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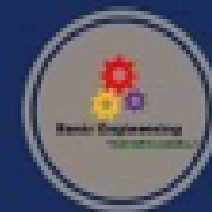
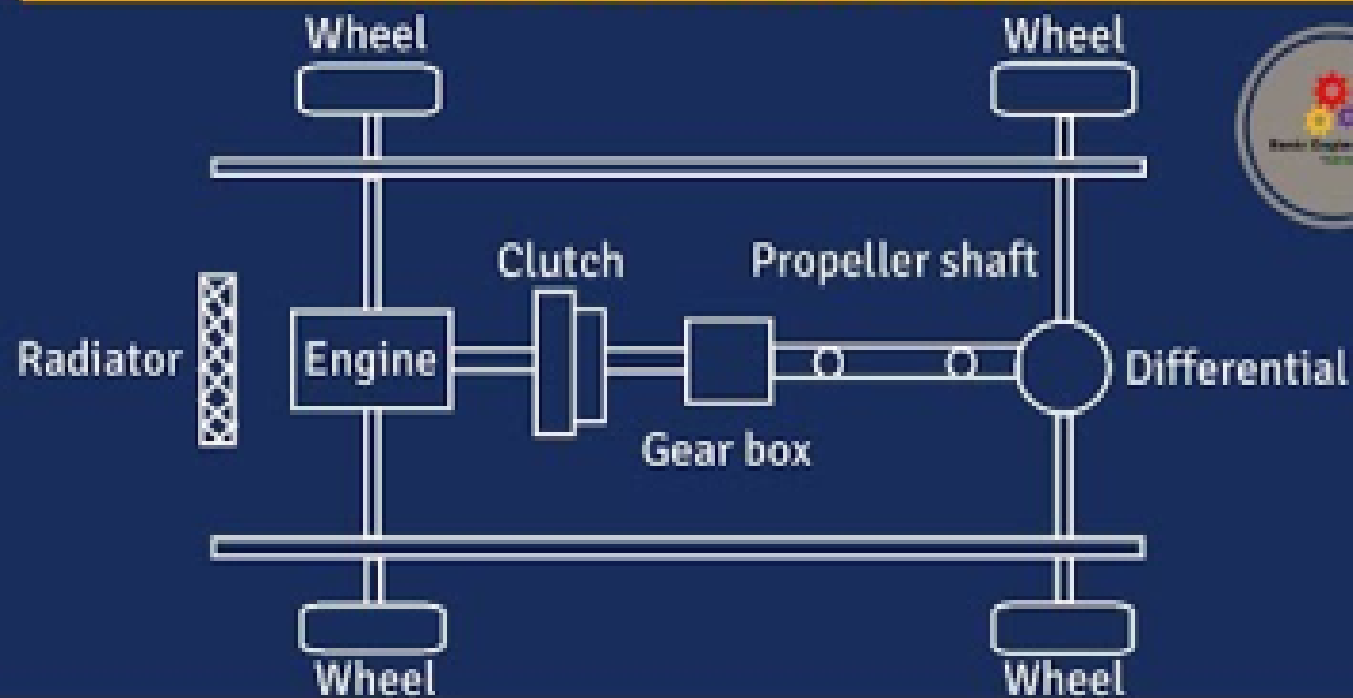
@ENGINEERINGWALLAH

UNIT IV

Vehicle Systems

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CHASSIS LAYOUT



Components

Engine

Steering mechanism

Clutches

Suspension System

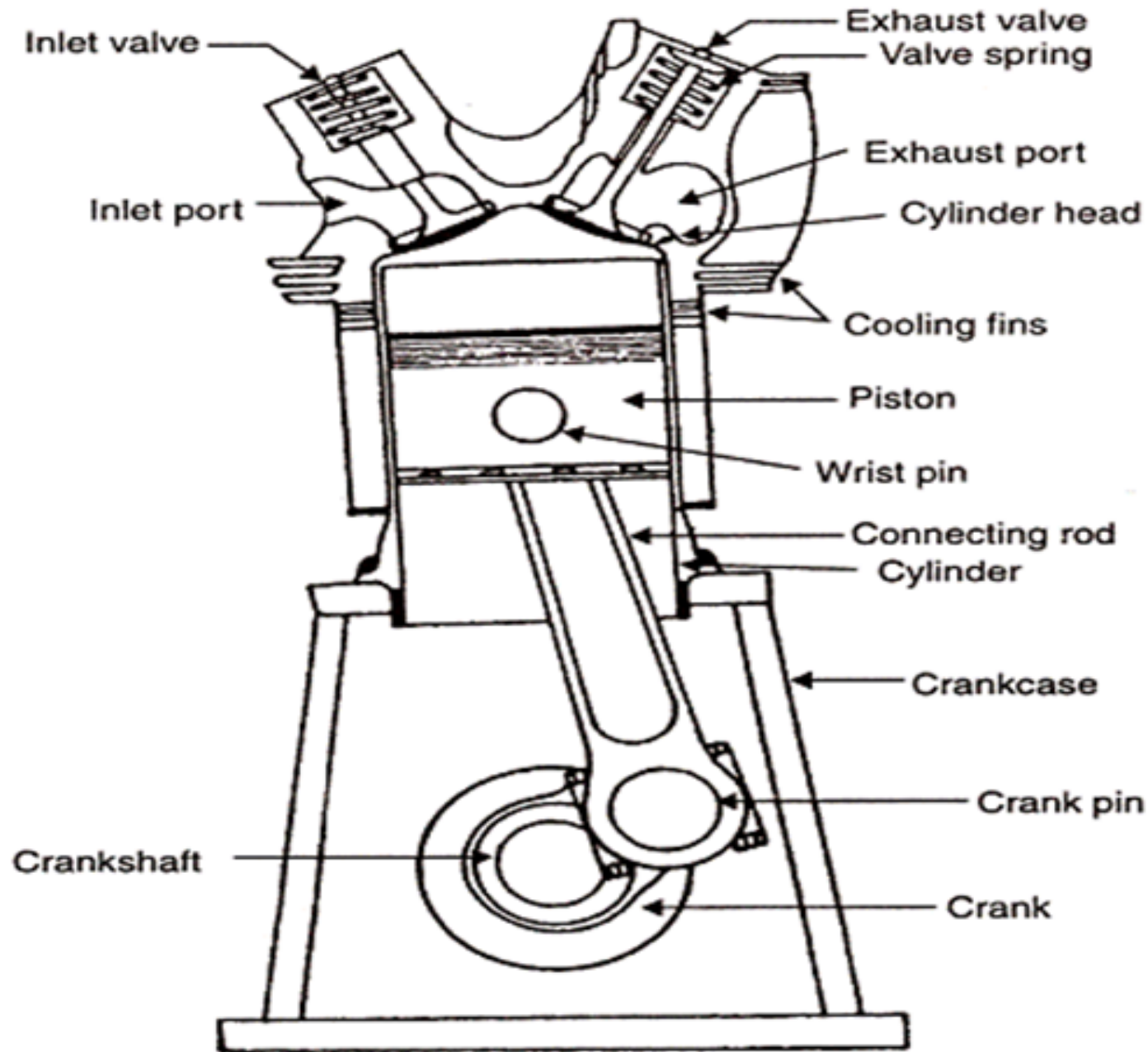
Cooling System

braking system

propeller shaft

Universal joint

Components of I C engine



Components of I C engine

1. Cylinder

- i. In cylinder the piston reciprocates to develop power
It has to withstand very high pressure upto 75 bar and temp upto 2400 C
- ii. The combustion is take place inside the cylinder
- iii. It is air cooled or water cooled
- iv. It is made of cast iron or alloy steel

2. Piston

- i. It is made of cast steel
- ii. It compressed the air fuel mixture during the compression stroke
- iii. It is used to transmit the gas force to the connecting rod and then crank during compression stroke

3. Piston pin

- i. It is made of hardened steel
- ii. It is used to connect piston to the end of connecting rod

4. connecting rod

- i. It is a rod of circular or rectangular cross section
- ii. Its small end is connected to the piston and large end is connected to the crank
- iii. It converts reciprocating motion of piston into rotary motion of crankshaft

5. Crank and crankshaft

- i. Crank is the integral part of the crankshaft
- ii. Crankshaft is supported in main bearings and carries the balancing weights

6. **Spark plug**

It is used to provide high intensity spark for combustion of air fuel mixture in petrol engines

7. **Engine bearings**

- i. Crankshaft is supported in main bearings
- ii. bearing provides smooth motion to the crankshaft and reduce friction

8. **Suction valve**

It is the passage which carries the charge from carburetor to the engine

9. **Exhaust valve**

it is the passage which carries the exhaust gases to the atm

Terminology used in I C engine

1. Bore

Bore is the inside diameter of the cylinder

2. Piston stroke

It is the distance travelled the piston from TDC to BDC

3. TDC

- i. In case of vertical engines when the piston is at the top most position then the crank position is known as TDC
- ii. In case of horizontal engines it is known as IDC

4. **BDC**

- i. In case of vertical engines when the piston is at the bottom most position then the crank position is known as BDC
- ii. In case of horizontal engines it is known as ODC

5. Swept volume

It is the volum swp by the pist as it moves from TDC to BDC or from BDC to TDC

6. Clearance volume

- i. It is a volume between the cylinder head and the piston top when the piston is at top dead center (TDC).
- ii. It can also be defined as the volume of cylinder that is not swept by the piston.

Steering System

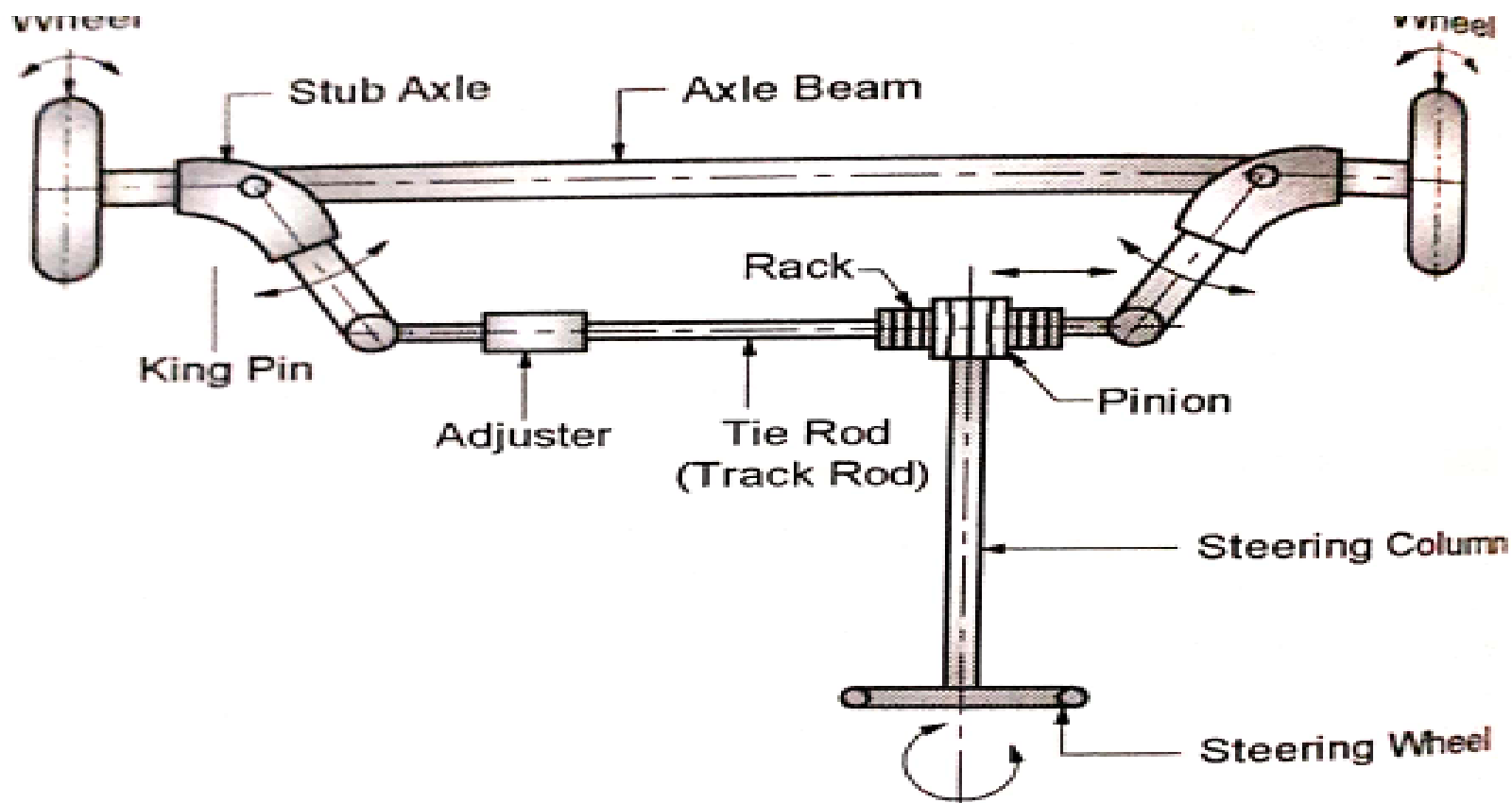
Functions

- i. Helps in swinging the wheels to the left or right.
- ii. Converts the rotary movement of the steering wheel into an angular turn of the front wheels.
- iii. Provide easiness to the operator by leverage in order to make it fairly easy to turn the wheels.
- iv. Absorbs a major part of the road shocks thereby preventing them to get transmitted to the hands of the operator

Ackerman Steering System

Introduction

this is to convert rotary motion of steering wheel into angular motion of front wheel to turn vehicle



Construction

1. Axle beam

- i. Vehicle chassis is supported on axle bam
- ii. Axle beam take the weight of the vehicle and transmit it to stub axle

2. Stub Axle

- i. It is pivoted at the two ends of the axle beam by king pins
- ii. one end of stub axle is connected to wheel and otherend is connected to tie rod

3. King Pin

King pin is used to pivots the the stub axle on axle beam

4. Tie Rod

- i. Two stub axle connected together through tie rod
- ii. The length of tie rod can adjust

5. Rack and Pinion

- i. It is a special type of gear which is to convert rotary motion of pinion into reciprocating motion of rack
- ii. rack is mounted on the tie rod and pinion is mounted on a steering column

6. Steering Wheel

To turn the vehicle we have to rotate the steering wheel
Steering wheel is connected to steering column

Working

- i. To turn the vehicle we have to rotate the steering wheel
- ii. As steering wheel is connected to steering column, so as we rotate the steering wheel, steering column also rotate
- iii. When steering column rotates, the pinion mounted on steering Column also rotate
- iv. Now the rotary motion of the pinion is converted into linear motion of rack and tie rod
- v. As per the rotation angle the length of tie rod can adjusted
- vi. Now as the tie rod is connected to stub axle, the linear motion of the tie rod oscillate the stub axle about the king pin
- vii. Stub axle is connected to wheel
- viii. Hence as the stub axle oscillates, wheel takes a turn

Advantages

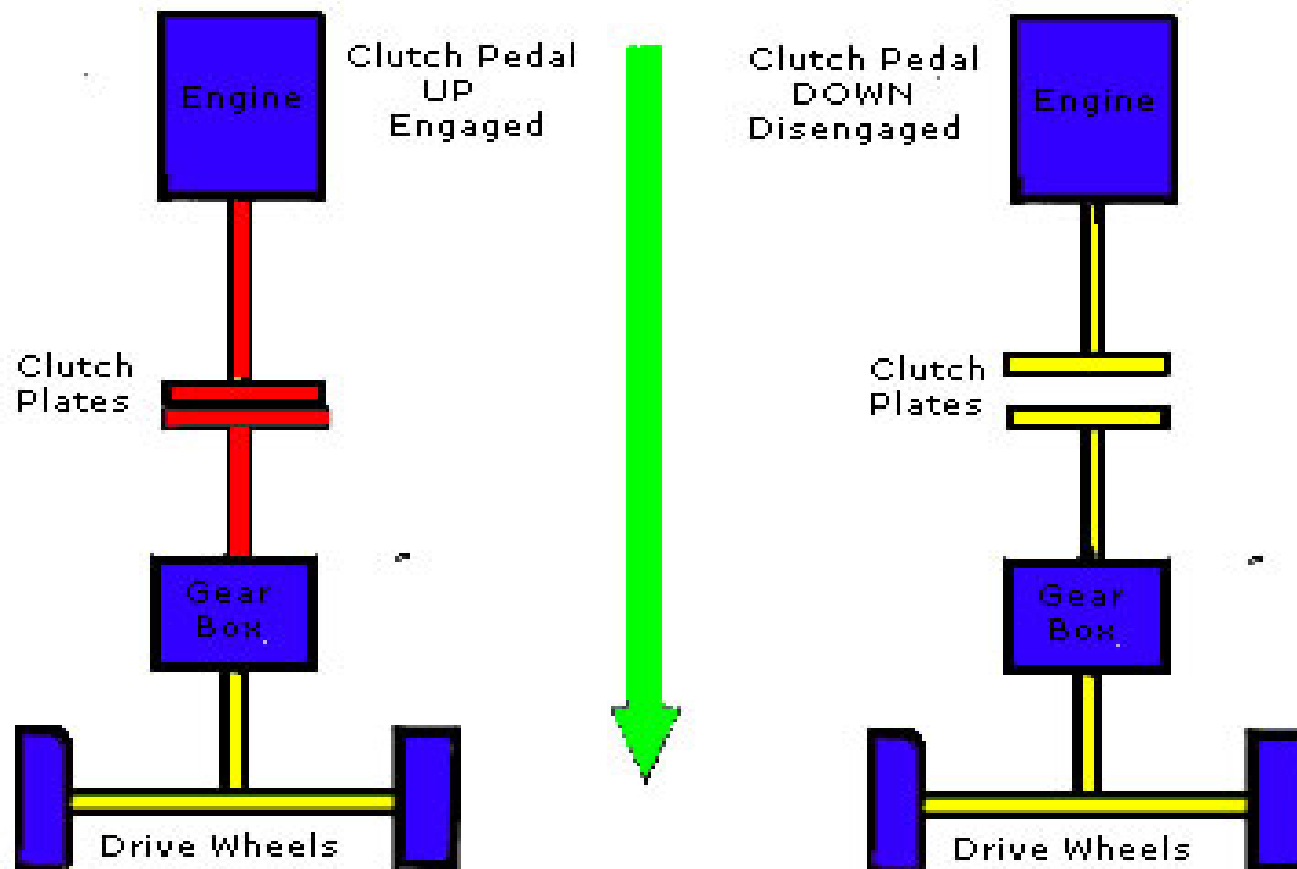
- i. Simple geometry and ease of calculations
- ii. Avoids front tire slippage and helps in achieving pure rolling
- iii. Easy to fabricate
- iv. Takes minimum space compared to other steering geometry like the Davis geometry

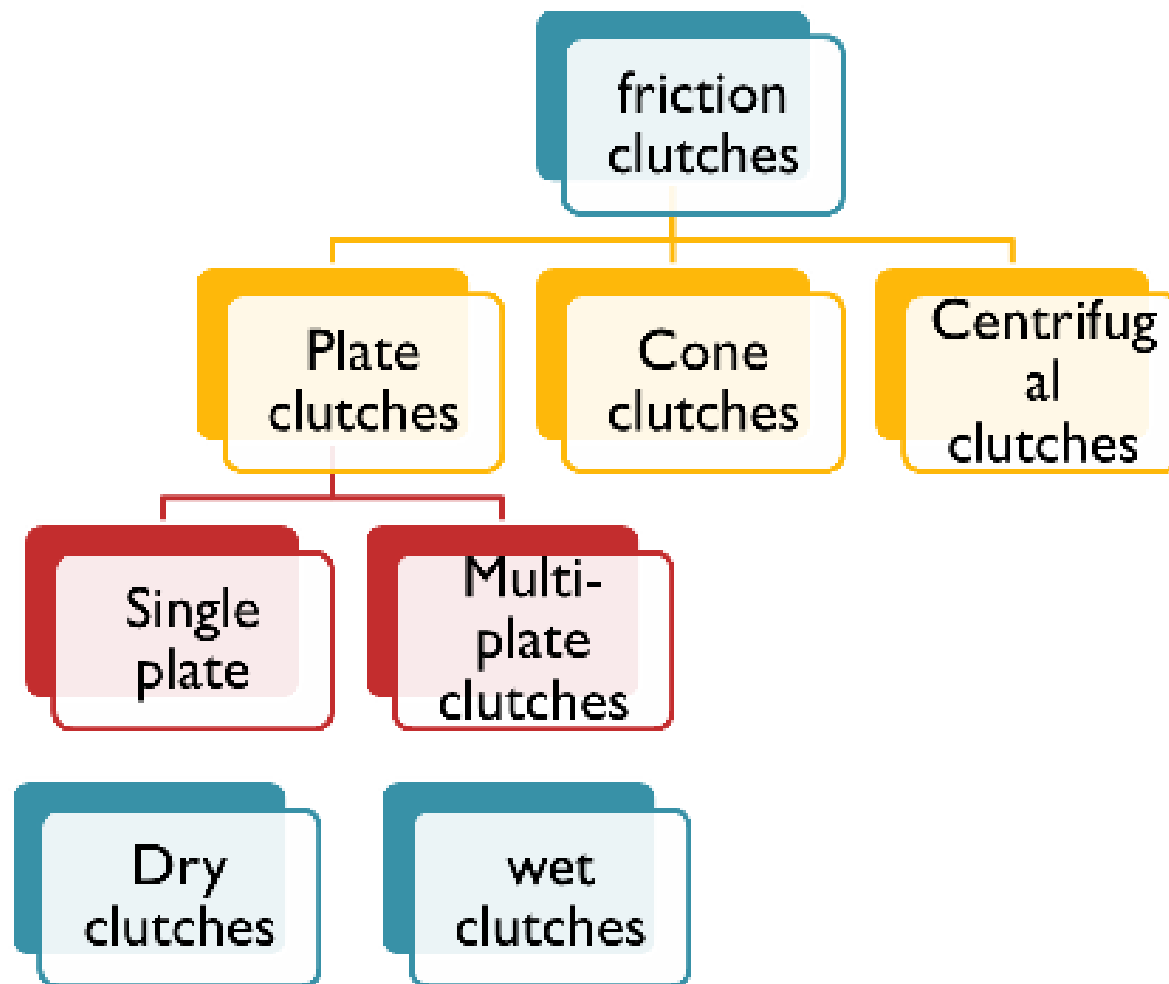
Applications

Many modern cars uses this mechanism

Clutches

It is a mechanical device which is used to connect or disconnect the driving shaft from the driven shaft at the will of the operator.





Single Plate Clutch

Introduction

- i. Single Plate Clutch is a type of friction clutch in which power is transmitted by means of friction between the contact surface usually called clutch plates.
- ii. As name suggest a this clutch consists of only one clutch plate with both side friction lining (frictional surface).
- iii. These surfaces have high Coefficient of friction.
- iv. Single plate clutch also called dry clutch because no lubricant is used as coolant.

Construction

- i. A single plate clutch is consisting of various parts; for proper working.
- ii. They are arranged in a systematical order. Mainly it consists of following parts

1. Clutch plate:

- i. In single plate clutch only one clutch plate is used.
- ii. Clutch plate is main component of clutches.
- iii. It is thin disc type metallic plate having both side frictional surfaces.
- iv. Clutch plate is assembled in between flywheel and pressure plate.

2. Pressure plate:

- i. The pressure plate which is generally made up of cast iron.
- ii. It helps in applying pressure on clutch plates to maintain the proper contact between the surfaces of flywheel and clutch plate by means of spring which are attached to it.

3. Springs:

- i. Springs are used to maintain the pressure on pressure plate for proper connection between clutch plate and flywheel
- ii. prevent the slipping of contact surfaces.

4. Flywheel:

Flywheel is attached to engine output and its other side comes in contact with clutch plate when pressure is applied by the pressure plate.

Working:

- i. Working of single plate clutch is very simple.
- ii. A mechanism is responsible for the engagement and disengagement of clutch.
- iii. We easily engage and disengage the torque transmitting shafts just by apply some force on the paddle of automobile.
- iv. A lever is attached to the paddle which is responsible for the force transmission from the paddle.
- v. When pedal is pressed spring is compressed and engine is free to move without any load. lever is attached in such a manner when we press the clutch paddle pressure plate moves away from the flywheel; due to this the connection between the clutch plate and flywheel released and shafts are disengaged.
- vi. During this disengaged position, only driving shaft rotates

- viii. This time we can easily change gears in case of automobiles. Again if we want to engage the shafts just release the clutch paddle; then springs attached to the pressure plate push the pressure plate forward.
- ix. Clutch plate has both side friction lining that's why it mounted in between pressure plate and flywheel and helps in torque transmission.

Advantages:

- i. The working of the single plate clutch is.
- ii. Power losses are very
- iii. Single plate clutches have quick operation and respond fast.
- iv. No requirement of coolant because less is generated therefore they are called dry clutches.

Disadvantages:

- i. It has less torque transmitting capacity
- ii. It has bigger in size even for transmitting less torque.
- iii. It requires high maintenance because they are dry clutches and it is necessary to prevent them from moisture or any leakage of lubricant/oil in machinery.
- iv. Single plate clutches have high wear and tear rate

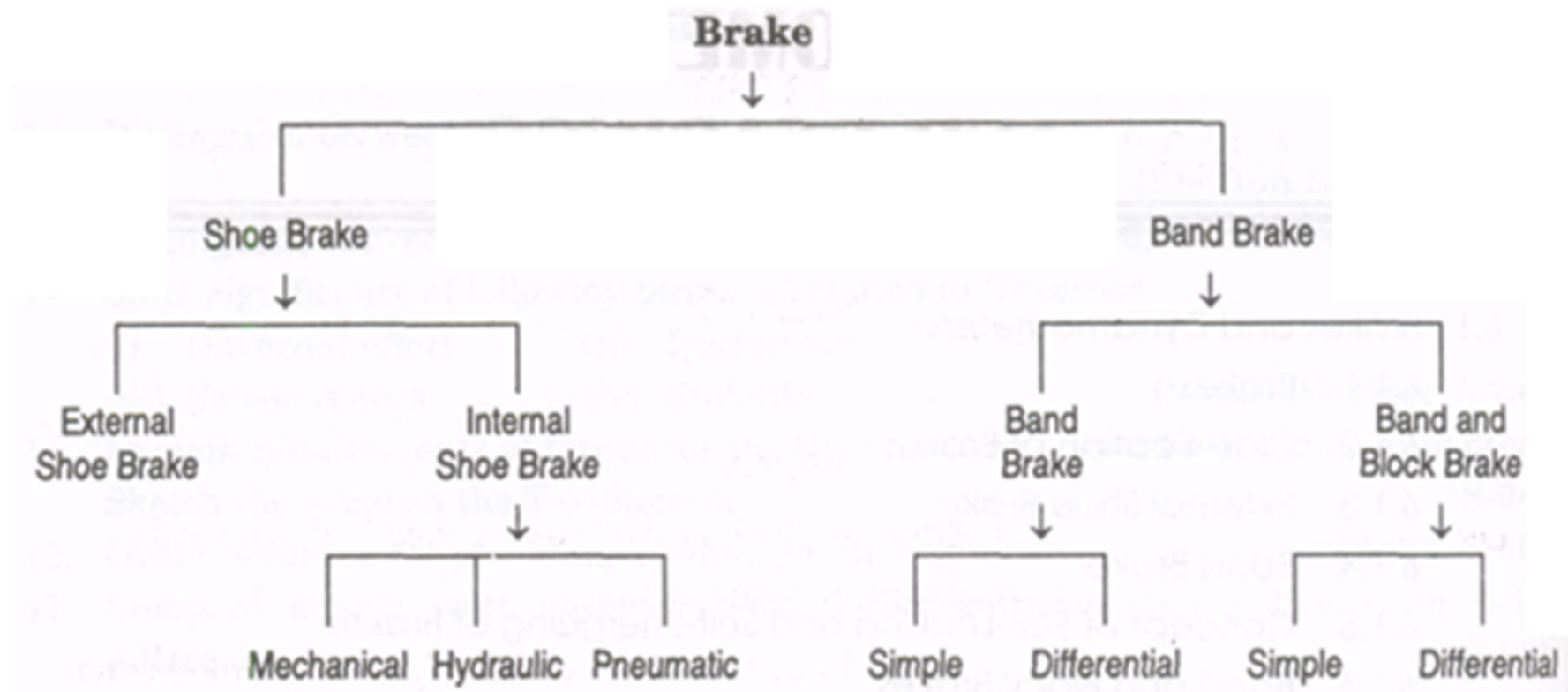
Applications:

These are used in large size automobiles where radial space is not constrain

Brakes

Function

Brake is the mechanical device used to slow down or completely stop the motion of a moving system by applying an artificial frictional resistance.



Drum Brake

Introduction

- i. This system is also known as the 'Internal Expanding Shoe Type' brake system.
- ii. This type of brake got its name from the drum structure of cylindrical-shape.

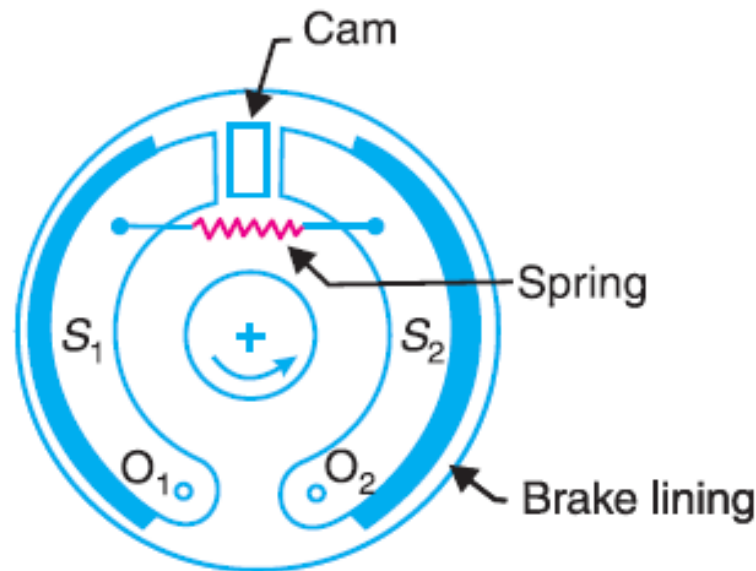


Fig. 19.24. Internal expanding brake.

Construction

this consists of following parts

- i. A cylindrical drum itself made of cast iron
- ii. A brake shoe actuating mechanism – either by a cam or a hydraulic wheel cylinder
- iii. A pair of brake shoes (one each of Leading & Trailing)
- iv. Shoe adjuster
- v. Return springs
- vi. Anchor Plate / pins

Working

- i. In this system, the brake shoes are actuated by a cam, which is pedal.
- ii. When you press the brake pedal, the cam turns..

- iii. Thus, it causes the brake shoes to expand outwards and rub against the drum.
- iv. The friction between the brake linings and the drum causes the drum to stop rotating; thereby stopping the wheel.
- v. When you release the brake pedal, the retracting springs bring the brake shoes back to their original position.
- vi. This results in a gap between them and the drum and to again spin it freely.

Advantages

- i. Simple design.
- ii. Fewer parts.
- iii. Easy & cheaper to manufacture.
- iv. Low maintenance

Disadvantages

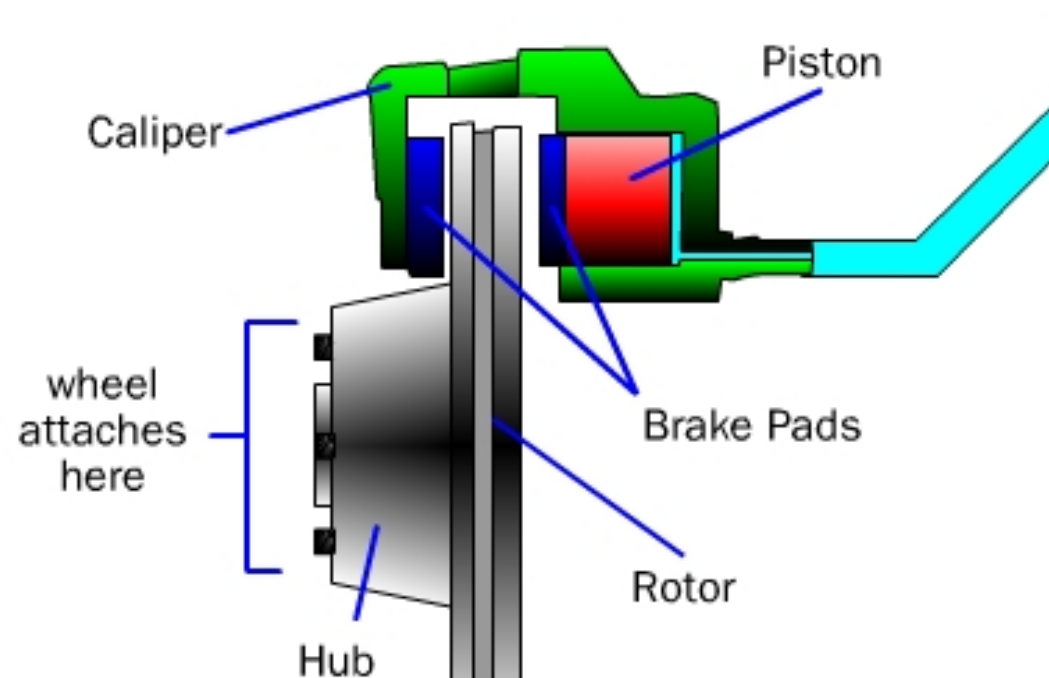
- i. Low braking force compared to Discs.
- ii. Brakes 'fade' when the driver applies them for a prolonged time.
- iii. The brake shoe lining made of asbestos is harmful to humans.
- iv. When wet, the braking grip reduces considerably.

Applications

Two-wheelers such as scooters, commuter bikes, three-wheelers including auto-rickshaws

Disc brake

Introduction



Construction

1. Wheel Hub

- i. The disc rotor is attached to the wheel hub and it rotates with it.
- ii. The wheel of the vehicle is bolted to the wheel hub.

2. Caliper Assembly

The caliper assembly consist of

- (i) Brake pad: It makes contact with the rotor disc and due to the friction between the brake pad and rotor disc the vehicle speed reduces and it stops.
- (ii) Caliper bracket
- (iii) Caliper frame

(v) Slider pin: It is the sliding pin which slides in the hole when brake is applied.

(vi) Dust boots: It prevents the entry of dust into the caliper pin or slider pin hole

3. Piston

It applies the brake force on the brake pads when brake lever is pressed

4. Disc Rotor

- i. It is the rotating part of disc brake.
- ii. When brakes are applied, a lot of heat is generated which can decrease the braking efficiency, so the rotor has drilled vent holes on it which dissipates the heat.

Working

- i. When brake pedal is pressed, the high pressure fluid from the master cylinder pushes the piston outward.
- ii. The piston pushes the brake pad against the rotating disc.
- iii. As the inner brake pad touches rotor, the fluid pressure exerts further force and the caliper moves inward and pulls the outward brake pad towards the rotating disc and it touches the disc.
- iv. Now both the brake pads are pushes the rotating disc, a large amount of friction is generated in between the pads and rotating disc and slows down the vehicle and finally let it stop.
- v. When brake pad is released, the piston moves inward, the brake pad away from the rotating disc.
- vi. And the vehicle again starts to move.

Advantages

- i. It is lighter than drum brakes.
- ii. It has better cooling
- iv. It provides uniform pressure distribution
- v. Replacement of brake pads are easy.

Disadvantages

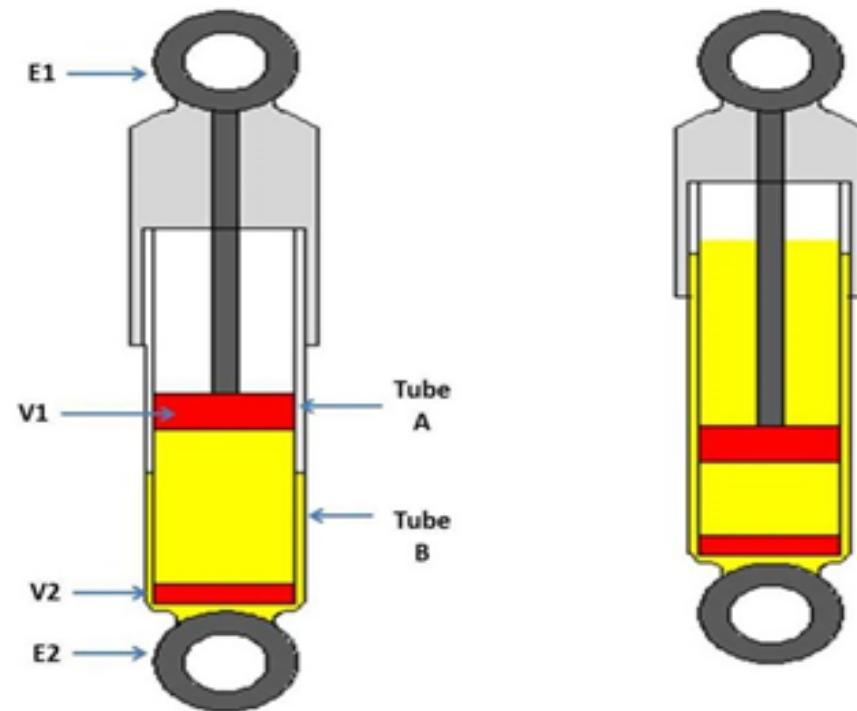
- i. It is costlier than drum brakes.
- ii. Higher pedal pressure is required for stopping the vehicle.
- iii. This brake system is installed with vacuum booster.
- iv. It is difficult to attach a suitable parking attachment.

Suspension System

Function

- i. To maintain correct vehicle ride height
- ii. To Reduce the effect of shock forces.
- iii. To maintain correct wheel alignment.
- iv. To Support vehicle weight.
- v. To Keep the tyres in contact with the road.
- vi. To Control the vehicle's direction of travel

Tube Telescopic Shock Absorber



Twin Tube Telescopic Shock Absorber

Construction

this type of shock absorber consists of

1. Tubes

- i. This consists of two tubes
- ii. one inner tube shown by symbol A and other outer tube shown by symbol B.

2 way valves

- i. There are two 2 way valves
- ii. one is shown by V1 and other is by V2.
- iii. Valve V1 is connected with a piston rod and free to move vertically inside the tube A.
- iv. The Valve V2 is fixed at one end of the tube A.

3. Oil

Oil is filled inside the tube A below the valve V1.

4. eyes of the shock absorber

- i. There are two eyes of the shock absorber which is shown by E1 and E2.
- ii. E1 is connected to the chassis frame and E2 is connected to the axle

Working

- i. At the initial position piston or we can say valve V1 is at middle of the cylinder.
- ii. The annular space between tube A and B is half filled with the oil.

- iii. When the vehicle come across a bump, the eye E2 tends to move upward.
- iv. Therefor to absorb the bump valve V1 start to move downward which compress the fluid trapped between the valve V1 and V2.
- v. This will pressuring the valve V1 and V2 thus the oil start to move from upper side of the valve assembly through valve V1 and also some oil move in the annular space between tube A and B through valve V2.
- vi. This process converts all the vibration energy into fluid friction and absorbs shocks.
- vii. When the vehicle rebound, the valve V1 start to move upward which again pressuring the valve V1 hence it open again and the oil start to flow below valve V1.
- viii. During its upward movement it also sucks some oil from the annular space between tube A and B thus the vehicle get its initial condition.

Advantages

- i. This shock absorber is available in various size according to the requirement.
- ii. Noise free operation
- iii. Less maintenance required.
- iv. Low manufacturing cost.
- v. High operating speed.
- vi. Simple Working

Cooling System

Purpose

- i. Normal process produces heat that must be carried away by coolant
- ii. Cooling system transfers heat to cooler outside air when engine is hot.
- iii. Cooling system keeps heat in the engine when engine is not warm enough.
- iv. Modern cooling systems are designed to maintain an even temperature of about 180 to 230°F (82 to 113°C).ff

Types of Cooling system

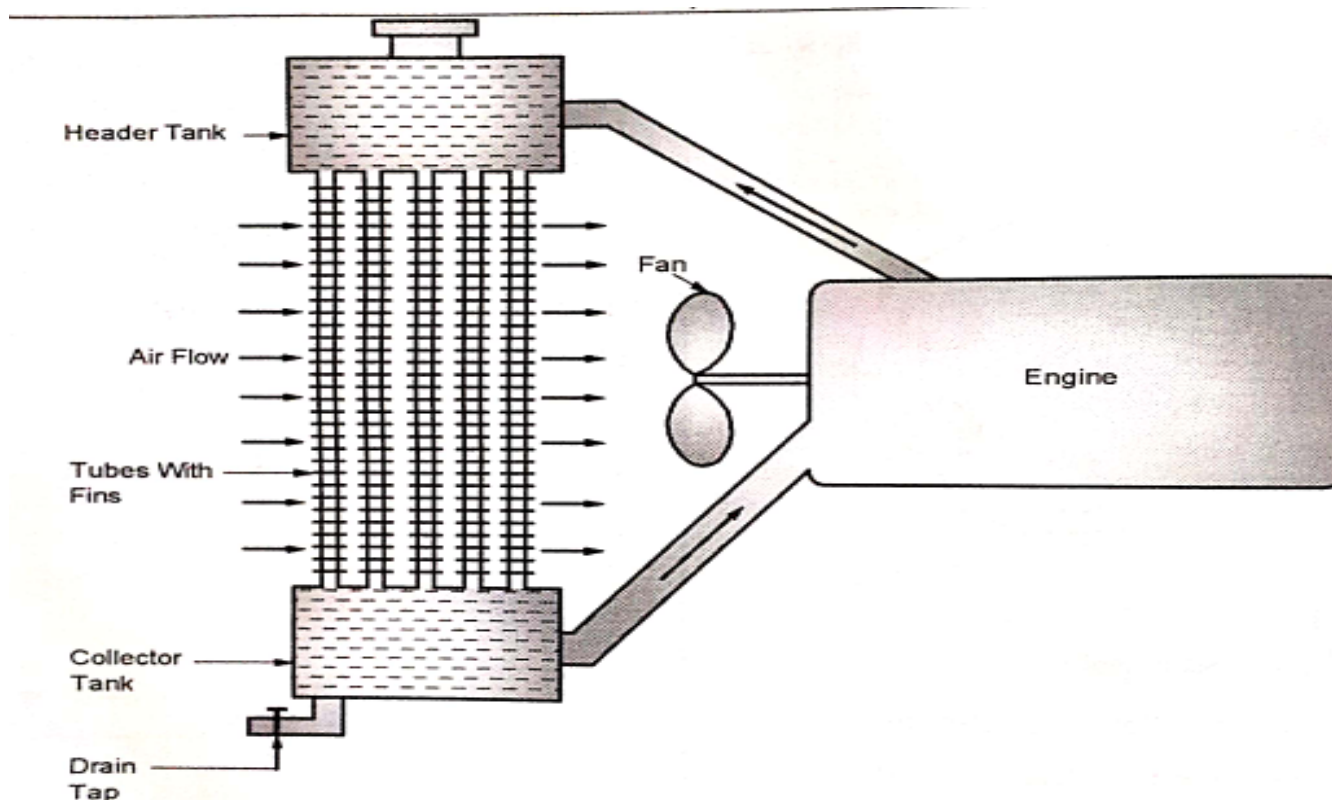
Air Cooling System

Water Cooling System

Thermo-syphon Water Cooling System

Introduction

- i. Thermo-syphon Water Cooling System is based on the fact that water becomes light on heating.
- ii. In this water is used as a coolant



Construction

this system consists of

1. Radiator

- i. The radiator is cooled by causing air to flow over it
- ii. The radiator consists of
 - Collector tank
 - Tubes with fins

2. Water Jacket

The top and bottom of the radiator are connected to the top and bottom of the cylinder water jacket respectively with the help of pipes.

Working

- i. The engine is surrounded by a water jacket
- ii. The water flows through a water jacket and absorbs heat from the cylinder
- iii. Now this heated water flows through a radiator
- iv. As the radiator consists of fins, heated water becomes cold.
- v. This cooled water from the lower tank is passed into the cylinder water jacket and
- vi. hence circulated again for the process.

Advantages

- i. Higher heat transfer rates compared to air cooling
- ii. More heat is removed because of higher heat capacity of liquid
- iii. Very suitable for massive engines which need large amount of heat to be removed

Disadvantages

- i. Extra equipment like radiator, pipes, motor are required.
- ii. Extra power is required to drive the liquid(unlike natural motion like thermo-siphon)
- iii. Need to build liquid jackets around cylinder to remove heat.

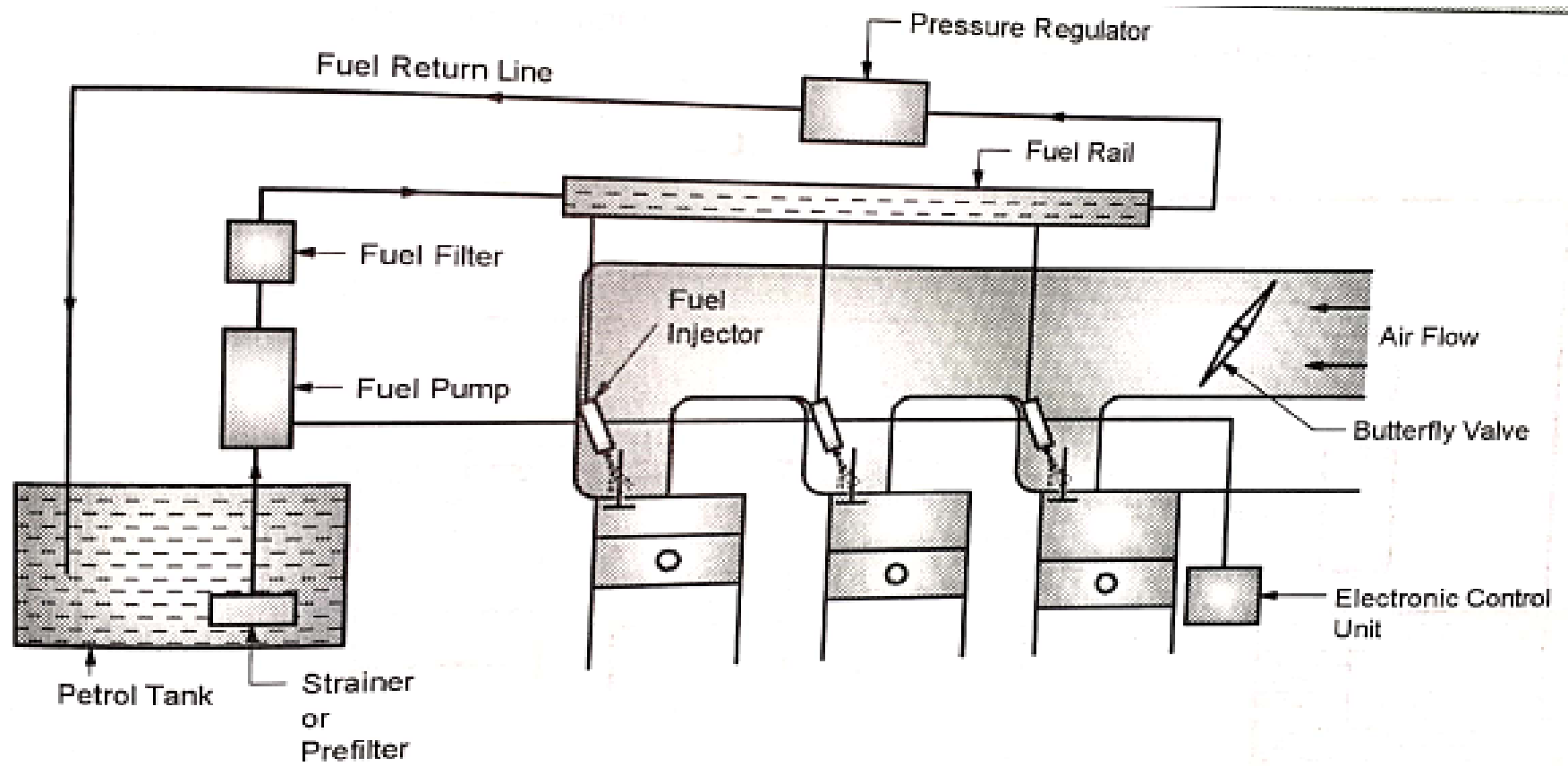
Applications

this system is highly effective used in four-wheelers

Multi Point Fuel Injection

Need For MPFI

- i. Due to ever increasing stricter environmental regulations automobile industry is required to meet very strict emission norms.
- ii. Catalytic converters were introduced for this purpose.
- iii. Now for catalytic converter to be effective very careful control of the air-fuel was required.
- iv. It was not feasible to achieve this type of close loop control with carburetors.
- v. Gradually new engines are equipped with MPFI system. MPFI have a fuel injector for each cylinder.
- vi. MPFI spray right at the intake valve and provide more accurate fuel metering and quicker response.



Construction

this system consists of

1. Diesel tank

Diesel is stored in diesel tank

2. Fuel pump

- i. Fuel pump increase the pressure of diesel before feeding it to the fuel rail
- ii. The fuel pump is driven by an electric motor

3. Fuel filter

Fuel filter is used to remove the dirt particles

4. Pressure regulator

Pressure regulator controls the pressure of diesel in fuel rail

5. Fuel injector

- i. the fuel injector is placed at the top of every cylinder
- ii. The high pressure diesel enters in the fuel injector and the fuel injector injects the diesel into cylinder

6. Electronic Control Unit (ECU)

- i. The ECU controls the fuel injection system
- ii. It decides the amnt of fuel injected

Advantages

- i. It increases fuel efficiency of the engine
- ii. With MPFI system vehicle have less emissions
- iii. Better atomization of fuel
- iv. It is reliable
- v. It improves cold start characteristics of the engine
- vi. It reduces vibrations in the engine

Disadvantages

- i. There could be a case of misfiring sometimes
- ii. Regular inspection of fuel injectors is required
- iii. It is costly as compared to conventional systems

Applications

Multi point fuel injection (MPFI) systems are used in Gasoline (or petrol) engines to inject fuel.

Anti-lock braking system (ABS)

Introduction

- i. Anti-lock braking system (ABS) is an automobile safety system that allows the wheels on a motor vehicle to maintain tractive contact with the road surface according to driver inputs while braking, preventing the wheels from locking up and avoiding uncontrolled skidding.
- ii. ABS generally offers improved vehicle control and decreases stopping distances on dry and slippery surfaces.

Purpose

- i. An anti-lock braking system or anti-skid braking system (ABS) is an automobile safety system that allows the wheels on a motor vehicle to maintain tractive contact
- ii. The basic purpose is that it does not allow to lock during braking or avoids skidding

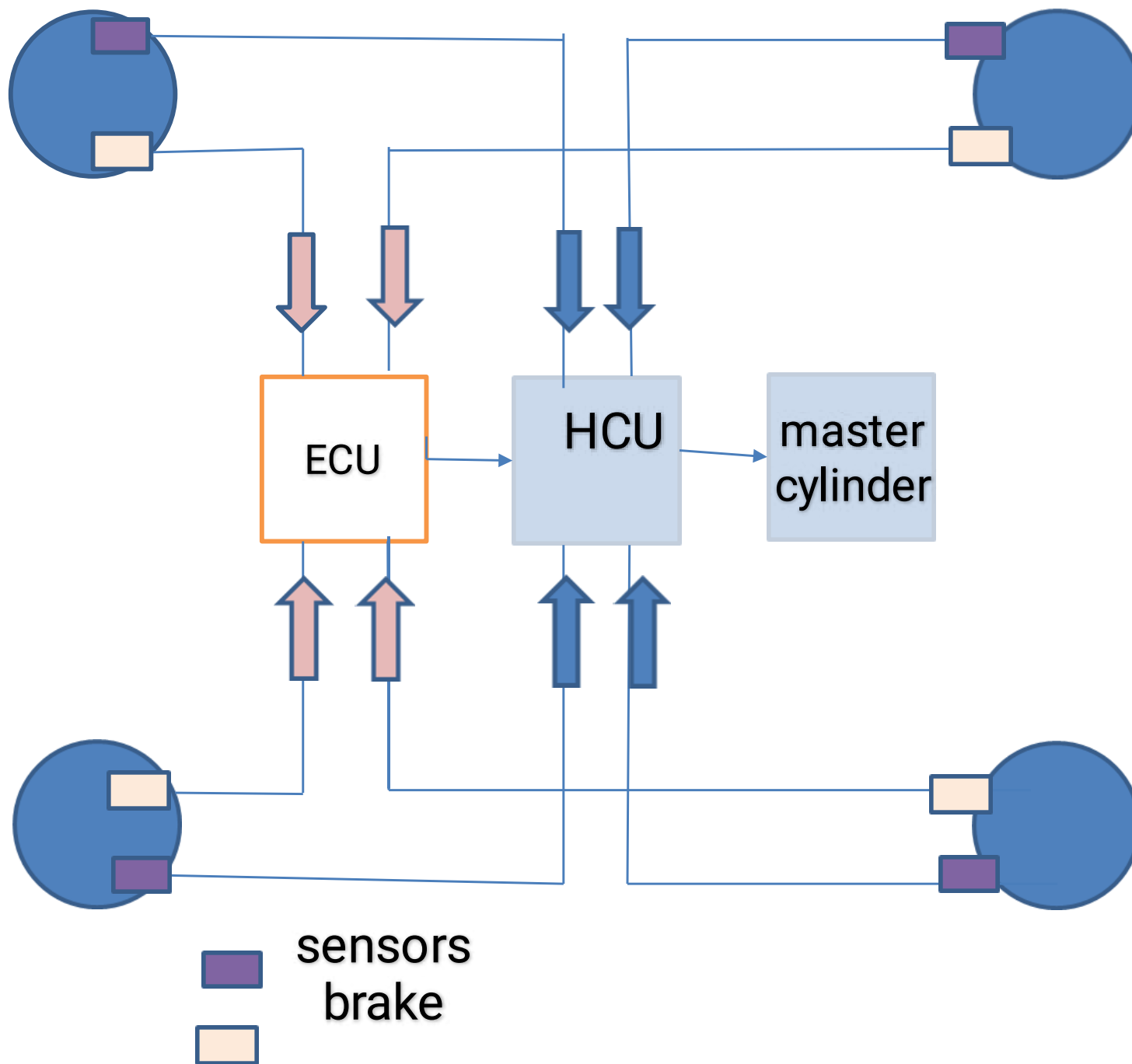
Components Of Abs

1. Electronic control unit (ECU)

- i. It receives signals from the sensors in the circuit and controls the brake pressure at the road wheels according to the data analysed by the Unit.
- ii. ECU assists the vehicle operator to prevent wheel lockup by regulating the wheel slip.

2. Hydraulic control unit or modulator

- i. It receives operating signals from the ECU to apply or release the brakes under ABS conditions.
- ii. It executes the commands using solenoid valves connected in
Thus brakes can be actuated by controlling hydraulic pressure.



3. Power booster and master cylinder assembly

- i. It is activated when the driver pushes down on the brake pedal. The master cylinder transforms the applied pedal force into hydraulic pressure which is transmitted simultaneously to all four wheels.
- ii. It provides the power assistance required during braking.

4. Wheel sensor unit

- i. Speed sensors are comprised of a magnet wrapped in a coil and a toothed sensor ring.
- ii. An electrical field given off by the contact between the magnet and the toothed ring creates a AC voltage.
- iii. The voltage frequency is directly proportional to the wheel's rotational speed.
- iv. It monitors the rotational speed of the wheel and transmits this data to the ABS control module.

Working

- i. If a wheel-speed sensor signals a lock up - the ECU sends a current to the hydraulic unit.
- ii. This energizes the solenoid valve.
- iii. The action of the valve isolates the brake circuit from the master cylinder.
- iv. This stops the braking pressure at that wheel from rising, and keeps it constant.
- v. It allows wheel velocity to increase and slip to decrease.
- vi. When the velocity increases, ECU re-applies the brake pressure to restrict the wheel slip to a particular value.
- vii. Hydraulic control unit controls the brake pressure in each wheel cylinder based on the inputs from the system sensor.
- viii. This in result controls the wheel speed.

Advantages

- i. With the use of Abs stops the car at a shorter distance than the conventional brakes.
- ii. Prevents the wheels from locking up hence avoids uneven tyre wear.
- iii. Increases control.
- iv. Enables the possibility of a traction control system.
- v. Better braking performance under most conditions.
- vi. Abs offers more safety
- vii. Significantly reduced risk of skidding while braking.
- viii. Makes better use of the brake pads and brake disc.

Disadvantages

- i. Inconsistent stopping distances on various surfaces under variable conditions.
- ii. Under generally poor road conditions, Abs braking increases stopping distance.
- iii. Experienced operator can often brake better manually than with Abs brakes.
- iv. More expensive to repair and maintain.
- v. Increases the cost of the vehicle.
- vi. Involves the use of an extra sensor and a controller which increases the complexity.

Applications

An anti-lock braking system (ABS) is a safety anti-skid braking system used on aircraft and on land vehicles, such as cars, motorcycles, trucks, and buses

PROPELLER SHAFT

- The propeller shaft is a shaft that transmits power from gear box to the differential.
- On one end, propeller shaft is connected to main transmission shaft by universal joint.
- On the other hand, it is connected to differential pinion shaft by another universal joint.
- Propeller shaft transmits the rotary motion of main transmission shaft (coming from gear box) to the differential so that rear wheels can be rotated.
- A sliding (slip) joint, is also fitted between universal joint and propeller shaft on transmission side which takes care of axial motion of propeller shaft.
- Propeller shaft is made of a steel tube which can withstand torsional stresses and vibrations at high speeds.

Introduction of Propeller Shaft



Universal Joint

- i. A universal joint is a joint or coupling connecting rigid rods whose axes are inclined to each other
- ii. commonly used in shafts that transmit rotary motion.
- iii. It consists of a pair of hinges located close together, oriented at 90° to each other, connected by a cross shaft.
- iv. The universal joint is not a constant-velocity joint

