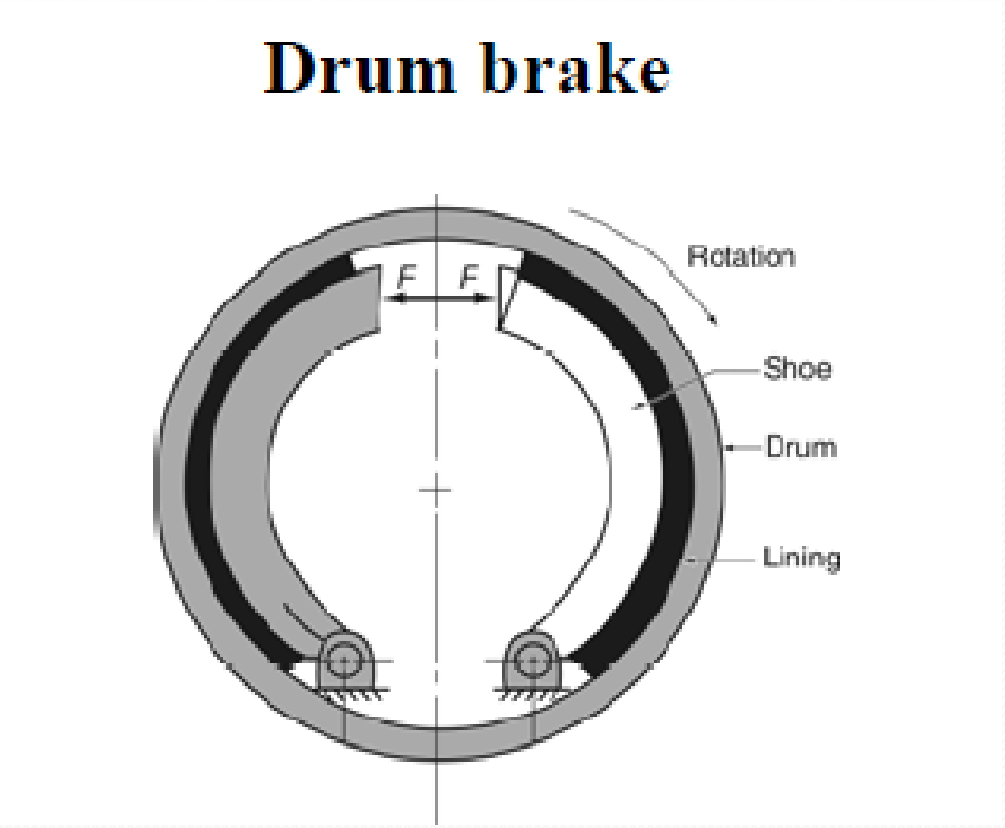
UNIT - VII

BRAKES

- **Principle:**
- Required to stop the vehicle within the smallest possible distance and this is done by converting the kinetic energy of vehicle into the heat energy which is dissipated into the atmosphere.
- **Breaking Requirements:**
- The brakes must be strong enough to stop the vehicle within minimum distance in an emergency. Driver must have proper control over the vehicle during the emergency braking and vehicle must not skid.
- Brakes should have good antifade characteristics i.e. their effectiveness should not decrease with constant prolonged application.

Drum brakes



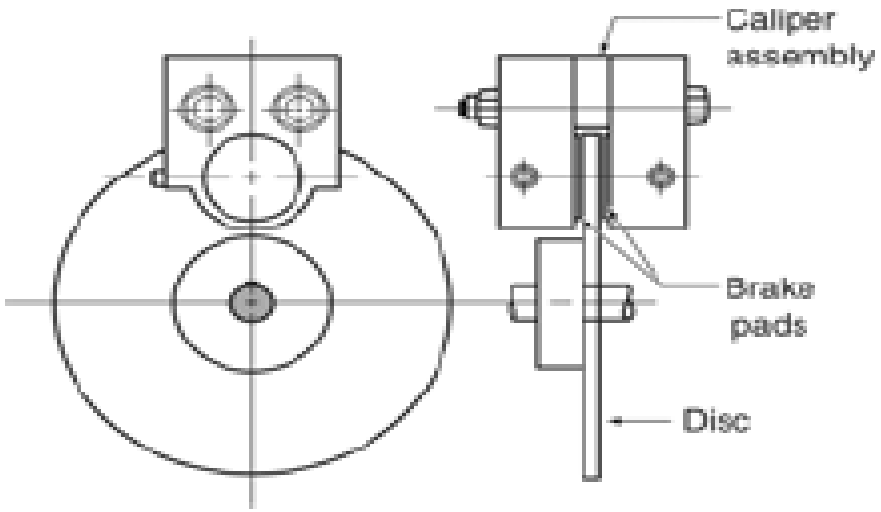
- **Construction and types**:
- In this a break drum is attached concentric to the axle hub whereas on the axle casing is mounted a black plate.
- In case of front axle , black plate is bolted to steering knuckle.
- The black plate is made up of pressed steel sheet and is ribbed to increase rigidity and to provide support for expander , anchor and break shoes.
- It also protects drum and shoe assembly from mud and dust, it absorbs the complete torque reaction of the shoes due to which reason it is also called torque plate.
- Two break shoes are anchored on black plate.
- Friction linings are mounted on break shoes.

- One or two retractor springs are used which serve to keep the break shoes away from the drum when brakes are not applied.
- The break shoes are anchored at one end , whereas on other ends Force F is applied by means of some break actuating mechanism which forces the break shoe against the revolving drum thereby applying the brakes.

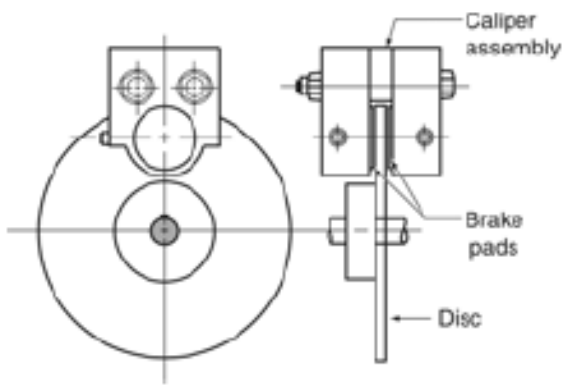
- Types of drum brakes:
- Fixed expander type
- Floating expander type
- Floating anchor type
- Two leading shoe type
- Two trailing shoe type

- Each cylinder contains a rubber sealing ring between the cylinder and the piston.
- When brakes are applied, hydraulically actuated pistons move the friction pads into contact with the disc , applying equal and opposite force.
- On releasing brakes , the rubber sealing rings act as return springs and retract the pistons and the friction pads away from the disc.

Caliper disc brake



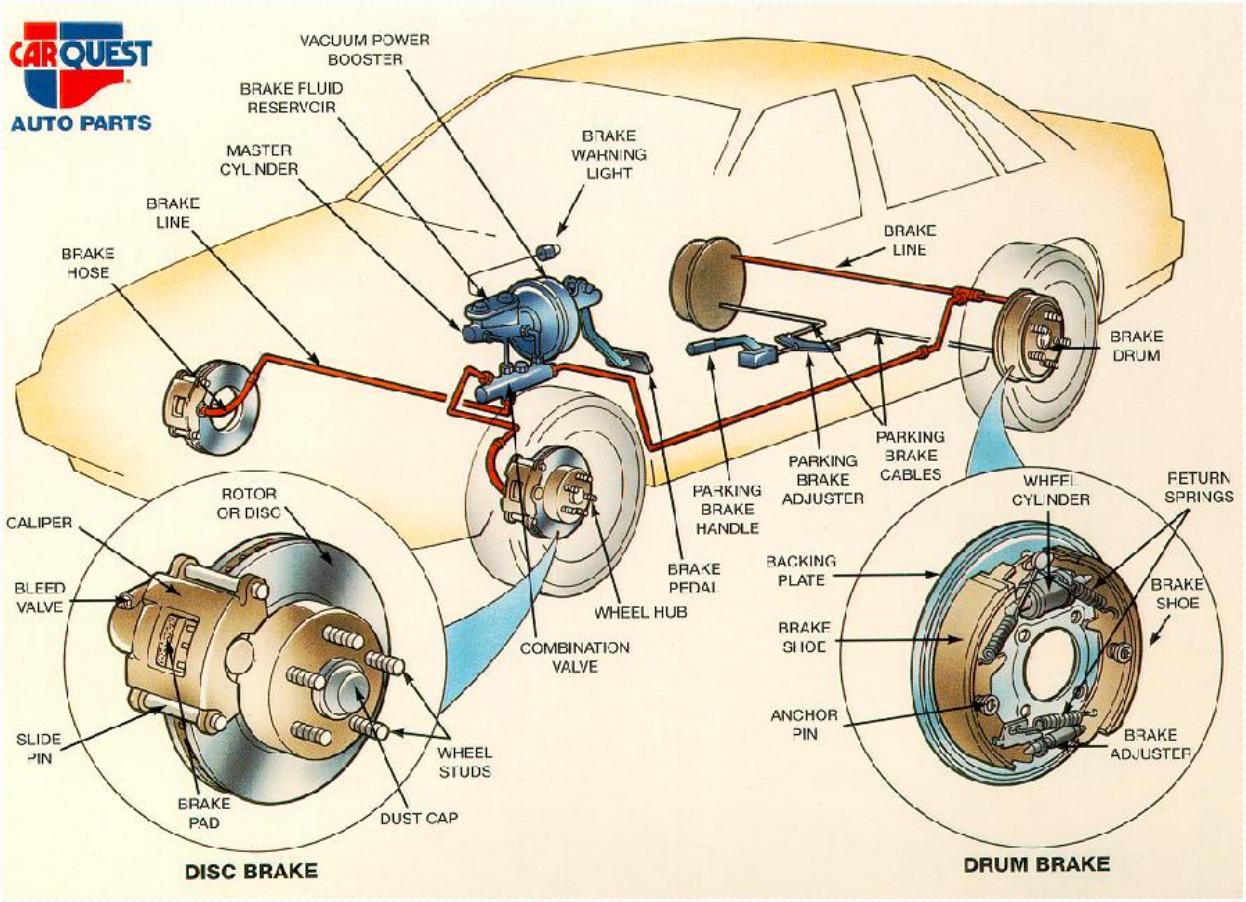
Caliper disc brake



- A disk brake consist of cast iron disc bolted to the wheel hub and stationary housing called caliper.
- The caliper is connected to some stationary part of the vehicle , like the axle casing or the stub axle and is cast in two parts, each part containing a piston.
- In between each piston and the disc , there is a friction pad held in position by retaining pins , spring plates etc.
- Passages are drilled in the calliper for the fluid to enter or leave each housing.

- **Comparison of disc and drum type of brakes:**
- In case of disc brakes friction surfaces are directly exposed to the cooling air whereas in the drum type , the friction occurs on the internal surfaces , from which heat can be dissipated only after it has passed by conduction through the drum.
- The friction pads in case of disc brakes are flat as compared to curved friction linings in case of drum brakes.This means that in disc brakes , there is uniform wear of friction pads.

- Disc brakes weigh less than their conventional drum type counterpart.
- Disc brakes have comparatively better anti-fade characteristics.
- Compared to drum type , the disc brakes are simple in design.
- It is very easy to replace the friction pads when required , compared to drum type where the brake linings have to be either riveted or fixed with adhesive to the brake shoes.

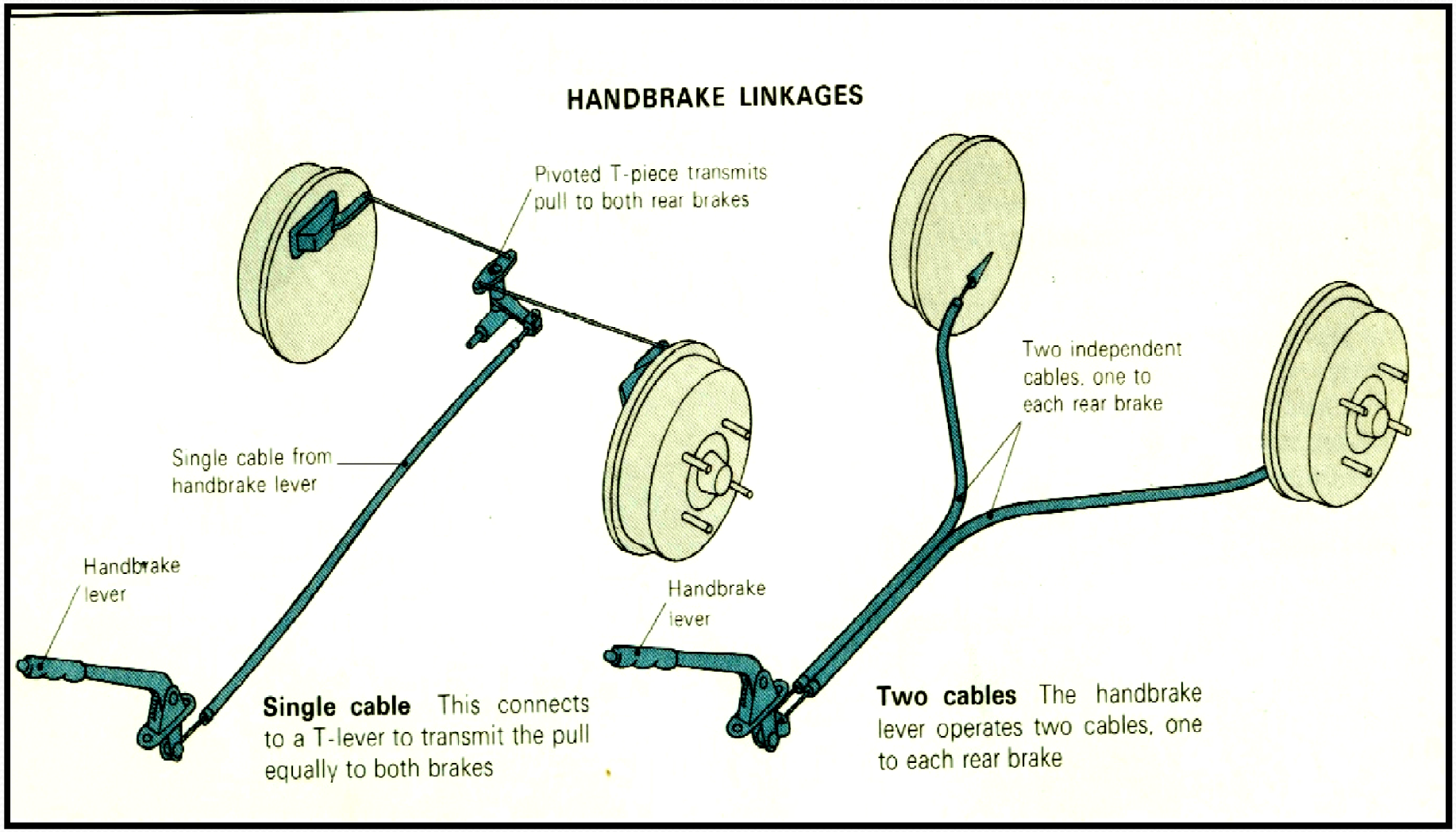

CARQUEST
AUTO PARTS
VACUUM POWER BOOSTER
BRAKE FLUID RESERVOIR
MASTER CYLINDER
BRAKE WARNING LIGHT
BRAKE LINE
BRAKE HOSE
BRAKE LINE
BRAKE DRUM
PARKING BRAKE CABLES
PARKING BRAKE ADJUSTER
PARKING BRAKE HANDLE
BRAKE PEDAL
WHEEL HUB
COMBINATION VALVE
ROTOR OR DISC
CALIPER
BLEED VALVE
SLIDE PIN
BRAKE PAD
WHEEL STUDS
DUST CAP
DISC BRAKE
WHEEL CYLINDER
RETURN SPRINGS
BACKING PLATE
BRAKE SHOE
BRAKE SHOE
ANCHOR PIN
BRAKE ADJUSTER
DRUM BRAKE

Mechanical Brakes

- Mechanical brakes are now obsolete as service brakes. These are still used on rear wheels in many cars as emergency brakes or parking brakes.
- **Brake shoe operation:**
- Brake shoe are operate d by means of cam or toggle lever which itself is actuated through various mechanical linkages.
- Earlier the drum brakes were mostly mechanically operated.
- Girling type mechanism is used to make both shoes leading by mechanical means.

- When the brakes are applied , the force at the expander pushes the arm of upper belt crank lever.
- This transmits its motion through vertical strut to lower bell crank and thus the lower arm of the bell crank tends to move towards the left.
- But as the adjuster mechanism is there it cannot actually move to the left , it gets a reaction and thereby whole of the brake shoe at the lower end moves towards the right , acting as a leading shoe.The other shoe is already leading.
- There is one disadvantage :
- On reverse both the shoes will become trailing , thus reducing the braking effort considerably.

HANDBRAKE LINKAGES

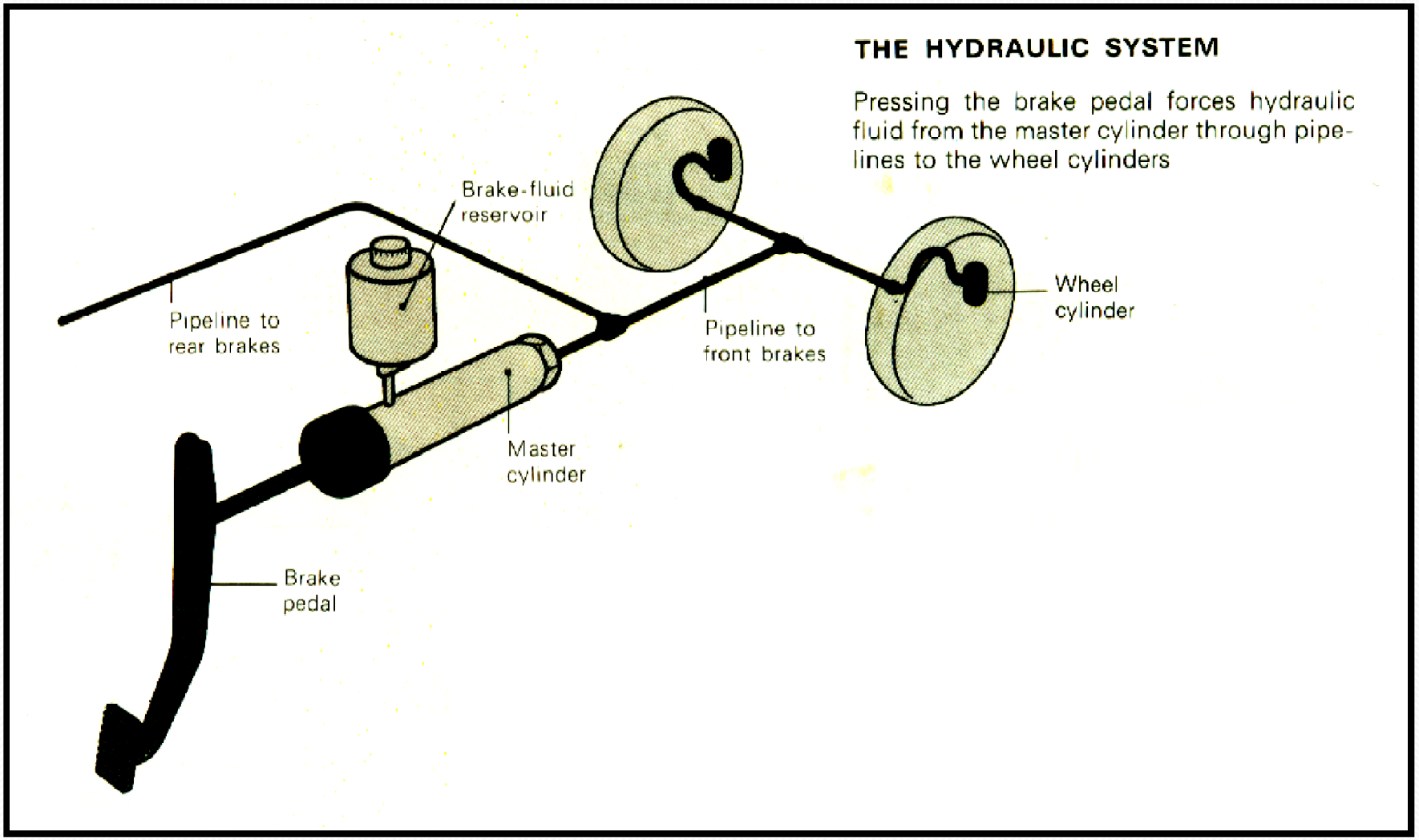


Single cable This connects to a T-lever to transmit the pull equally to both brakes

Two cables The handbrake lever operates two cables, one to each rear brake

Hydraulic brakes

- Most of the cars today use hydraulically operated foot brakes on all the four wheels with and additional hand brake mechanically operated on the rear wheels.
- The main component in this is the master cylinder , which contains reservoir for the brake fluid.
- Master cylinder is operated by the brake pedal and is further connected to the wheel cylinders in each wheel through steel pipe lines , unions and flexible hoses.
- In case of rear wheel there is only one cylinder on each wheels which operates both the shoes.


THE HYDRAULIC SYSTEM
Pressing the brake pedal forces hydraulic fluid from the master cylinder through pipelines to the wheel cylinders
Brake-fluid reservoir
Pipeline to rear brakes
Pipeline to front brakes
Wheel cylinder
Master cylinder
Brake pedal

Advantages of hydraulic system

- The fluid exerts equal pressure everywhere in the circuit. For this reason equal braking effort is obtained at all the four wheels.
- The system is simple in construction due to absence of brake rods , joints etc.
- Less rate of wear.

Disadvantages of hydraulic system

- Even slight leakage of air into the braking system makes it useless.
- This system is suitable only for applying brakes intermittently.
- For parking seperate mechanical linkage has to be provided

The wheels are legs of the vehicle which carry it to far-off distances. *They support the whole weight of the vehicle and convert rotary motion into longitudinal one.*

Essential requirement of wheels

In case of automobiles the *essential requirements of wheels are as follows :*

1. Strong enough to take the weight of the vehicle. torque etc.
2. Flexible to absorb the road shocks.
3. Perfectly balanced statically as well as dynamically.
4. Lightest possible so that the unsprung weight is least.
5. Able to grip the road surface.
6. Mounted or removed easily.

Types of automobile wheels

The automobiles wheels are of the following *three* types :

1. Pressed steel disc wheels.
2. Wire wheels.
3. Light alloy casting wheels.

1. Pressed steel disc wheels :

These wheels are most popular and most of the cars are fitted with this type of wheels. They have the following *merits/advantages* :

(*i*) Simple and robust in construction.

(*ii*) Easy to produce in large numbers at low cost.

(*iii*) Require negligible maintenance.

(*iv*) Ease in cleaning.

Fig. 6.43 shows a pressed steel disc wheel. If consists of a steel rim and a pressed steel disc. The rim is rolled section, sometimes riveted but usually welded to the flange of the disc. The disc performs the function of spokes. The disc is frequently dished to bring the point of ground contact under the large wheel bearing. The wheel assembly is bolted to the brake drum. The disc is often perforated with slots near the rim, which acts as a fan to blow air on the brakes. A hole in the rim serves to accommodate tube valve. A large chrome-plated or stainless steel hub cover can be sprung over the lugs in the disc. It improves the general appearance of wheel and acts as a dust and water excluder as well. This cover can be readily detached by a screw driver.

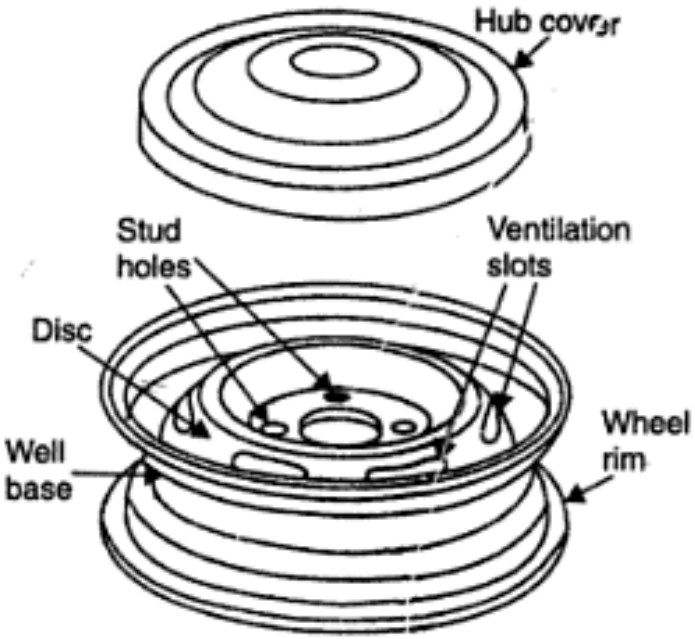


Fig. 6.43. Pressed steel disc wheel.

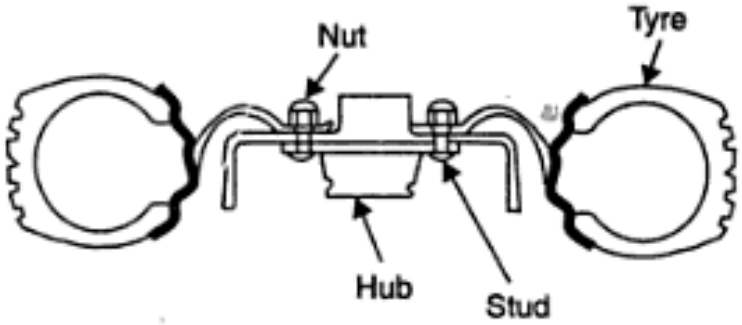


Fig. 6.44. Fitting of the disc wheel to the hub.

2. Wire wheels :

The wire wheel is the earliest type of wheel but presently its *use is limited to certain vintage sports and racing cars.* It is higher, heat dissipation is better and it can be fitted and removed very easily. However, tubeless tyres cannot be fitted over wire wheels which are also difficult to clean.

A wire wheel consists of a separate hub connected to the rim with a number of wires or spokes. The headed inner ends of the spokes fit in the hub holes and the threaded outer ends fit in the rim holes, where mushroom-headed tubular nuts are screwed through the rim holes to tighten the spokes. All the spokes must be of correct length and at correct tension to hold the rim, centrally around the hub. The spokes do not stick straight out as radii from the hub, but alternate spokes are screwed to slope forwards and backwards towards the rim (Fig. 6.45). This arrangement of spokes serves special purpose of the wheel.

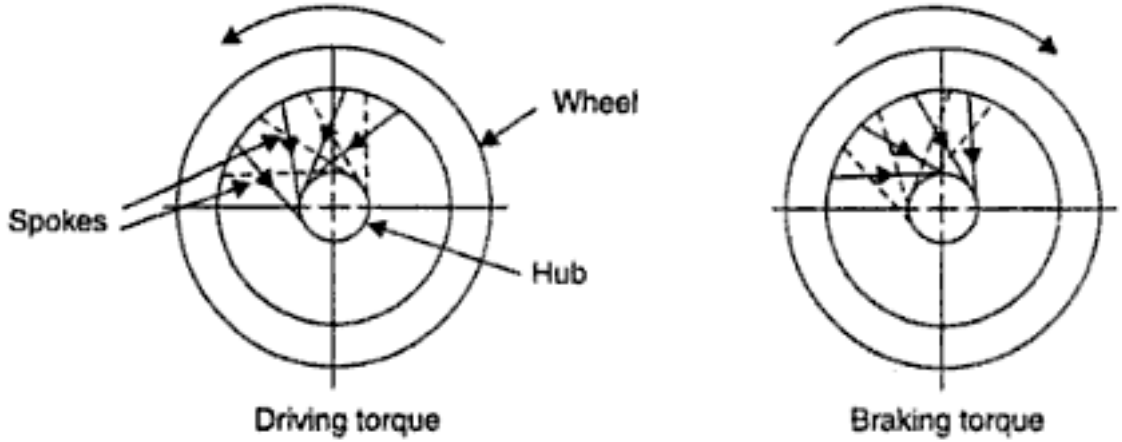


Fig. 6.45. Arrangement of spokes.

3. Light alloy casting wheels :

The light alloy cast or forged wheel is the most recent type, whose use in ever increasing in both road-and sports cars. The use of light alloys (aluminium and magnesium alloys) makes it possible to *use wider rims, which allow low aspect ratio (i.e., wider tyres to be fitted), thus improving good adhesion, especially on corners.*

The advantages and disadvantages of such wheels may be summed up as follows :

Advantages :

(*i*) Light in weight.

(*ii*) Light alloys being good heat conductors dissipate heat produced by tyres and brakes more efficiently than steel.

(*iii*) Heavier sections can be used which improve the wheel stiffness and better stress distribution is obtained.

(*iv*) Rims with larger area can be used which results in the use of wider tyres with less diameter.

Disadvantages :

(*i*) Relatively costly.

(*ii*) More prone to corrosion.

- *Generally aluminium alloys are used for wheels of cars and commercial vehicles, whereas sports and racing cars usually have magnesium alloy wheels. Probably the higher cost is the only main disadvantage of light alloys.*

Tyres

A **tyre** *is a cushion provided with an automobile wheel.* It consists of mainly the outer cover *i.e.*, the tyre proper and the tube inside. The tyre-tube assembly is mounted over the wheel rim. *The air inside the tube carries the entire load and provides the cushion.*

The tyres are final contact points between the road and the vehicle. They take all the load of the vehicle. They are flexible and absorb most of the shocks when a car in moving on rough roads. The surface of the tyre has certain patterns which enable it to grip the road and provide good traction.

Functions of a tyre

A tyre performs the following *functions* :

1. Supports the load of vehicle.
2. Provides cushion against shocks.
3. Transmits driving and braking forces to the road.
4. Provides cornering power for smooth steering.

Requirements of a good tyre

Some important *requirements of a good tyre* are :

1. To be strong enough to carry loads and resist damage.
2. To provide a comfortable ride to the motorists.
3. To provide good road grip for traction, cornering, accelerating and braking.
4. To provide quiet running.
5. To have a long life.
6. To respond accurately to steering without deflection by the ridges on the road.
7. To be flexible to cushion all shocks and impacts at least partly.
8. To be economical.

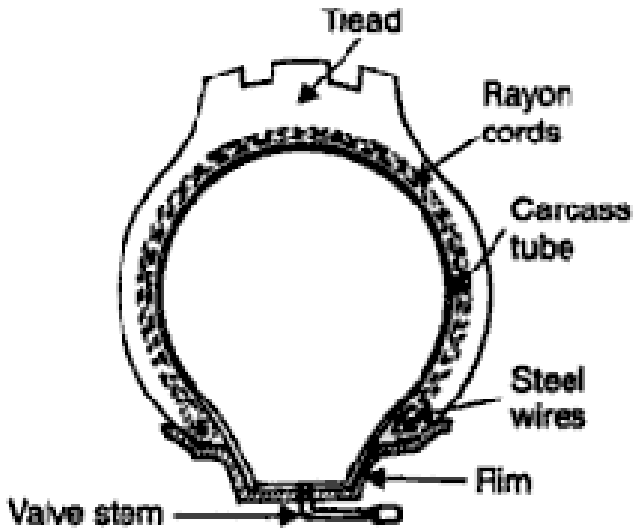
Types of tyres

The pneumatic tyres (the use of solid tyres on automobiles is now obsolete) are of the following two types :

1. Conventional tubed tyre.
2. Tubeless tyre.

1. Conventional tube tyre :

- The outer portion of the tyre which rolls on the road is made of synthetic rubber and is called *"tread"*.
- The tyre encloses a *tube* in which air is forced to a high pressure as a cushioning medium. A valve stem is attached to the tube for inflating or deflating the same.

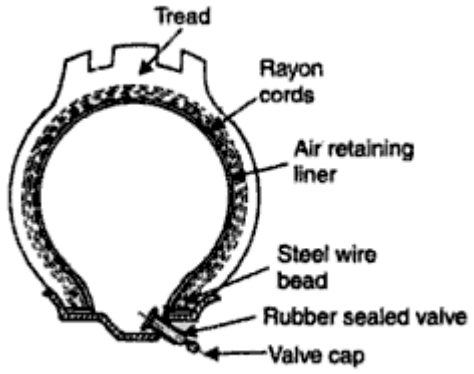


Conventional tube tyre.

- In order to prevent the tyre from being thrown off the rim, the plies (formed from rayon cords) are attached to two rings of high tension steel wire. These rings are made to fit snugly against the wheel rim thereby anchoring the tyre to the rim. These rings are called *"beads"*.

Tubeless tyre :

- A tubeless tyre is shown in Fig. This type of tyre *does not enclose a tube*, instead *the air under pressure is filled in the tyre itself for which purpose a non-return valve is fitted to the rim.*
- The inner construction of the type is almost same as that of the tubed tyre, except that it is lined with a special *air-retaining liner* made up of halogenated butyl rubber (*e.g.*, chlorobutyl or bromobutyl) for better air permeability together with heat and weather resistance.
- A tubeless tyre retains air for a longer period even after being punctured by nail, provided the nail remains in the tyre. Also, any hole in the tubeless tyre can be repaired simply by rubber plugging. Ordinary punctures can be repaired without removing the tyre from the wheel. It can be retreated in the same manner as the tube tyre.



Tubeless tyre.

The tubeless tyre has the following ***advantages*** *over a tubed tyre* :

(*i*) Easier to fit.

(*ii*) Slower leakage of air.

(*iii*) Lesser unsprung weight.

(*iv*) Better cooling.

(*v*) Improved safety.

Causes of tyre wear

Following are the *causes of tyre wear* :

(*i*) Incorrect inflation.
(*ii*) Unequal tyres.
(*iii*) Bleeding of air in tyre.
(*iv*) Incorrect rotation of tyres.
(*v*) Misalignment.
(*vi*) Out of balance wheel.
(*vii*) Worn steering mechanism.
(*viii*) Incorrect castor, camber, or toe in.
(*ix*) Excessive braking or violet acceleration.
(*x*) Wrong loading.
(*xi*) Careless driving.
(*xii*) Toe-out incorrect on turn.
(*xiii*) Defective brakes.
(*xiv*) Overloading.
(*xv*) Worn kingpins.

Wheel balance

The balance of a tyred wheel is essentially required *to avoid front wheel wobble which affects steering and increases tyre wear rates.*

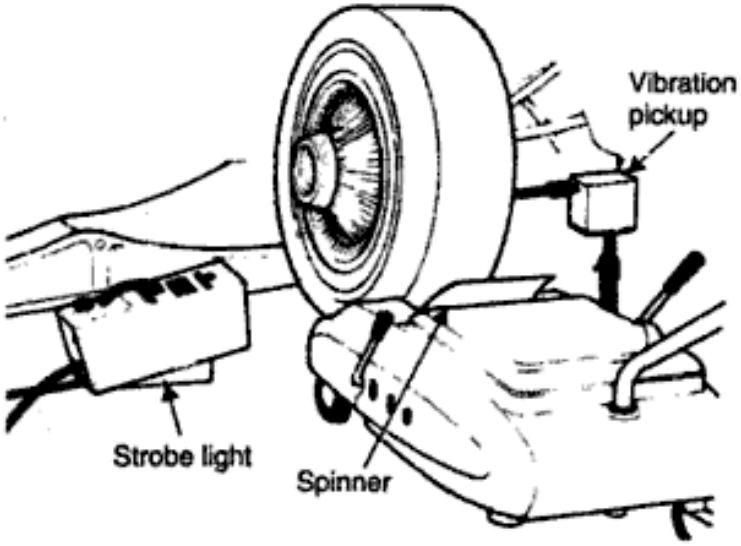
The wheel may be checked for balance on or off the car. This is done by either of two methods : "*Static*" or "*Dynamic*".

In ***static balancing***, the wheel is taken off the car and put on a "*bubble*" balancer to detect any imbalance. A wheel that is out of balance is heavier in section. This will cause the bubble in the centre of the balancer to move off centre. To balance the wheel, *weights are added to the wheel rim until the bubble returns to centre.*

To ***dynamic-balance*** (or "*spin balance*") a wheel, the wheel is spun either on or off the car. Fig. 6.55 shows an electronic wheel balancer being used to balance a wheel on a car. Lack of balance shows up as a tendency for the wheel to move off centre or out of line as it spins.

A magnet is attached to the brake backing plate. Any movement of the magnet is sensed through a short arm by a vibration pickup. This causes the strobe light to flash indicating where to attach a wheel weight.

If the wheel is out of balance, one or more weights are installed on the wheel rim.



Dynamic wheel balancer (Electronic type).