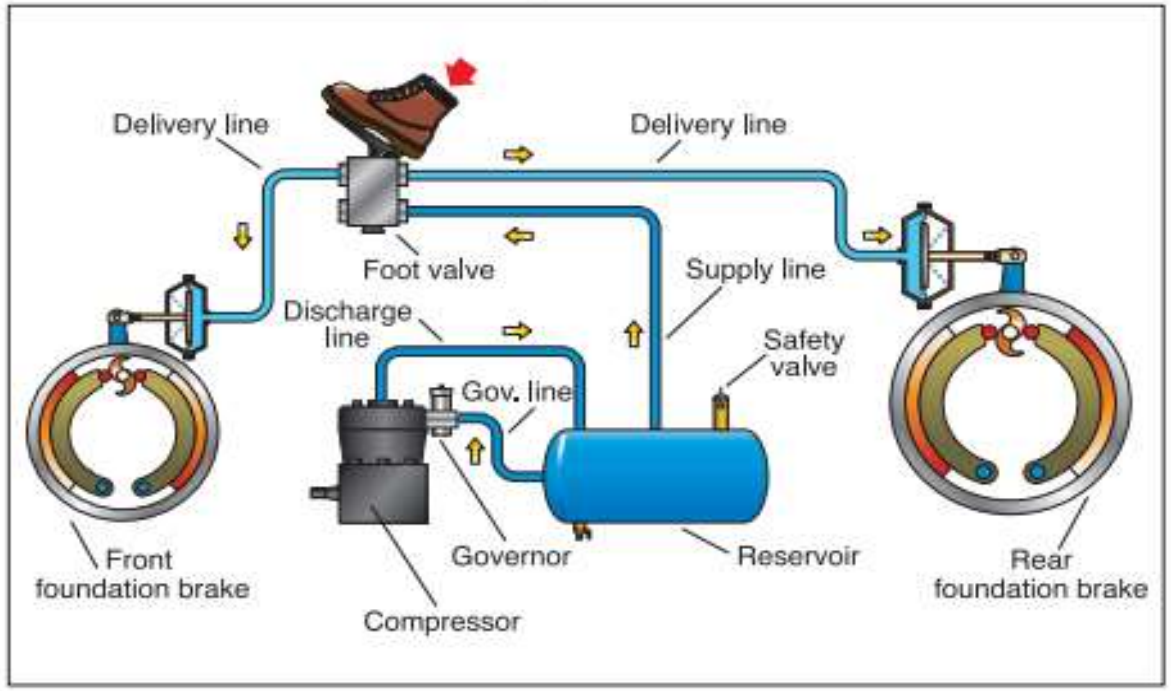
Precautions:

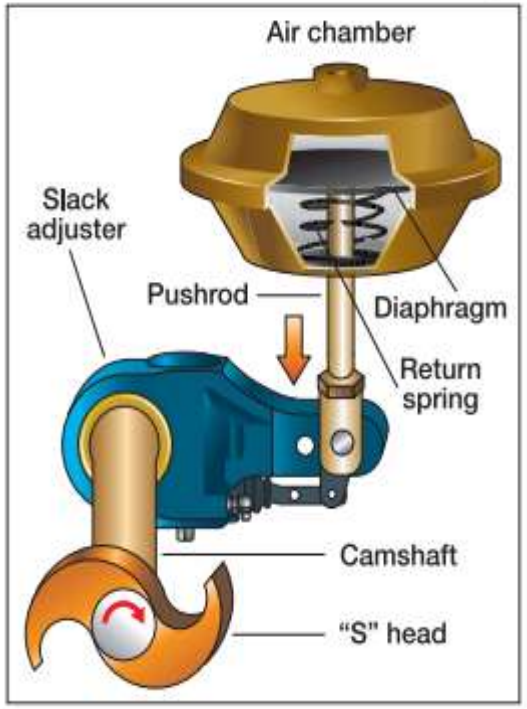
DOT 3 or DOT 4 brake fluid absorbs water, its boiling point decreases.
It can absorb water from air, that is why we should avoid opening the car's brake fluid reservoir and the container of the brake fluid should be tightly sealed.
Also DOT 3 and DOT 4 brake fluids eat paint.

None of the different types of brake fluids should be mixed.
They can react badly with each other and corrode the brake system.



Air Brake

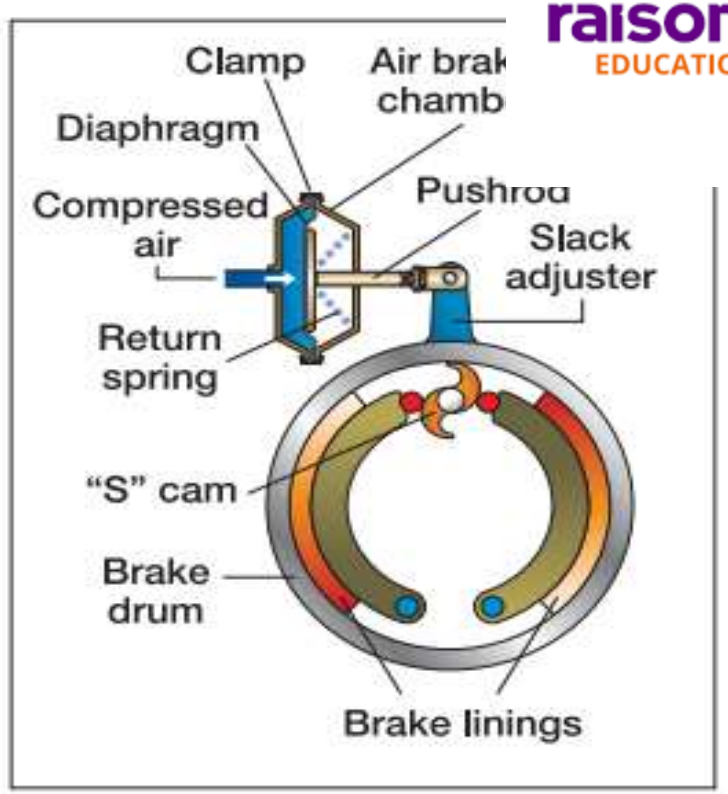


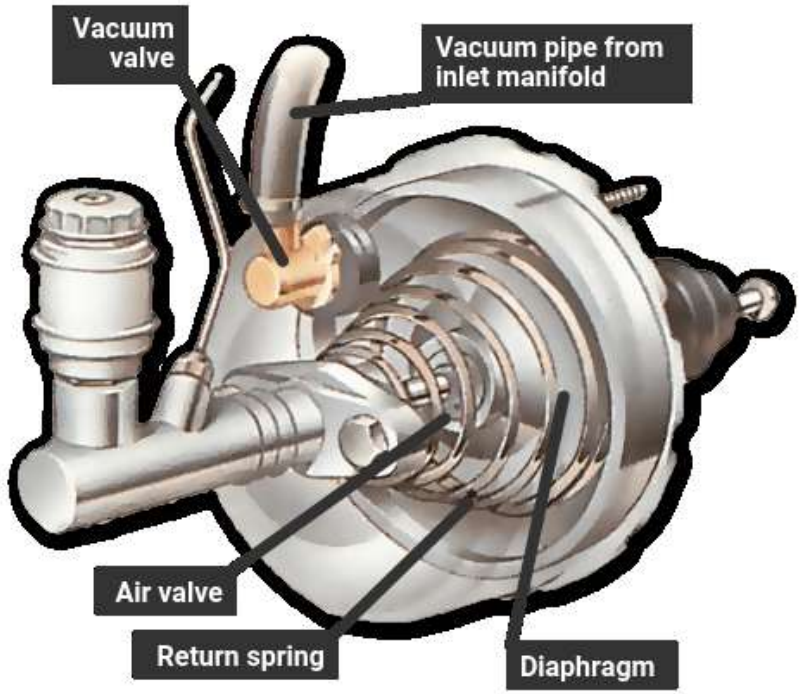


It converts the force of compressed air into a strong mechanical force through the pushrod and slack adjuster. The air brake chamber consists of a flexible diaphragm clamped between two steel housings. The diaphragm con struction is similar to a tire sidewall, consisting of a reinforced fabric core with a rubber coating. Other main parts are the pushrod and plate assembly, and a return spring.

Air Brakes

This diagram shows how air under pressure is admitted to one side of the diaphragm, causing it to inflate. As it inflates, the diaphragm pushes against the pushrod, plate assembly and the return spring, causing them to move. Note the position of the slack adjuster — it is now at about a 90 degree angle to the pushrod.





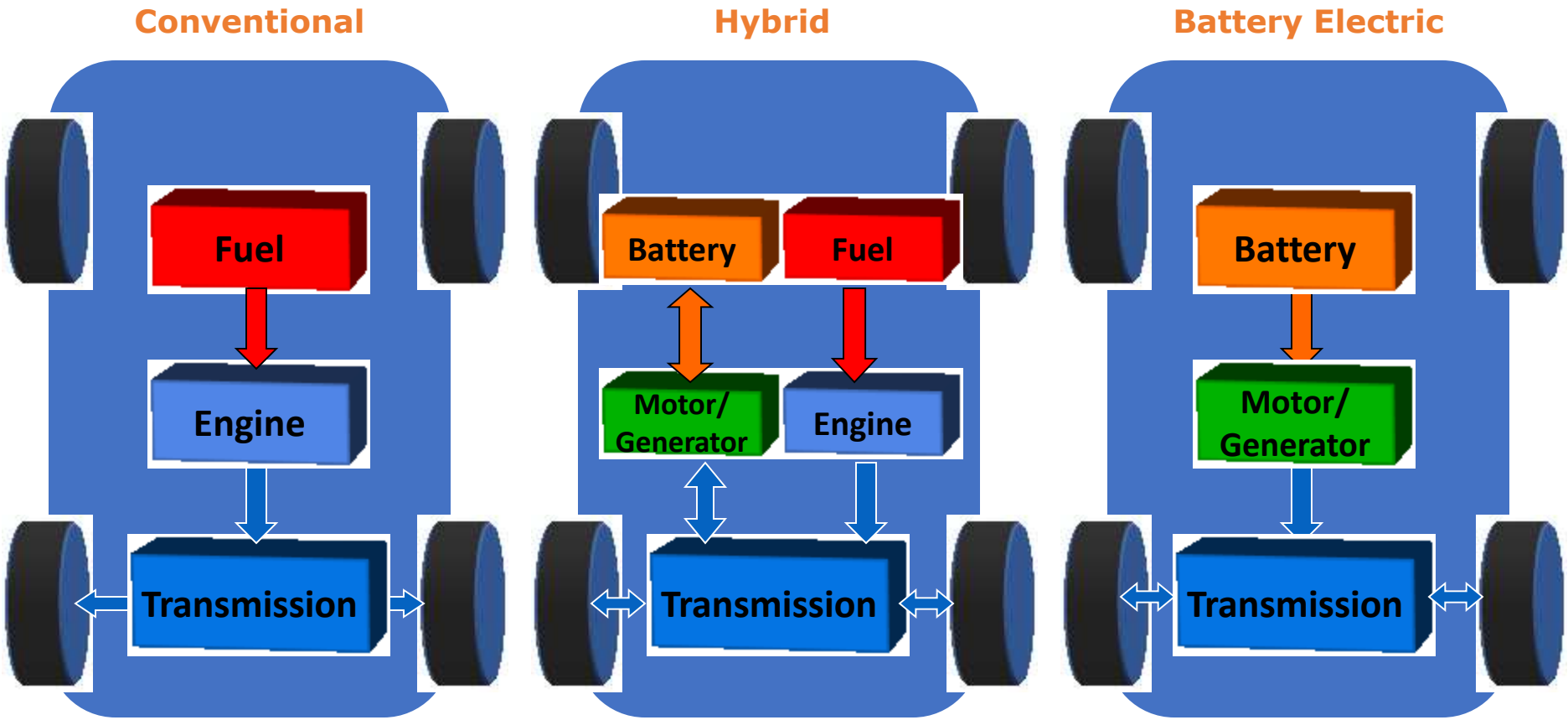
- The amount of pushrod force is governed by the air pres sure (in pounds per square inch) and the effective surface area of the diaphragm (in square inches). The pushrod force is exerted against the brake mechanism, causing the brakes to apply.

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Unit 4

Electric Vehicle

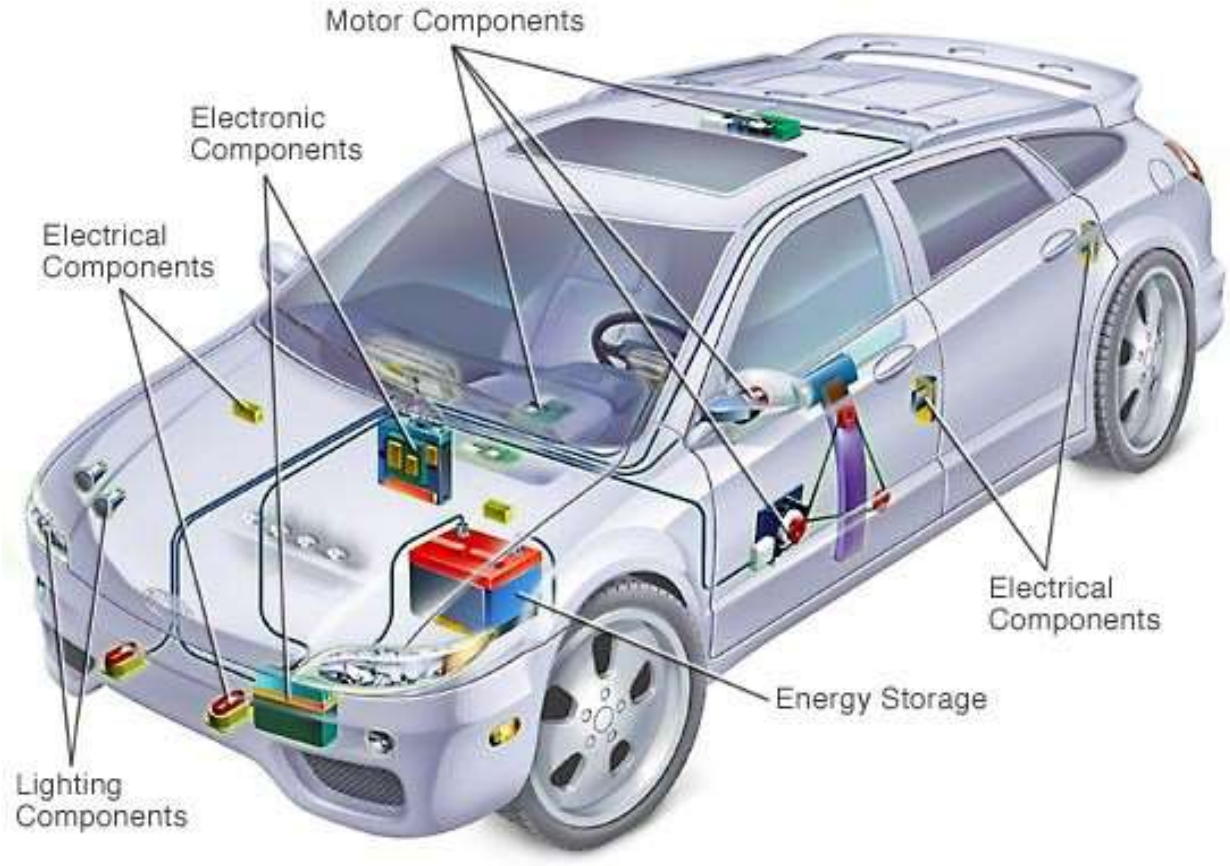
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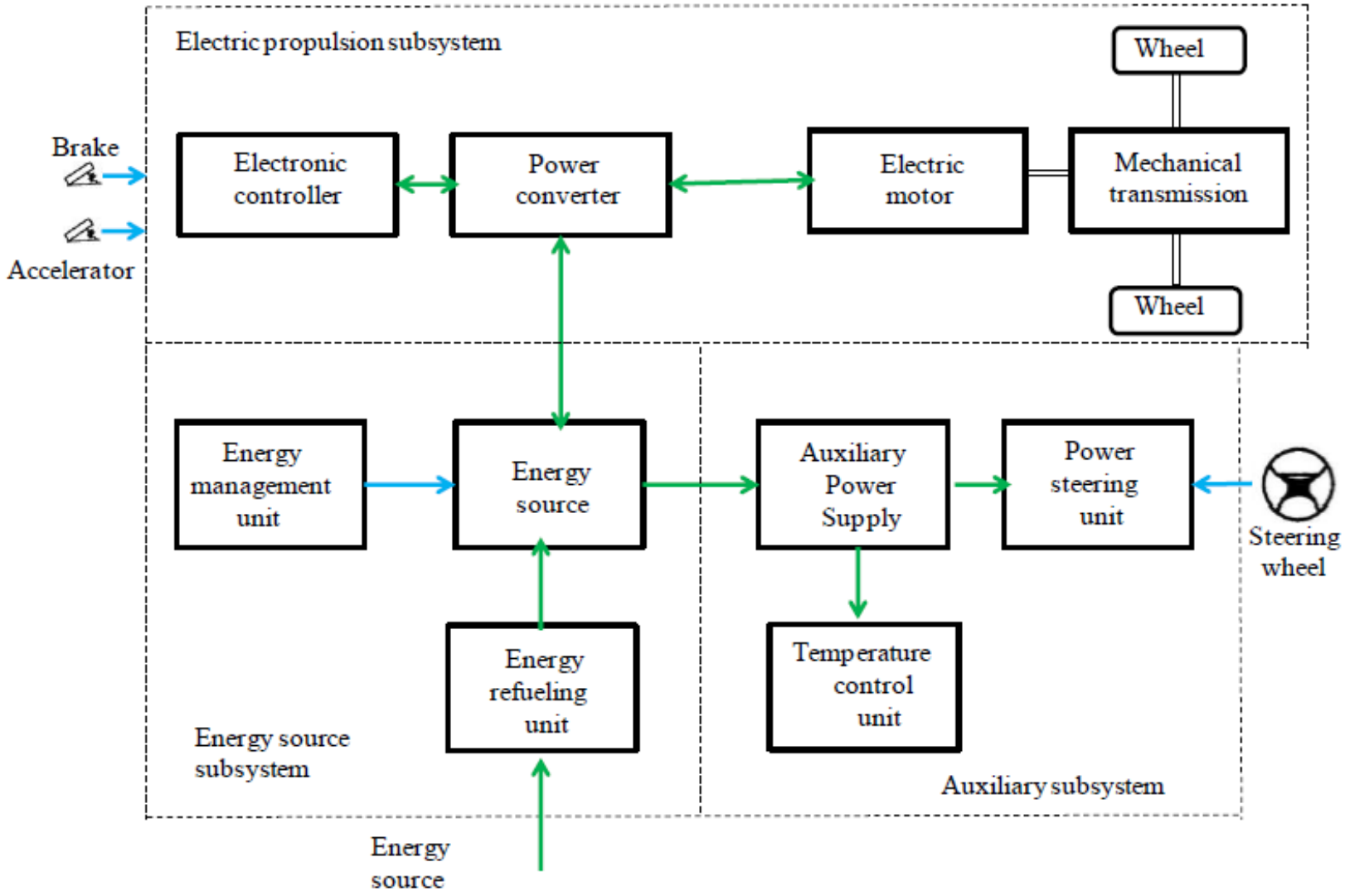
Components of Electrical vehicle

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- Motor
- Batteries
- Controller
- Transmission
- Braking
- Steering

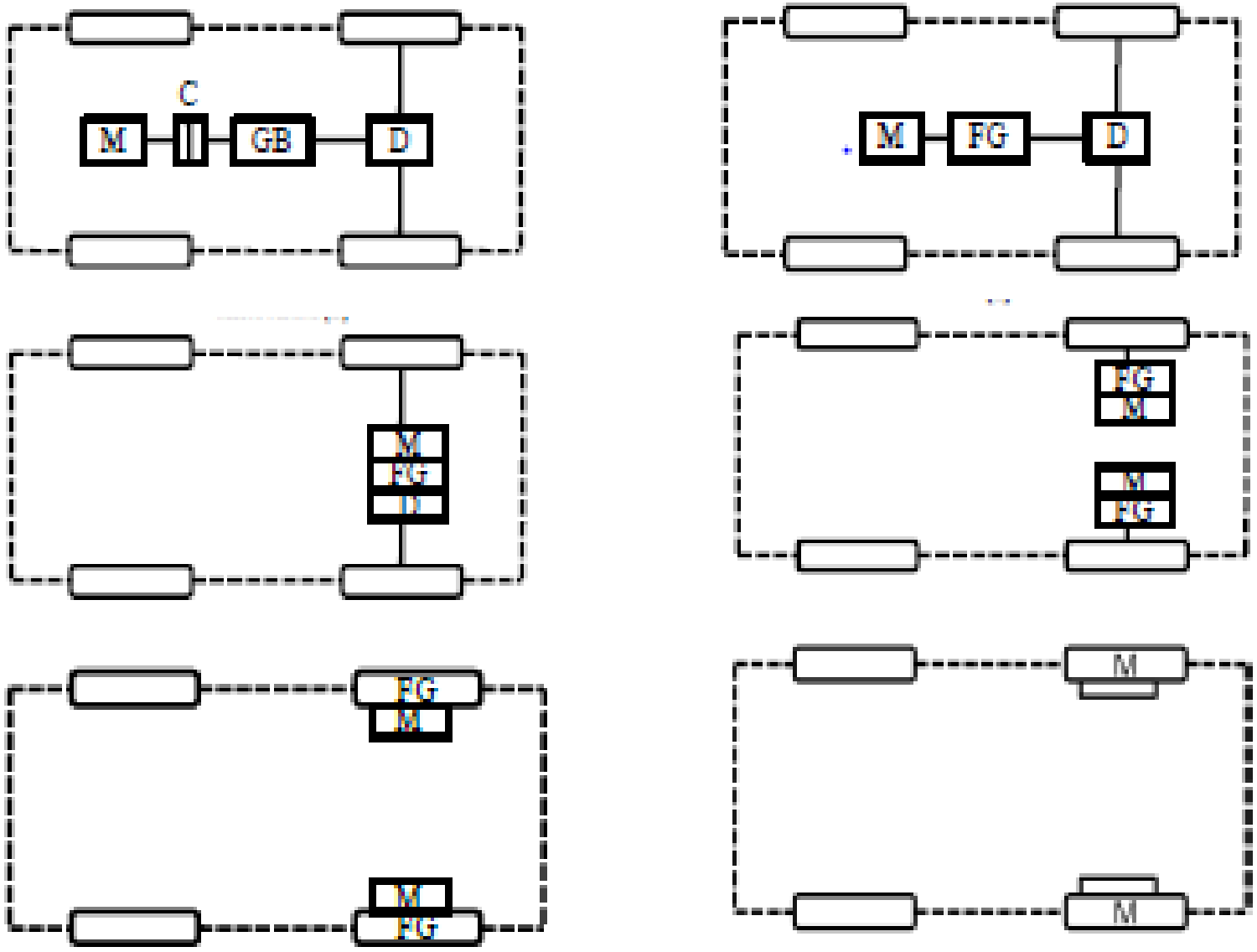


Configuration of Electric Vehicle



EV Drive train alternative based on drive train Configuration

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EV Drive train alternative based on drive train Configuration

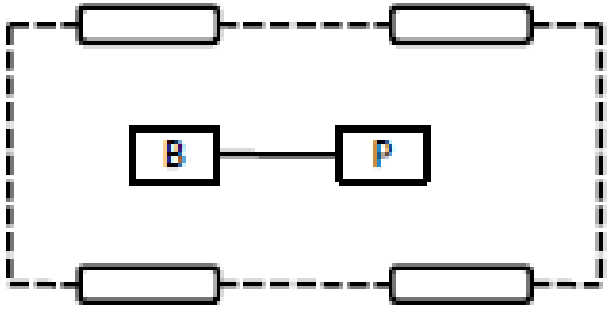


Figure 4a: EV configuration with battery source [1]

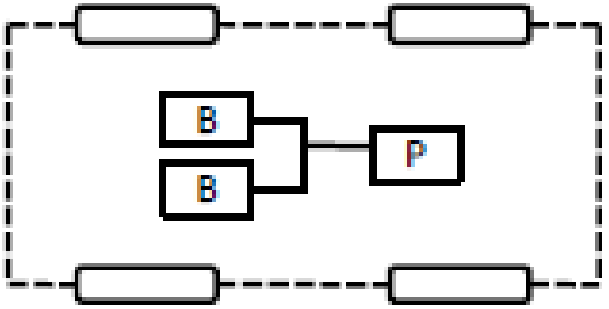


Figure 4b: EV configuration with two battery sources [1]

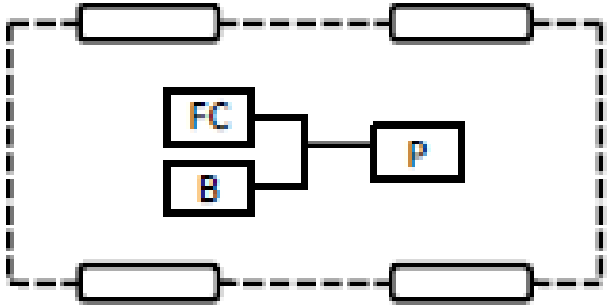


Figure 4c: EV configuration with battery and fuel cell sources [1]

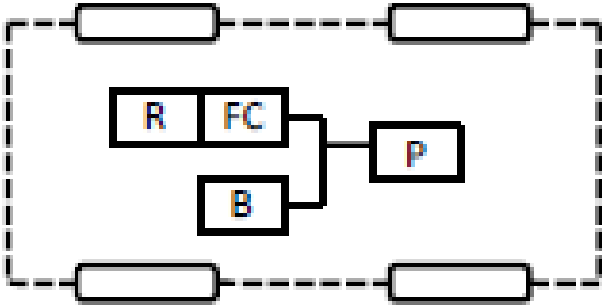


Figure 4d: EV configuration with multiple energy sources [1]

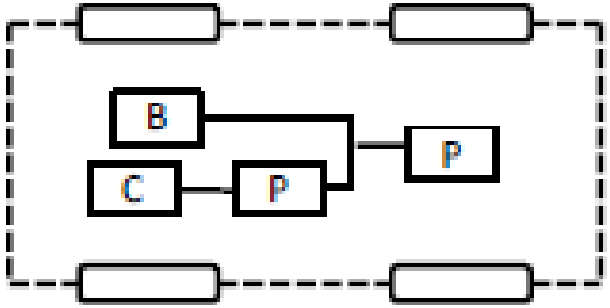


Figure 4e: EV configuration with battery and capacitors sources [1]

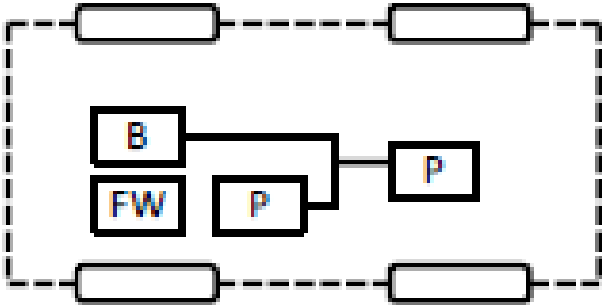


Figure 4f: EV configuration with battery and flywheel sources [1]

Controller

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A motor speed controller uses a microprocessor to drive a preamplifi and then power stage amplifier which controls the flow of power fro... the battery to the motor, with various feedback sensors to monitor the system's operation

- Switch Controller
- Solid-State Controller
- Electronic Controllers
- AC Controller
- Controller Choice
- DC Motor Controller—The Lesson of the Jones Switch
- An Off-the-Shelf Curtis PWM DC Motor Controller

Controllers and their selection criteria

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- Switch Controller
  - Basically, they are a set of big switches tha tconnect the batteries and motor(s) in various series/parallel combinations to get discrete speeds.

- Electronic Controllers
  - Electronic switches can be switched on/off much faster, and don't wear out. The controller switches them on/off so fast (thousands of times per second) that the motor gets the average current rather than the peak or zero. This is called Pulse Width Modulation (PWM). PWM controllers are modestly priced, readily available in a wide variety of sizes, and provide smooth stepless motor control.

- AC Controller
  - The AC motor with solid-state inverter is the most sophisticated type. They are used in high-end EVs where meeting performance objectives is more important than cost.

- High reliability, high performance
- High performance, minimum cost
- High reliability, low cost

Battery charging and discharging

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- **Battery Discharging Cycle**
- **Ampere-Hours**—The measure of the battery's capacity and percent state-of charge (the area under the line in this case) are shown decreasing linearly versus time from its full charge to its full discharge value.
- **Cell Voltage**—Cell voltage predictably declines from its nominal 2.1-volt fully charged value to its fully discharged value of 1.75 volts.
- **Specific Gravity**—Specific gravity decreases linearly (directly with the battery's discharging ampere-hour rate) from its full charge to its full discharge value.

Battery charging and discharging

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- **Battery Charging Cycle**
- **Ampere-Hours**—This is the opposite of the discharging case, except that you have to put back slightly more than you took out (typically 105 to 115 percent more) because of losses, heating, etc. The area under the line increases linearly versus time from its fully discharged value to its fully charged value.
- **Specific Gravity**—Specific gravity increases wildly over time as a battery is charging, so making specific gravity measurements during the charging cycle is not a good idea. At the early part of the charging cycle, specific gravity increases slowly because the charging chemical reaction process is just starting. Specific gravity increases rapidly as the sulfuric acid concentration builds, and gassing near the end of the cycle contributes to its rise.
- **Cell Voltage**—Voltage also increases wildly over time as a battery is charging, so making voltage measurements during the charging cycle is not a good idea either. Notice cell voltage jumps up immediately to its natural 2.1-volt value; slowly increases until 80 percent state-of-charge (approximately 2.35 volts); increases rapidly until 90 percent state-of-charge (approximately 2.5 volts); and then builds slowly to its full charging value of 2.58 volt.

Battery charging

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- Charging Between 0 and 20 Percent
  - The first 20 percent of a fully discharged battery's charging cycle is a critical phase. Every battery is rated to deliver 100 percent of its rated capacity at the C/20 rate.

- Charging Between 20 to 90 Percent
  - In the middle of the charging cycle, you can charge at up to the C/10 rate. This rate is not as efficient as the C/20 rate—more energy is wasted in heat.

- Charging Between 90 and 100 Percent
  - At this point, you want to drop back to the C/20 rate or, ideally, switch to a constant voltage method. deep-cycle battery's full charging value of 2.58 volts

Hybrid Electric Vehicles

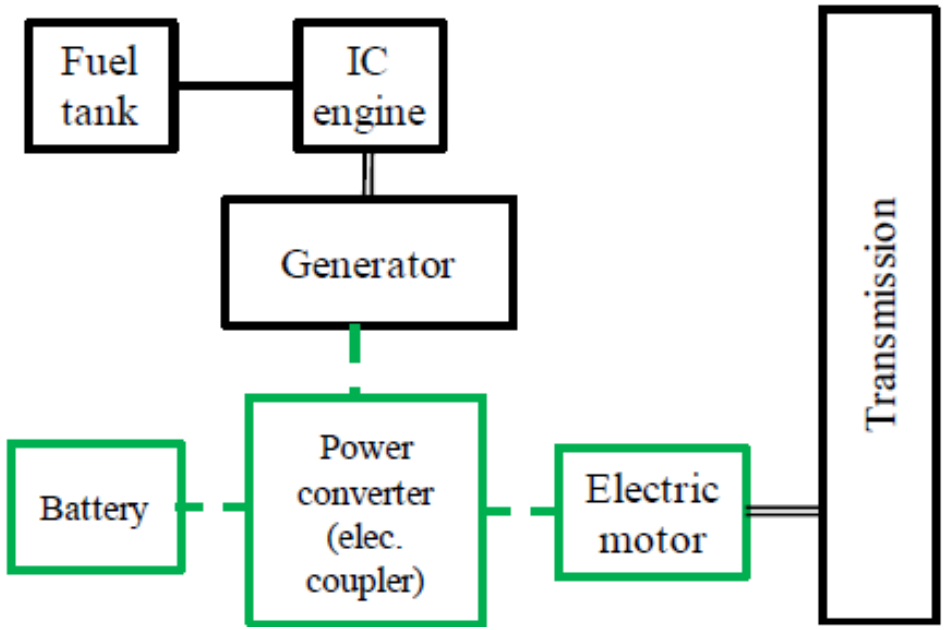
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- Hybrid-electric vehicle indicates that one source of power is provid by an electric motor and other source of motive power comes from internal combustion engine designed to run on either gasoline or diesel fuel.
- Based on this general definition, there are many types of HEVs, such as:
  - Gasoline ICE and battery
  - Diesel ICE and battery
  - Battery and FC
  - Battery and capacitor
  - Battery and flywheel
  - Battery and battery hybrids.

Hybrid Electric Vehicles

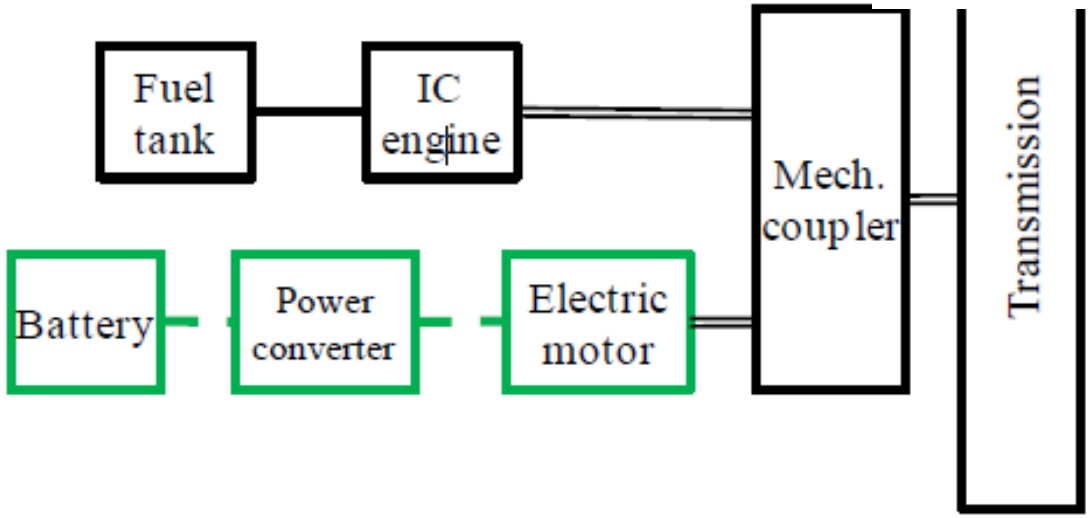
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- ***Series Hybrid System***
- In case of series hybrid system the mechanical output is first converted into electricity using a generator. The converted electricity either charges the battery or can bypass the battery to propel the wheels via the motor and mechanical transmission.
- Advantages
  - Mechanical decoupling between the ICE and driven wheels allows the IC engine operating at its very narrow optimal region
  - Nearly ideal torque-speed characteristics of electric motor make multigear transmission unnecessary.
- Disadvantages
  - The energy is converted twice and this reduces the overall efficiency.
  - Two electric machines are needed and a big traction motor is required because it is the only torque source of the driven wheels.



Electric vehicles

- ***Parallel Hybrid System:***
- Both ICE and electric motor (EM) to deliver power to drive the wheels. Since both the ICE and EM are coupled to the drive shaft of the wheels via two clutches, the propulsion power may be supplied by ICE alone, by EM only or by both ICE and EM.



- Advantages
  - Both engine and electric motor directly supply torques to the driven wheels and no energy form conversion occurs, hence energy loss is less
  - compactness due to no need of the generator and smaller traction motor.

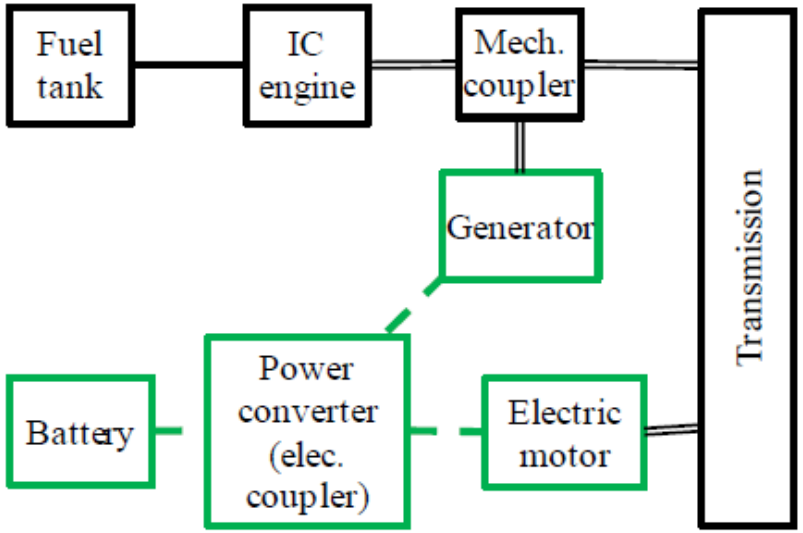
- Drawbacks
  - mechanical coupling between the engines and the driven wheels, thus the engine operating points cannot be fixed in a narrow speed region.
  - The mechanical configuration and the control strategy are complex compared to series hybrid drivetrain.

Electric vehicles

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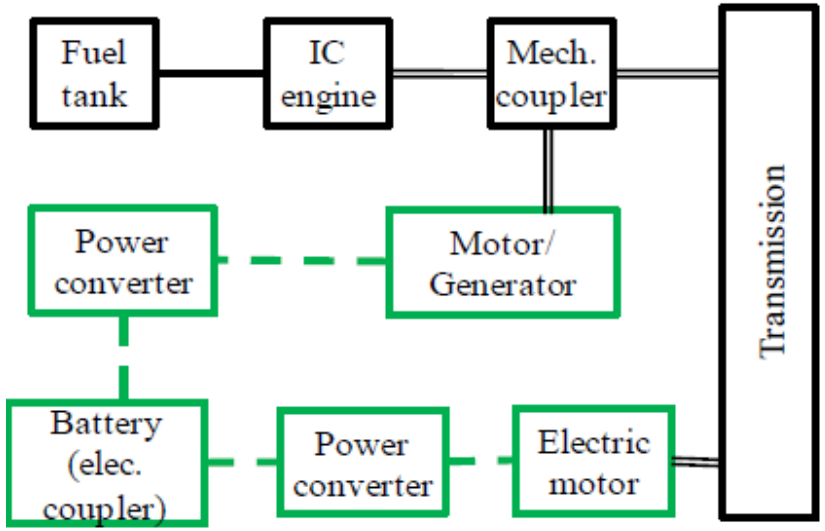
- ***Series-Parallel System***

The configuration incorporates the features of both the series and parallel HEVs. However, this configuration needs an additional electric machine and a planetary gear unit making the control complex.



- ***Complex Hybrid System***

The complex hybrid is similar to the series-parallel hybrid However, the key difference is due to the bi-directional power flow of the electric motor in complex hybrid and the unidirectional power flow of the generator in the series-parallel hybrid. The major disadvantage of complex hybrid is higher complexity.



Degrees of Hybridization

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The vehicle is a….

If it…	Micro Hybrid	Mild Hybrid	Full Hybrid	Plug-in Hybrid
Automatically stops/starts the engine in stop-and-go traffic				
Uses regenerative braking and operates above 60 volts				
Uses an electric motor to assist a combustion engine				
Can drive at times using only the electric motor				
Recharges batteries from a wall outlet for extended all-electric range				



Citroën C3



Honda Insight



Toyota Prius



Chevy Volt

Efficiency

Benefits of EVs and PHEVs

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- More efficient, lower fuel costs, lower emissions
- Simpler transmission, fewer moving parts
- Fuel Choice
- Oil/energy independence
- Emissions improve with time
- Emissions at few large locations is easier to control than millions of tailpipes

Challenges

- Limited Range
  - Large battery weight/size
- Long Charge times
- High initial cost
- Battery life
- Consumer acceptance
- Grid Integration

Addressing customer perception

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- Accepting limited range
  - Most people drive less than 40 mi/day
  - Most cars are parked 23 hours of the day anyway
- Smaller vehicles & reduced performance
  - In the last 30 years, nearly 100% of efficiency improvements have gone to increasing vehicle size and performance, not reducing consumption
- How do you get people to charge at the right time?

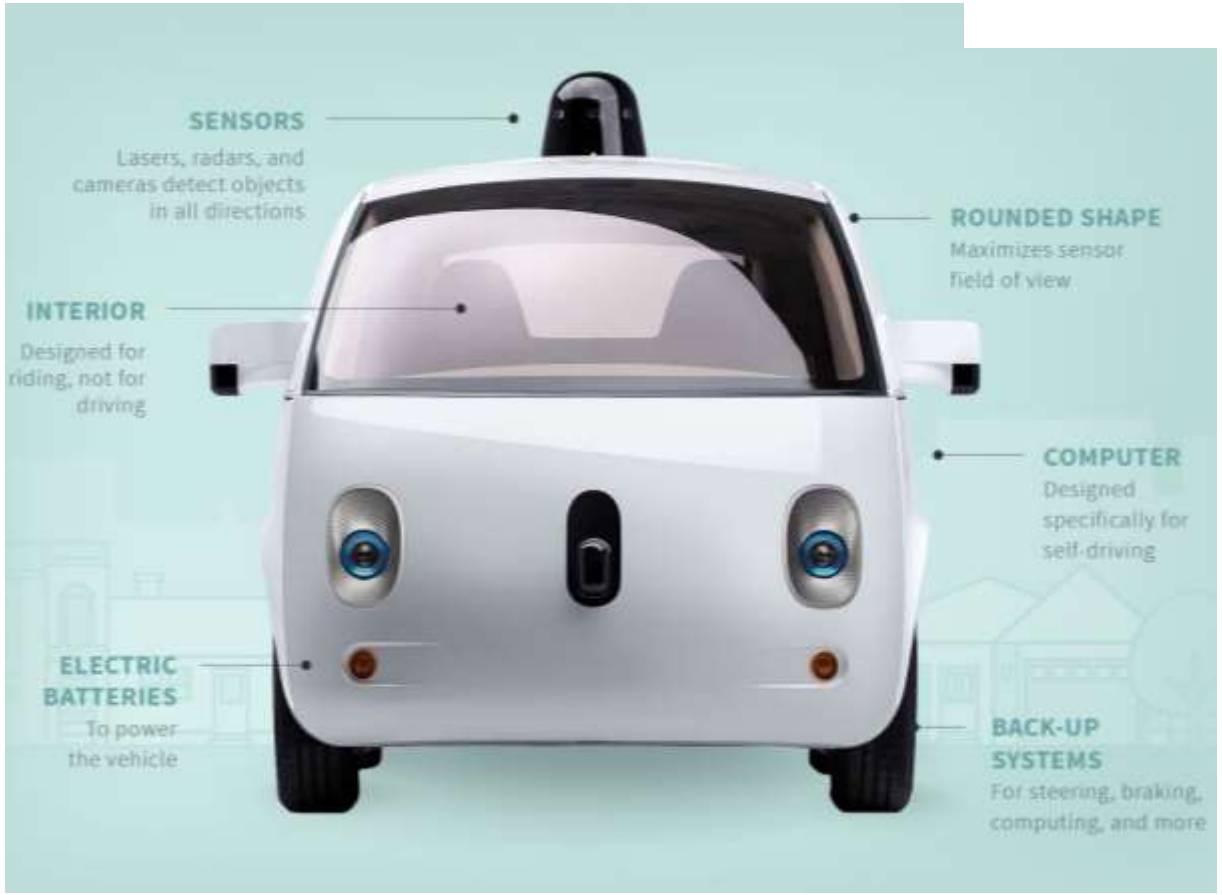
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Unit 5

Autonomous Cars

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- An Autonomous car or a self driving car is vehicle that is capable of sensing its environment and navigating without human inputs
- A human passenger is not required to take control of the vehicle at any time, nor is a human passenger required to be present in the vehicle at all.
- Example : Google's self driving car



Autonomous Cars

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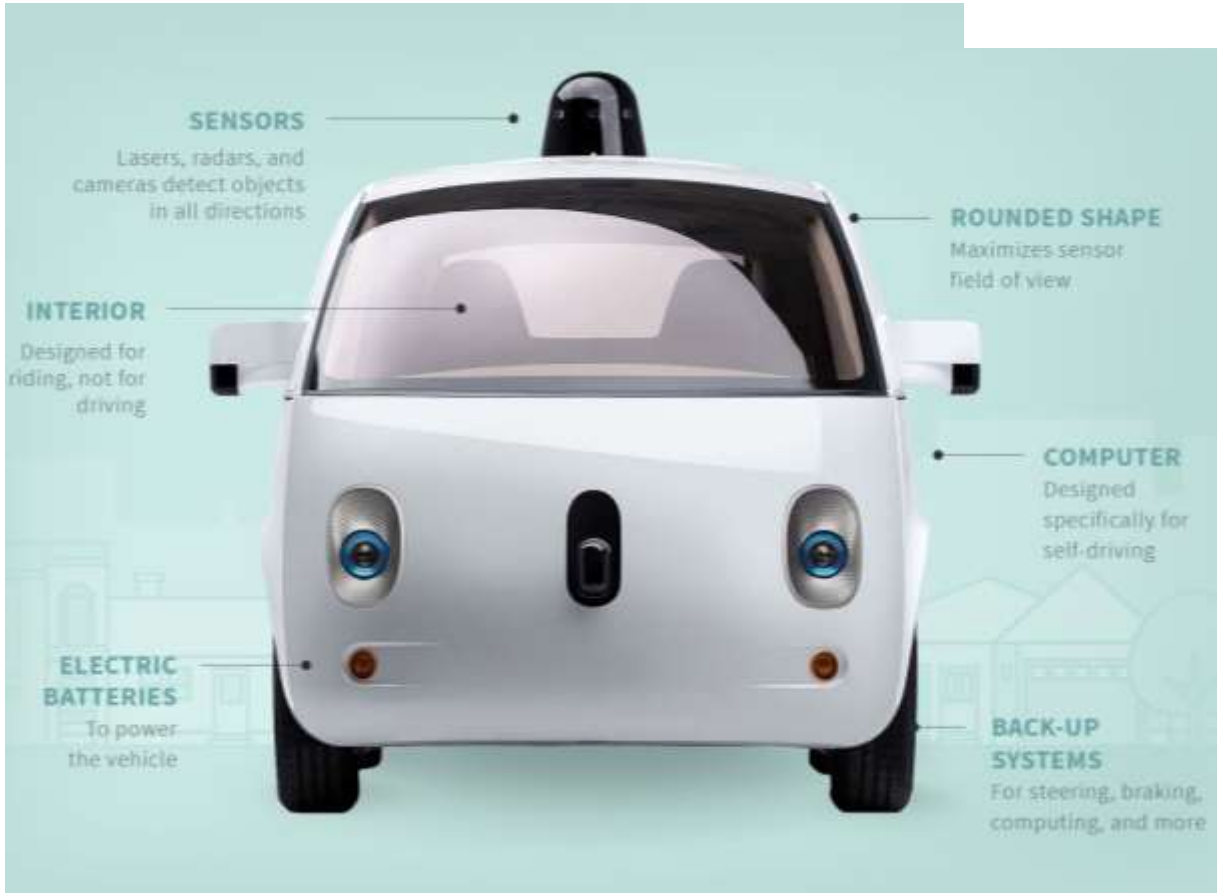
- Levels of autonomous driving

	Level 1 Driver Assistance	Level 2 Partial	Level 3 Conditional	Level 4 High	Level 5 Full automation
Overview	• Driving assistance by using either steering or braking/ acceleration	• Driver assistance by combining multiple operation simultaneously (e.g. by steering control while accelerating)	• Driving control with assumption that drivers can intervene when requested	• Driving control even if drivers can not react immediately • Not applicable to all scenarios (e.g. highway driving, parking)	• Driving control even if drivers can not react immediately • Applicable full-time
Benefit	• Assist drivers attention • Assist driver with basic repetitive operations	• Assist driver by doing some operations such as lane changing. • Burden on the driver can be reduced	• Drivers may do other tasks as long as drivers can take control when requested by driving system	• In certain scenario, driver can do other tasks • Efficient use of time by drivers	• Drivers can always do other tasks than driving • Reduced traffic jam • Operation efficiency of vehicles maximized

Component

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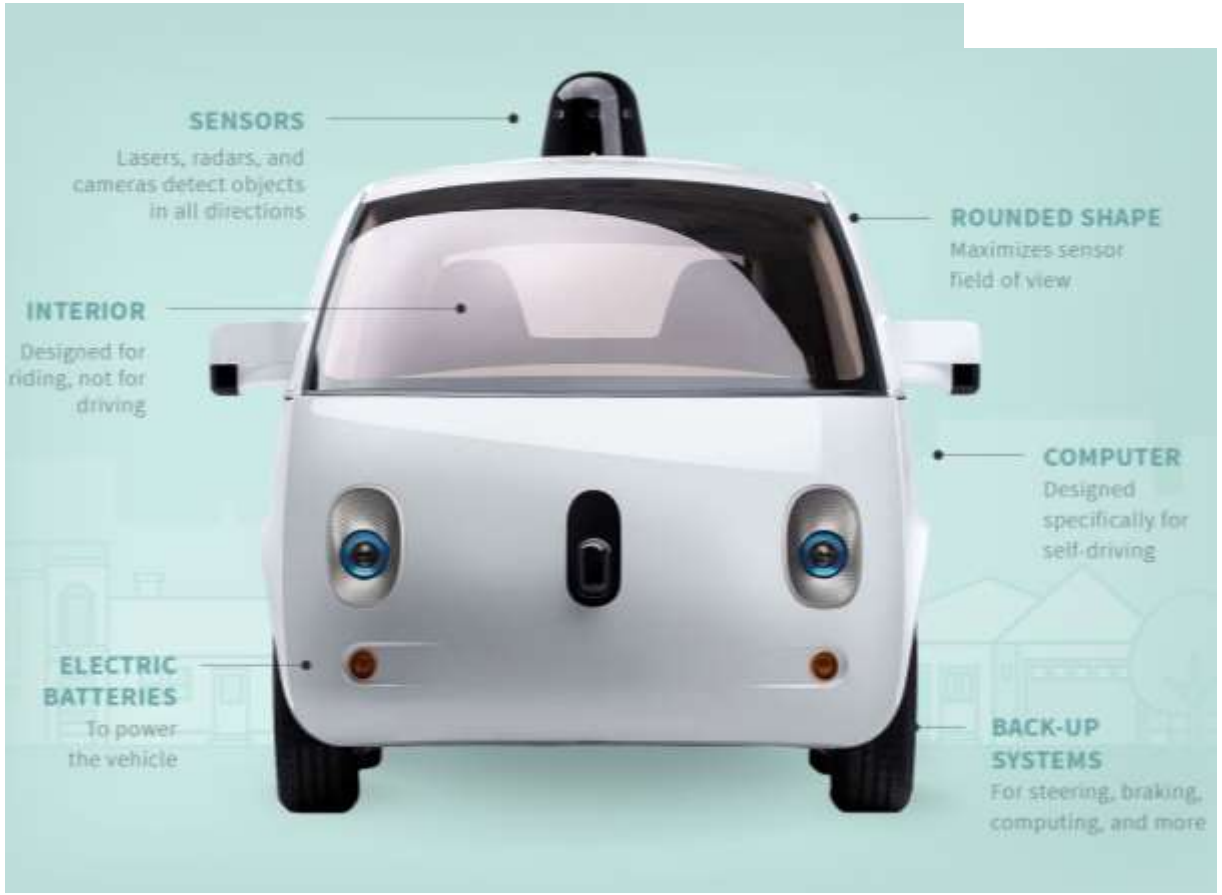
- Lidar System
- GPS
- Radar Sensor
- Ultrasonic Sensor
- Video Cameras
- Central Computer



Autonomous Cars

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- An Autonomous car or a self driving car is vehicle that is capable of sensing its environment and navigating without human inputs
- A human passenger is not required to take control of the vehicle at any time, nor is a human passenger required to be present in the vehicle at all.
- Example : Google's self driving car



THE LIDAR SYSTEM

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- The Light Detection on and Ranging (LIDAR) which is mounted the roof of the vehicle is the most important device in the Autonomous vehicles.
- The LIDAR consists of an emitter, mirror and receiver.
- The emitter sends out a LASER beam that bounces o a mirror that is rotating along with the cylindrical housing at 10 revolution on per minute.
- After bouncing off objects ,the LASER beam returns to the mirror and is bounced back towards the receiver . Where it can be interpreted into data.
- The vehicles can then generate a map of its surroundings and use the map to avoid objects

GPS

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- To obtain macro location – accuracy up to 2-3 meters
- A GPS is used just like the satellite navigation system is most cars, to get rough location of the car, also radar laser and cameras take over to monitor the world around the car 360 degree for precise location

Video camera

- Used for near vision
- A camera mounted near the rear – view mirror/windshield build a real time 3D images of the road ahead spotting hazards like animals.
- It is also used to identify road signs, marking and traffic signals

Radar

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- Radar are fitted in the bumper at front
- The radar chirps between 10 to 11GHz over a 5 millisecond period transmitting the radar signals fron a centrally located antenna cone and two receive cone
- Traditional radar sensors are used to detect dangerous objects in the vehicle path are more than 100m away, Accident prevention system trigger alerts when something is detected in car blind spot

Ultrasonic Sensor

- It is used to measure the position of the object very close to the vehicle . It will alert the car about thee obstacles in the rear
- Reverse park assistant uses ultrasonicator sensor to navigate into tight parking spot

Central Computer

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- Software can recognize objects, people, cars, road marking and tra... light and safety navigate around them.
- It is working on Machine learning
- Information from all the sensors is analysed by a central based on the information received the software takes self driving decision like steering, braking and acceleration

Working Mechanism

- Input from sensors are processed using algorithms/coding, computer software and output is function of mechanical mechanism such as breaking, acceleration, steering etc.

Automobile safety

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- **ACTIVE SAFETY:**
- Active safety systems help prevent accidents and thus make a preventive contribution to safety in road traffic.
- Active safety features are designed to keep in full control of the vehicle at all times using advanced technologies. These technologies attempt to avoid accidents in the first place, and they are always on, alerting commuters.
- Low driver stress, and thus a high degree of driving safety, requires optimum design of the driver surroundings with regard to ease of operation of the vehicle controls.

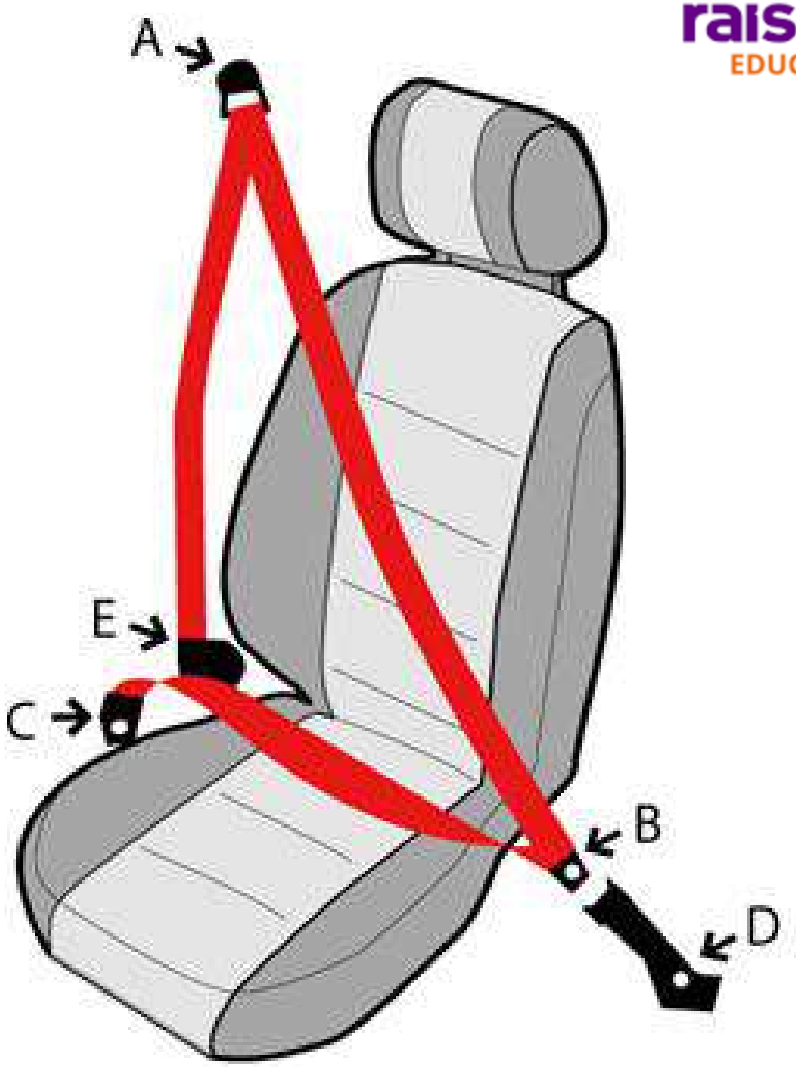
Passive safety

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- A passive safety system helps to protect from injury if a crash is unavoidable. It refers to components of the vehicle (primarily airbags, seatbelts and the physical structure of the vehicle) that help to protect occupants during a crash
- Passive safety systems serve to protect the occupants against serious or even fatal injuries.
- Passive safety features are designed to mitigate the impact of a collision when it does occur. So, they remain passive unless called upon

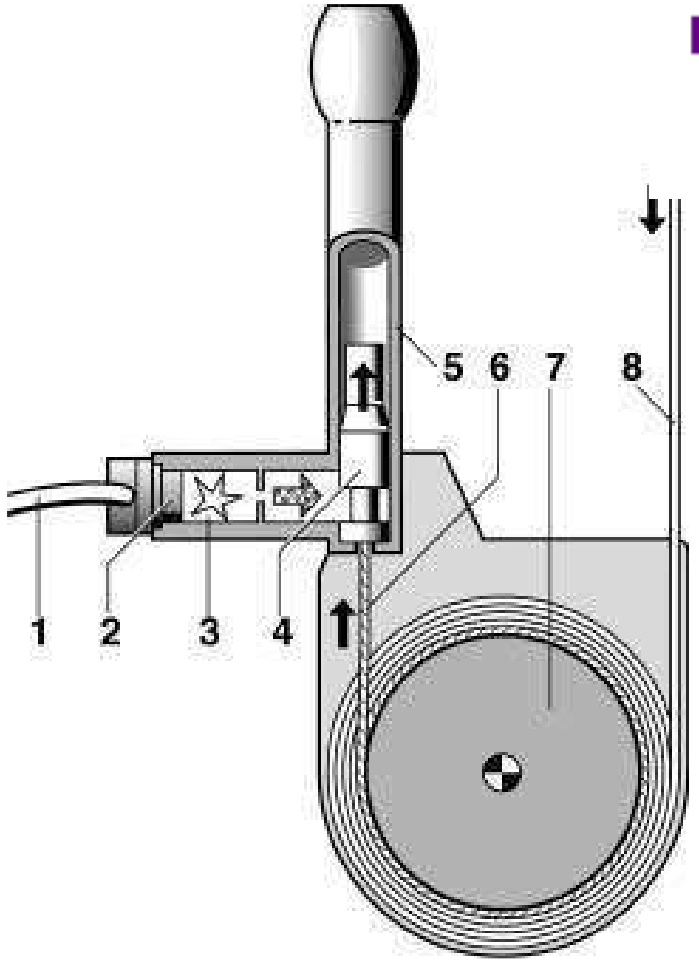
Seat belt

- A seat belt, sometimes called a safety belt, is a safety harness designed to secure the occupant of a vehicle against harmful movement that may result from a collision or a sudden stop.
- Types of seat belts
  - Lap seat belt
  - Three points seatbelt Lap



Working of Seat belt

- Deceleration to standstill and forward displacement of an occupant at an impact speed of 50 km/h.1 Impact, 2 Firing of belt tightener/airbag, 3 Belt tightened, 4 Airbag inflated. without/ with restraint systems. In an impact, the shoulder belt tightener compensates for the belt slack and the "film-reel effect" by retracting and tightening the belt strap.



1.Ignition cable, 2 Firing elements, 3 Propellant charge, 4 Piston, 5 Cylinder, 6 Metal cables, 7 Belt reel, 8 Belt strap.

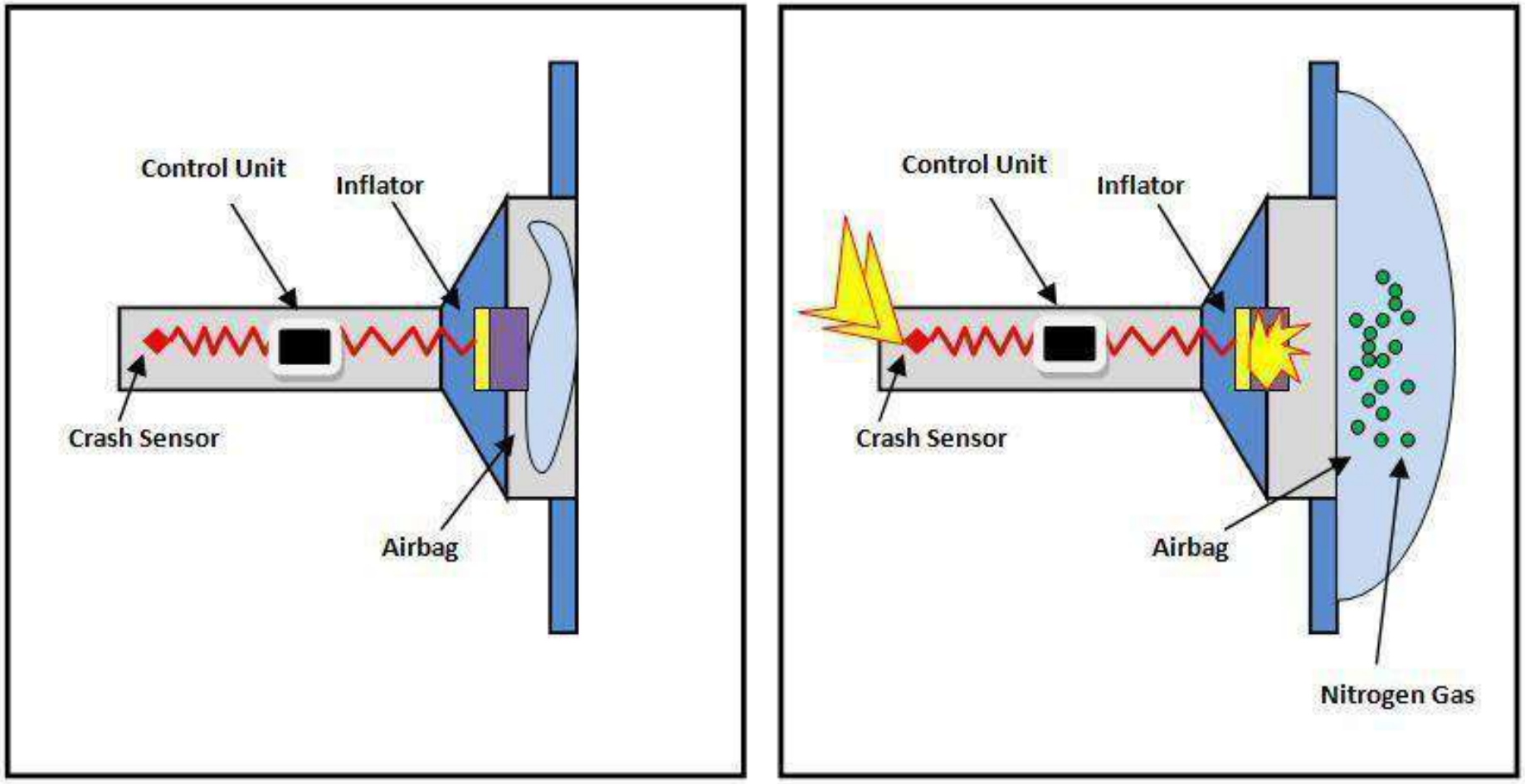
Functions of seat blet

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- The function of seat belts is to restrain the occupants of a vehicle in their seats when the vehicle hits an obstacle.
- Seat-belt tighteners improve the restraining characteristics of a three-point inertia-reel belt and increase the protection against injury.
- In the event of a frontal impact, they pull the seat belts tighter against the body and thus hold the upper body as closely as possible against the seat backrest.
- This prevents excessive forward displacement of the occupants caused by mass inertia.

Air Bags

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Working of Seat belt

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- To protect driver and front passenger, pyrotechnical gas inflators inflate the dri and passenger airbags in pyrotechnical, highly dynamic fashion after a vehicle impact detected by sensors.

- In order for the affected occupant to enjoy maximum protection, the airbag must be fully inflated before the occupant comes into contact with it.

- In a 50 km/h crash, the airbag takes approx. 40 ms to inflate fully and a further 80...100 ms to deflate through the deflation holes. The entire process thus takes little more than a tenth of a second, i.e. the batting of an eyelid.

Anti-Lock Breaking System

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- An electronic system which monitor and control the skidding of t vehicle during breaking or can say prevents the wheels from locking while braking.

- ABS allows the driver to maintain steering control while braking and shorten braking distances on slippery surfaces like wet or icy surfaces. But it increases the stopping distances in simple surfaces.

- Anti-lock Braking System on any vehicle is simply an additional monitoring and controlling function superimposed on the existing vehicle brake system. ABS is neither a second brake system, nor replace the vehicle brake system.

Why Anti-Lock Breaking System

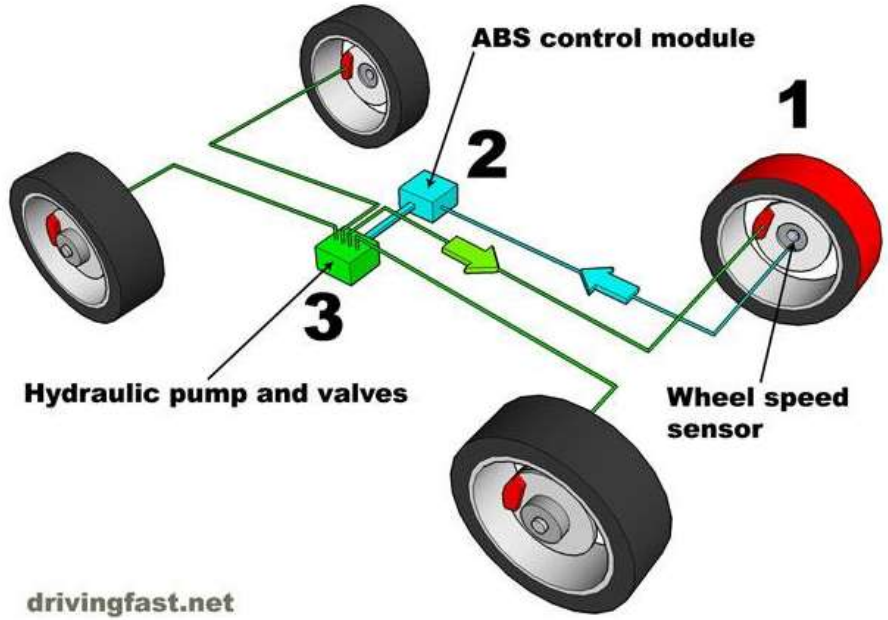
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- While hard break is applied to stop the vehicle then friction of the breaks loc wheels solidly and contact between wheel and road loses then wheels starts skidding across road .
- If traction between wheel and road goes down (In the cases when surface is wet, icy etc.) then wheel could slip and resulting in longer stopping distance.
- If driver apply break forcefully and then try to use steer, but the steering doesn't work, because all the wheels are locked up while driver is holding down the brake pedal. As a result, he lose the ability to steer the vehicle.
- To overcome these problems this new electronics system “ABS” is invented.

Parts of Anti-Lock Breaking System

A Typical ABS System contains:

- Electronic Control Unit
- Speed Sensors
- Hydraulic Control Unit
- ABS Control Valves
- Control Algorithm
- CAN bus



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Working of an ABS systems

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Wheel speed sensor :

- Electromagnetic device in conjunction with a rotating toothed wheel
- Constantly monitors wheel performance
- Transmit the information to the ECU after particular interval of time.

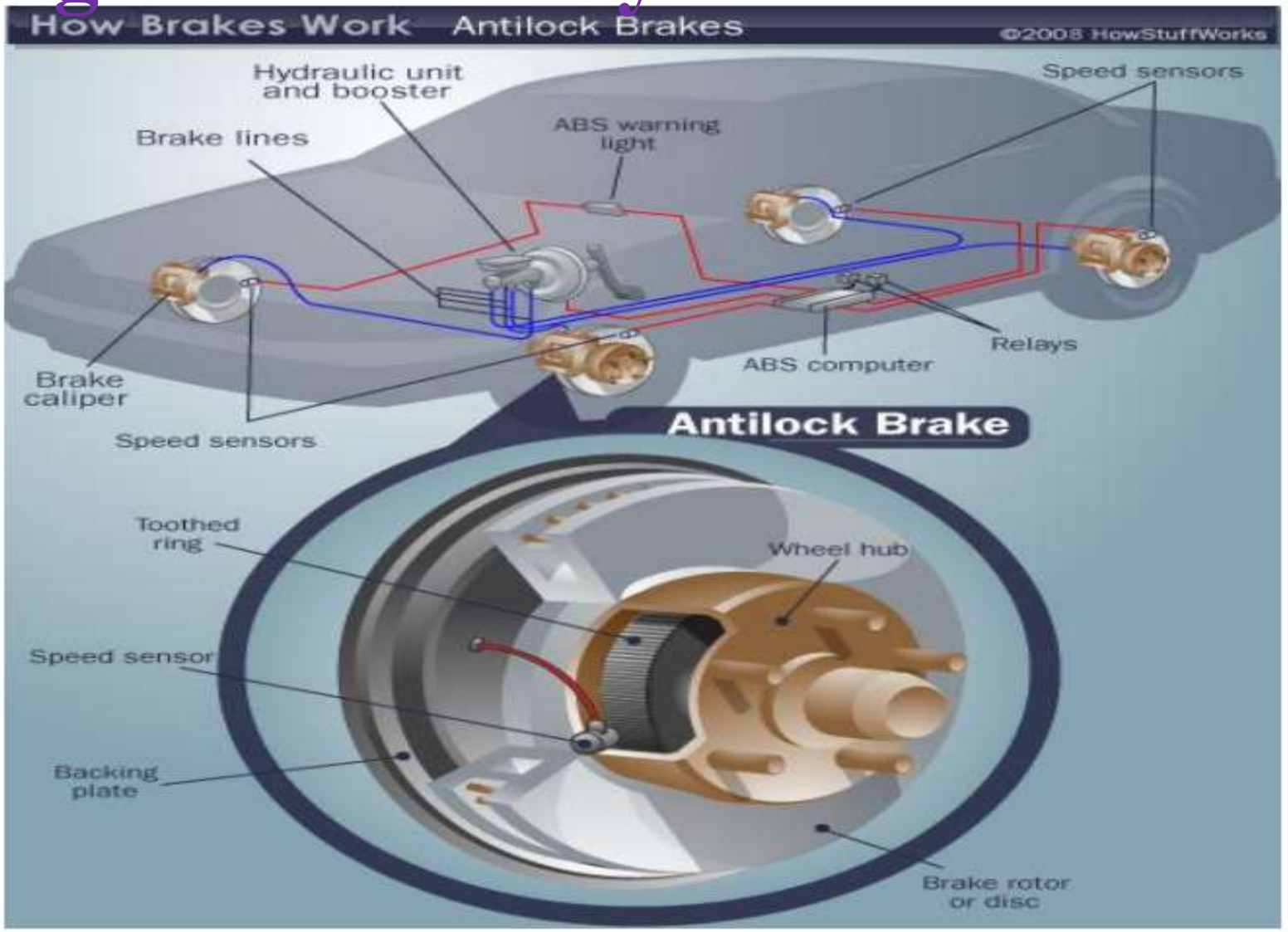
Electronic Control Unit (ECU):

- A microcomputer that functions as the ``brain'' of the ABS system.
- The ECU receives wheel performance data from each wheel sensor.
- When the wheels try to lock, the ECU delivers commands to the hydraulic valves to control brake pressure.

Hydraulic valve :

- Control valves that are actuated by the electronic control unit (ECU) to ensure each wheel is optimally braked.
- Depending on the control signal from ECU it
- Increases pressure at the affected wheel , thus increasing the breaking force at the affected wheel
- Decreases pressure at the affected wheel, thus reducing the braking force at the affected wheel

Working of an ABS systems



Working of an ABS systems

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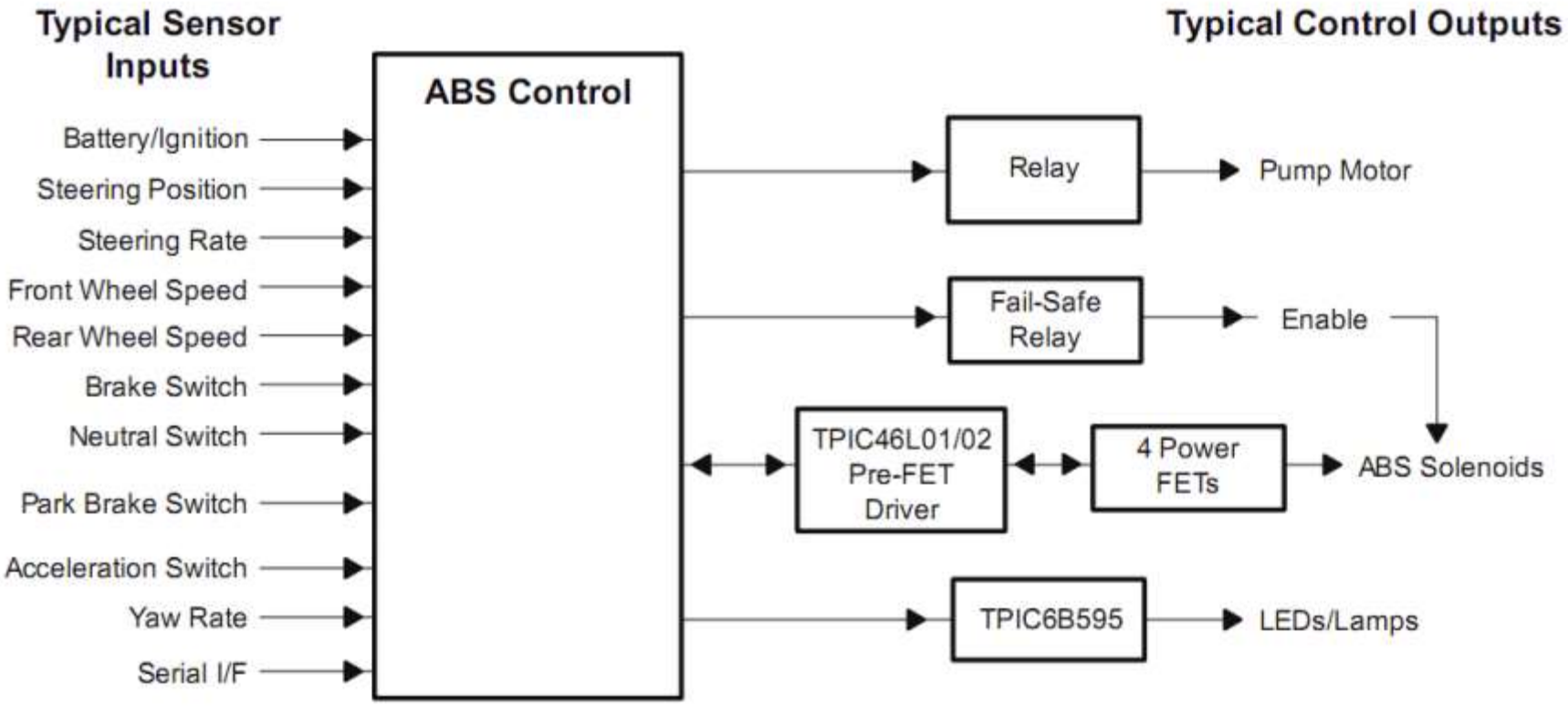
- First of all wheel speed sensor detects speed based on speed of rotating toothed wheel
- Increase in no. of pulses generated if wheel speed increases
- Decrease in no. of pulses generated if wheel speed decreases
- No change in no. of pulses generated if wheel speed remains same
- No. of pulses generated is sent to ECU
- ECU compares the inputs coming from different channels
- ECU generates suitable control signals
- Signals will be sent to hydraulic valves
- Normally valves are open and don’t interfere with breaking process

Working of an ABS systems

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- When the controller senses that a wheel is locking up while braking, it first activates solenoid to close a valve in the affected wheel's brake line which prevents the pressure from increasing any further.
- If the locked wheel continues to lose speed, the controller activates a second solenoid which bleeds pressure off the affected brake line, in effect releasing the brake for that wheel regardless of whether the driver is still pushing on the brake pedal.
- As soon as the wheel regains traction and its speed increases, the solenoids are de-activated, and normal braking resumes.
- If the wheel starts to skid again, the brake will promptly begin to lock up, ABS will take over again. This cycle is repeated 12 to 15 times per second until either the road condition changes or the driver releases the brakes.
- The ABS will minimize the skid and will allow the driver to maintain directional control of the vehicle.

Working of an ABS systems



Advantages of ABS

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Feature	Benefit
Control of steering	Increase steering ability and vehicle stability during braking
Fail safe electrical/electronic system	If the electrical/electronic system fails, the ABS is shut off, returning the vehicle to normal braking.
Self-diagnosing system	Built-in system makes maintenance checks quick and easy.
Diagnostic tool compatibility	ABSs are compatible with industry standard hand-held and computer-based diagnostic tools
ABS Malfunction Indicator Lamp	Informs the driver or technician that an ABS fault has occurred.

Electronic brake Force distribution

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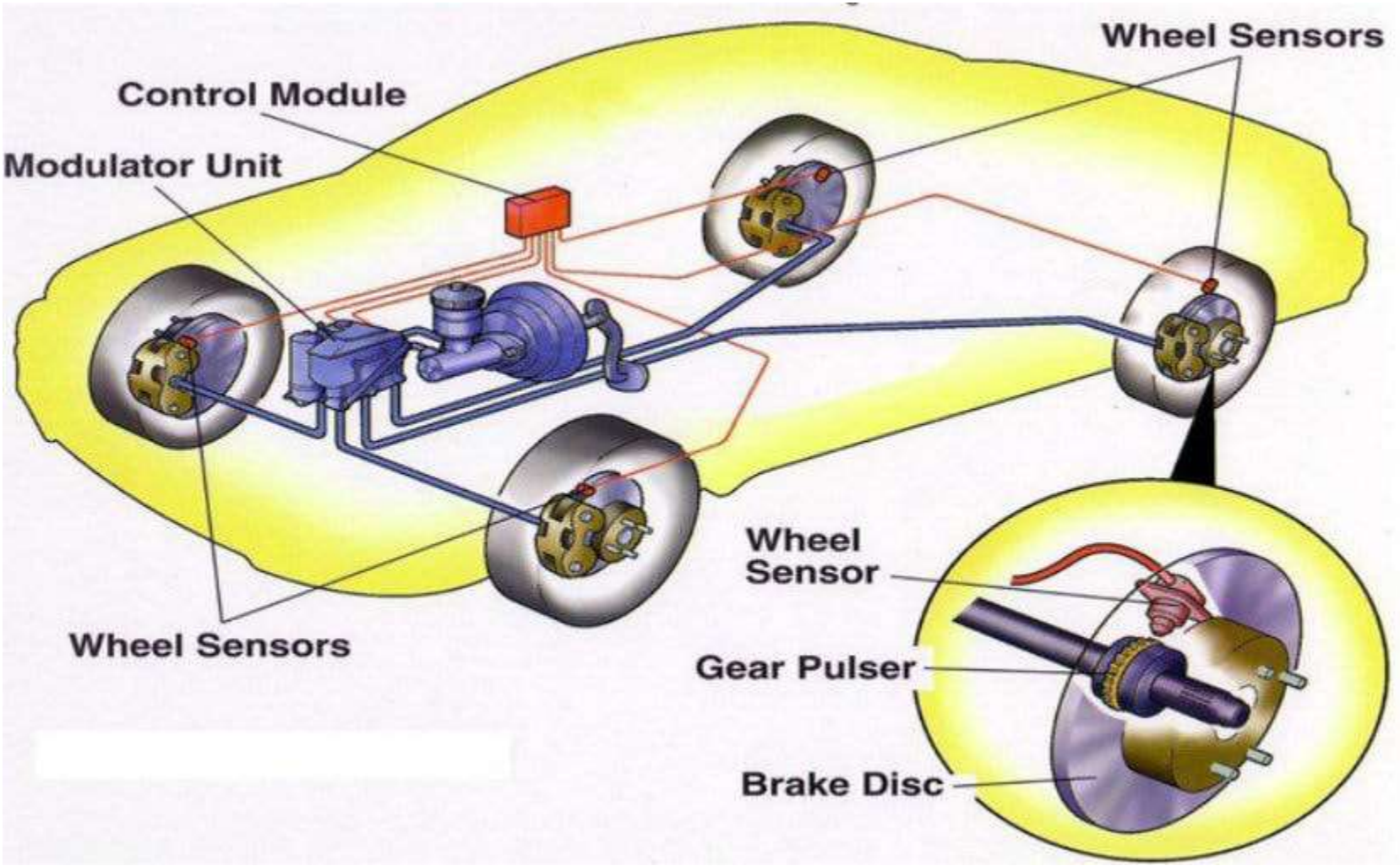
- EBD is an automobile brake technology that automatically varies th amount of force applied each wheel based on road condition, speed, loading on wheel.

Main purpose of EBD

- To prevent the wheel of a vehicle from locking up.
- To prevent the vehicle from over – steering and under steering
- To effectively reduce the stopping distance of a vehicle

Electronic brake Force distribution

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Working of EBD

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- EBD system are usually made up of four subcomponents that are monitored and guided by an electronic control unit
- Speed Sensor
  - To monitor how fast the wheel is rotating
- Brake force modulator
  - It increases or decreases brake force applied to a wheel
- Acceleration / deceleration sensor
  - Detect the vehicle forward and sideways acceleration/ deceleration
- Yaw sensor
  - Monitor a vehicle movement along its vertical axis

Working of EBD

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- The electronic control unit interprets the information from the speed and yaw sensors and then sends commands to the brake force modulators.
- EBD works by monitoring each wheel's response to the brake and then tailoring the amount of brake – force applied to each wheel.
- If one of the wheel is locked, EBD senses it and redistribute the brake force to the unaffected wheels to obtain optimal braking power.